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SWEDRES | SVARM

Sales of antibiotics and occurrence of antibiotic resistance in Sweden

Folkhälsomyndigheten
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SVA SWEDISH VETERINARY AGENCY

A report on Swedish Antibiotic Sales and Resistance in Human Medicine (Swedres) and Swedish Veterinary Antibiotic Resistance Monitoring (Svarm)

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Public Health Agency of Sweden and Swedish Veterinary Agency

Editors:

Olov Aspevall, Ragda Obeid and Jennifer Jagdmann
Public Health Agency of Sweden
Oskar Nilsson and Märit Pringle,
Swedish Veterinary Agency

Addresses:

Public Health Agency of Sweden
Solna. SE-171 82 Solna, Sweden
Östersund. Box 505, SE-831 26 Östersund, Sweden
Phone: +46 (0) 10 205 20 00
Fax: +46 (0) 8 32 83 30
E-mail: info@folkhalsomyndigheten.se
www.folkhalsomyndigheten.se

Swedish Veterinary Agency
SE-751 89 Uppsala, Sweden
Phone: +46 (0) 18 67 40 00
E-mail: svarm@sva.se
www.sva.se

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Preface

The Swedres-Svarm report on antibiotic resistance and antibiotic sales in human and veterinary medicine has been published jointly by the two sectors for more than two decades. In the report, data from humans, animals and food is analysed and presented to give a comprehensive overview of the current situation, as well as trends over time. Presenting data regarding both resistance and consumption in both human and veterinary medicine in a comprehensive manner will continue to be the goal of Swedres-Svarm. However, this year will be the last chance to get a printed report as we are planning to present data in a new format online. This will be gradually developed and aimed at being a useful source of One Health data on both antimicrobial use and resistance. A further ambition for this site will be to use it in international contacts to inform on Swedish work regarding antimicrobial resistance.

Last year, several important steps were taken in Swedish work against antimicrobial resistance. A joint country visit by the European Centre for Disease Prevention and Control and the European Commission's Directorate General for Health and Food Safety reported several areas to develop further, including surveillance of healthcare-associated infections, monitoring compliance to infection prevention and control routines and improved availability of data on antimicrobial resistance. When it comes to the veterinary sector, the country visit gave valuable input as well, especially regarding monitoring of antibiotic resistance among animal pathogens where developments are being made in Europe. For Sweden, ensuring a higher number of isolates and national representativeness of the samples are of top priority.

In addition, national evaluations of Swedish work against antimicrobial resistance were undertaken. All these reports will be used in a revision of the Swedish strategy against antimicrobial resistance.

Furthermore, a new version of Svebar 2, Sweden's automated system for collection of all results from bacteriological cultures in humans, was recently released. This will greatly improve availability of data for all participating laboratories, and also be a prerequisite for a planned visualisation and other uses of data. Unfortunately, confidentiality issues continue to block the reporting of important data on antimicrobial sales in Sweden. Efforts to resolve these issues are ongoing. In addition, the quality of data collected on the on-farm consumption of antibiotics in food-producing animals is improving and will be of great value to the work for good animal health and against antibiotic resistance. In the near future, data collection on antibiotic use will be expanded to include additional animal species, making the data even more valuable.

Increased emphasis on international and regional collaboration is crucial in light of recent disruptions in global health funding that have had a negative impact on all sectors concerned with One Health. In line with the Swedish strategy to combat antibiotic resistance, international work on antimicrobial resistance will remain a high priority for Sweden, especially with regards to surveillance.

In January last year, an important European One Health joint action started: EU-JAMRAI 2, the second edition of the European Joint Action on Antimicrobial Resistance and Healthcare-Associated Infections, which will run until end of 2027. Sweden is co-lead of two work packages, WP8 One Health Surveillance and WP9 Access to antibiotics and diagnostics.

As always, the work against antimicrobial resistance will continue with advances both in the methods and tools used, and the ways we use surveillance data to inform our decisions.

Solna and Uppsala, June 2025

Jan Cedervärn

Acting Director General
Swedish Veterinary Agency

Olivia Wigzell

Director General
Public Health Agency of Sweden

Contributors and participants

Editors

Olov Aspevall, Ragda Obeid and Jennifer Jagdmann,
Public Health Agency of Sweden
Oskar Nilsson and Märit Pringle,
Swedish Veterinary Agency

Project Manager

Oskar Nilsson, Swedish Veterinary Agency

Authors Swedres

Public Health Agency of Sweden
Barbro Mäkitalo, Caroline Kaipe, Eva Morfeldt, Hanna Billström, Jessica Darenberg, Jennifer Jagdmann, Jerker Jonsson, Nadja Karamehmedovic, Nasanin Hashemi, Olov Aspevall, Ragda Obeid, Saga Alvring, Thomas Åkerlund, Tomas Söderblom, Vilhelm Müller, Gunilla Skoog Ståhlgren and Kerstin Stewart

National Reference Laboratory for Sexually Transmitted Infections & National Reference Laboratory for *Neisseria meningitidis*
Magnus Unemo and Susanne Jacobsson

Department of Clinical Microbiology, Karolinska University Hospital
Karin Haij Bhattarai

Clinical microbiology and infection control, Region Skåne Office for Medical Services
Ylva Lindroth

Authors Svarm

Swedish Veterinary Agency
Anna Bergström, Anna Bonnevie, Anna Werinder, Annette Backhans, Christina Greko, Annica Landén, Mattias Myrenås, Oskar Nilsson and Märit Pringle

Swedish Food Agency
Jakob Ottoson

Other contributors in Svarm

Swedish Veterinary Agency
Ayda Shams, Boel Harbom, Charlotta Fasth, Elisabeth Bagge, Paulina Hysing and Thorbjorg Einarsdottir

Farm & Animal Health
Frida Matti

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Content

Sammanfattning/Summary

Sammanfattning

Under lång tid har Sverige haft en gynnsam situation jämfört med många andra länder när det gäller antibiotikaresistens hos bakterier från människor. Det läget kvarstår fortfarande. En av anledningarna är att vi har effektiva strategier för att främja en ansvarsfull användning av antibiotika och begränsa spridningen av antibiotikaresistens.

Trots det goda läget finns det problem med kontinuerligt ökande antibiotikaresistens och smittspridning inom sjukvården. Viktiga exempel är de återkommande utbrotten av vankomycinresistenta enterokocker på sjukhus och ett ökande antal vårdrelaterade kluster av ESBL-CARBA. Detta poängterar vikten av ett kontinuerligt arbete inom Strama, vårdhygien och smittskydd för att förebygga infektioner och ökande antibiotikaresistens.

Antibiotikaförsäljningen inom humanmedicinen i Sverige minskade kraftigt under pandemin men började öka under 2022 och fortsatte att öka under 2023. Under 2024 har ökningen bromsat och försäljningen är väsentligt oförändrad jämfört med året innan. Försäljningen ligger fortfarande under prepandemiska nivåer. Antibiotikaförsäljningen har minskat generellt sedan peaken i 1992. Störst minskning under denna period observerades hos barn i åldrarna 0–4 år.

Inom veterinärmedicinen har antibiotikaförsäljningen minskat kraftigt sedan mitten av åttiotalet för att de senare åren ha stabiliserats på en jämförelsevis låg nivå.

Vidare har förekomsten av resistens bland bakterier från djur generellt sett varit stabilt låg. För vissa substanser och bakterier har förekomsten över tid till och med minskat. Ett sådant exempel är ESBL-bildande Escherichia coli hos slaktkyckling. Det finns dock undantag, exempelvis har förekomsten av resistens mot ampicillin, sulfonamider och trimetoprim ökat hos slumpmässigt utvalda E. coli hos såväl slaktkyckling som slaktgris.

Viktiga fynd 2024

- Den totala antibiotikaförsäljningen inom humanmedicinen i Sverige är på en liknande nivå 2024 som året innan med en ökning på 0,2 procent jämfört med 2023.
- Försäljningen av antibiotika inom tandvården minskade med 1,0 procent under samma period.
- Antibiotikaförsäljningen inom öppenvården ligger på ungefär samma nivå som året innan och försäljningen av antibiotika på rekvisition till vårdinrättningar minskade under samma period.
- Sedan 2020 används resistens mot cefotaxim hos Escherichia coli och andelen meticillinresistenta Staphylococcus aureus (MRSA) isolerade från blod som indikatorer på antibiotikaresistens i Sverige. Både andelen MRSA och andelen E. coli som är resistenta mot cefotaxim har långsamt ökat under en tioårsperiod till nuvarande 2,6 respektive 9,2 procent. Dessa indikatorer är relaterade till Sveriges mål i EU:s rådsrekommendationer som sträcker sig fram till 2030. Målen är att minska förekomsten av MRSA i blod med 3 procent och ESBL-producerande E. coli i blod med 10 procent, jämfört med referensåret 2019. Då man ser på hittills använda indikatorer i Sverige är båda högt ställda målsättningar.
- Antalet rapporterade fall av anmälningspliktig antibiotikaresistens ökar utom för pneumokocker med nedsatt känslighet för penicillin (PNSP). För ESBL-CARBA, anmäldes 410 fall, mot 314 år 2023 varav femtiosju kluster eller parvis relaterade fall identifierades under 2024 (2–9 fall per kluster). För 27 av de 57 klustren, fanns ett eller flera fall rapporterat som vårdrelaterad smitta i Sverige 2024.
- För vankomycinresistenta enterokocker förekom åtta större (10–37 fall) och tjugotvå mindre (2–8 fall) sjukhusrelaterade smittspridningar under 2024.
- Försäljningen av antibiotika för användning till djur är stabilt låg och domineras av penicillin med smalt spektrum.
- Under året isolerades MRSA från gris och sporadiskt från djurslagen hund, häst och katt.
- ESBL-bildande E. coli är generellt sett ovanliga hos både lantbrukets djur och sällskapsdjur samt på kött.
- Bakterier som bildar ESBL-CARBA har inte bekräftats hos tamdjur i Sverige.

Försäljning av antibiotika

Antibiotikaförsäljning inom humanmedicin

Den totala mängden antibiotika som såldes i Sverige ökade med 0,2 procent under 2024 och ligger nu på 11,0 DDD per 1 000 invånare och dag som är ungefär samma som året innan. I detta innefattas all antibiotikaförsäljning inom humanmedicin. Det inkluderar all antibiotika som sålts på recept till individer och på rekvisition till olika vårdinrättningar.

Öppenvård

Antalet antibiotikarecept som hämtades ut på apotek under året låg på 271 recept per 1 000 invånare, en ökning med 0,3 procent jämfört med 2023. Bland landets 21 regioner uppnådde 3 regioner det nationella målet på högst 250 recept per 1 000 invånare. Försäljningen minskade i åldersgrupperna 0–4 år och 5–14 år, mest i gruppen barn i åldern 0–4 år där den minskade med 13,5 procent jämfört med året innan. Övriga grupper ökade och mest i gruppen 15–64 år med 1,9 procent jämfört med året innan.

Försäljningen av antibiotika på recept inom tandvården minskade med 1,0 procent under 2024 jämfört med året innan, och utgör 7,0 procent av alla uthämtade antibiotikarecept under året. Sedan år 2007 har antibiotikaförsäljningen inom tandvården minskat med nästan hälften.

Sjukhus och andra vårdformer

Den totala försäljningen av antibiotika på rekvisition till vårdinrättningar minskade under 2024 med 3,9 procent jämfört med 2023. Försäljningen minskade i 20 av 21 regioner under samma period. Liksom tidigare år fanns stora regionala variationer i försäljningen av antibiotika på rekvistion.

Antibiotikaförsäljning inom veterinärmedicin

Försäljningen av antibiotika för djur från apotek i Sverige uppgick 2024 till 9 088 kilogram. Sedan 2015 har försäljningen av alla antibiotikaklasser utom aminoglykosider minskat eller förblivit stabil. Jämfört med tidigare år ökade försäljningen av aminoglykosider påtagligt 2022 och 2023, följt av en svag nedgång 2024. Ökningen förklaras av ökad användning av aminoglykosider för behandling av avvänjningsdiarré hos gris som en följd av tillbakadragandet under 2022 av veterinärmedicinska läkemedel med hög halt av zinkoxid.

Av den totala användningen 2024 var cirka 58 procent penicillin med smalt spektrum. Försäljningen av antibiotika som bör användas särskilt restriktivt (fluorokinoloner, tredje generationens cefalosporiner och polymyxin) har minskat väsentligt sedan 2015. Under samma tioårsperiod har andelen produkter för behandling av enstaka djur varit omkring eller över 90 procent av den totala försäljningen.

Den totala försäljningen av antibiotika för djur har minskat med över två tredjedelar sedan 1986, när användningen av tillväxtbefrämjande antibiotika upphörde. Detta är korrigerat för att antalet djur av olika arter har förändrats genom åren. Under 90-talet minskade användningen av antibiotika som läkemedel till hela djurgrupper, och under det senaste decenniet ses också en minskad användning av antibiotika för behandling av enstaka djur.

Jämförelse av försäljning inom human- och veterinärmedicin

Under 2024 såldes 63,5 ton antibiotika för behandling av människor och 9,0 ton för behandling av djur (inkluderar inte produkter för intramammärt eller intrauterint bruk). Uttryckt i relation till kroppsvikt (milligram aktiv substans per skattad kilogram biomassa) var försäljningen 96,4 milligram per kilogram för människor och 11,9 milligram per kilogram för djur.

Anmälningspliktig resistens

ESBL-bildande Enterobacterales, människa

ESBL-bildande Enterobacterales hos människor har varit anmälningspliktigt sedan 2007. Det är den vanligaste av de anmälningspliktiga resistenstyperna.

Resultat 2024, Enterobacterales med ESBL

- Antal rapporterade fall: 12 527 (föregående år 10 895), relativ förändring: 15 procent ökning.
- Antal fall med blodförgiftning: 1 055 (föregående år 897).
- Som tidigare år var E. coli den vanligaste arten, 83 procent, följt av Klebsiella pneumoniae, 12 procent.
- Andelen E. coli från blododling som är resistenta mot tredje generationens cefalosporiner var 9,2 procent.

Resultat 2024, Enterobacterales med ESBL-CARBA

- Antal rapporterade fall: 410 (föregående år 314), relativ förändring: 31 procent ökning.
- Antal fall med blodförgiftning: 22 (föregående år 21).
- E. coli var den vanligaste arten, 67 procent, följt av K. pneumoniae, 33 procent.
- Antalet E. coli från blododling som är resistenta mot meropenem var 5 av 10 499, jämfört med 3 av 10 719 under 2023.
- Femtiosju kluster, med mellan två och nio fall vardera, har identifierats med helgenomsekvensering. Bland de 57 klustren ingår även 33 kluster som haft ett eller flera fall innan 2024. För 27 av klustren, fanns ett eller flera fall rapporterat som vårdrelaterad smitta i Sverige 2024, jämfört med 16 under 2023.
- För första gången i Sverige påvisades ESBL-CARBA-producerande Salmonella. Det rörde sig om en Salmonella Agona som bar på en IMP-gen.

ESBL-bildande Enterobacterales, djur

Bakterier som bildar ESBL är inte anmälningspliktiga vid fynd hos djur. Sådana bakterier är generellt sett ovanliga hos djur i Sverige. Tidigare var förekomsten hos slaktkyckling hög men den har minskat under senare år. Under 2024 undersöktes förekomsten av ESBL-bildande E. coli i tarmprov från slaktkyckling, kalkon och nötkreatur under ett år samt från köttprov från kyckling och kalkon med selektiva metoder.

Sådana bakterier hittades i 3 procent av tarmproven från slaktkyckling och 4 procent av köttproven av kycklingkött men inte i några av proven av tarmproven från kalkon eller nötkreatur eller köttprov från kalkon.

Bakterier som bildar ESBL-CARBA har inte bekräftats hos tamdjur i Sverige.

Staphylococcus aureus resistenta mot meticillin (MRSA), människa

Samhällsförvärvad smitta är sedan länge den vanligaste typen hos människor smittade med MRSA i Sverige, med hälften av fallen. Familje-/hushållssmitta och samhällsförvärvad smitta utgjorde 25 procent respektive 21 procent av fallen.

Resultat 2024

- Antal rapporterade fall: 3 937 (föregående år 3 547), relativ förändring: 11 procent ökning.
- Antal fall med blodförgiftning: 123 (föregående år 103).
- Andelen MRSA bland S. aureus från blododling har ökat till 2,6 procent, från 2,1 procent 2023.

Staphylococcus aureus resistenta mot meticillin (MRSA), djur

Under året isolerades MRSA från gris och sporadiskt från djurslagen hund, häst och katt. Förekomsten hos gris är otillräckligt undersökt men en baslinjestudie med provtagning på slakteri genomförs under 2025. Hos hund och katt var antalet MRSA-fall 6 respektive 8. De typer som dominerar hos dessa är samma som hittas hos människor, vilket tyder på att människor är smittkällan. Hos häst var antalet MRSA-fall 14 vilket är lägre än åren 2020–21 (27 respektive 23 fall), då det förekom utbrott av MRSA på hästsjukhus.

Staphylococcus pseudintermedius resistenta mot meticillin (MRSP), djur

Under 2024 var antalet anmälda fall av meticillinresistenta Staphylococcus pseudintermedius (MRSP) hos djur på ungefär samma nivå som de senaste åren. Totalt anmäldes 57 fall av MRSP till Jordbruksverket, varav 49 fall från hund samt sju från katt och ett från häst. Samtliga isolat utom två fanns tillgängliga för vidare undersökning. De första åren efter att MRSP hade hittats hos djur i Sverige var i princip alla fall av en viss sekvenstyp (ST71). På senare år förekommer fler olika sekvenstyper, (29 olika 2024) varav ST551 är den vanligaste.

MRSP är inte anmälningspliktig vid förekomst hos människor.

Streptococcus pneumoniae med nedsatt känslighet för penicillin (PNSP), människa

Resultat 2024

- Antal rapporterade fall: 148 (föregående år 152), relativ förändring: 3 procent minskning.
- Antal fall med blodförgiftning: 12 (föregående år 7).
- Andelen S. pneumoniae med nedsatt känslighet för penicillin (PNSP) från blododling har minskat till 5,5 procent, från 5,8 procent 2023.

Enterococcus faecium och Enterococcus faecalis resistenta mot vankomycin (VRE), människa

Resultat 2024

- Antal rapporterade fall: 390 (föregående år 260), relativ förändring: 50 procent ökning.
- Antalet fall av VRE varierar kraftigt mellan år beroende på hur många och hur stora smittspridningar som förekommit på sjukhus.
- Antal rapporterade fall av E. faecium med vankomycinresistens: 372 (föregående år 250), relativ förändring: 49 procent ökning.
- Antal rapporterade fall av E. faecalis med vankomycinresistens: 18 (föregående år 10).
- Sju fall av VRE rapporterades med både E. faecium och E. faecalis.
- Antal fall med blodförgiftning: 6 (föregående år 5).
- Trettio smittspridningar rapporterades under året med 2–37 fall. Av dessa var åtta större sjukhusrelaterade utbrott med 10–37 fall vardera. År 2023 rapporterades sjutton sjukhusrelaterade smittspridningar.
- Andelen VRE hos enterokocker från blododling är låg, 1,1 procent för E. faecium och 0,1 procent för E. faecalis.

Resistens hos zoonotiska bakterier

Salmonella är ovanligt hos djur i Sverige och isolerade stammar är oftast känsliga för antibiotika. Resistens mot fluorokinoloner är ovanlig. Bland 101 isolat från djur 2024 var 83 procent känsliga för alla testade antibiotika. För salmonellaarter var resistensen bland faeces- och urinisolat från människor högst mot fluorokinoloner, 21 procent. Ingen resistens mot karbapenemer rapporterades bland Salmonella från djur. Salmonella från invasiva infektioner hos människor är mer resistenta än isolat från djur i Sverige. Detta beror troligen på att en stor andel av fallen hos människor är smittade utomlands eller via importerade livsmedel. För första gången i Sverige påvisades ESBL-CARBA-producerande Salmonella hos människa. Det rörde sig om en Salmonella Agona som bar på en IMP-gen.

Campylobacter från djur i Sverige är oftast känsliga för relevanta antibiotika och exempelvis är resistens mot erytromycin mycket ovanligt. Hos Campylobacter jejuni från människor var resistensen mot ciprofloxacin 47 procent och mot tetracyklin 29 procent 2024. Resistensen mot erytromycin var 2,2 procent.

Vanligtvis behandlas inte infektioner som orsakas av salmonella eller campylobacter med antibiotika, hos vare sig människor eller djur. Hos människor resistensbestäms därför endast en liten andel av isolaten, varav de flesta gäller allvarliga infektioner.

Resistens hos kliniska isolat från människor

Alla data för dessa sammanställningar samlas in automatiserat via det nationella övervakningssystemet Svebar, ett samarbete mellan de kliniska mikrobiologiska laboratorierna och Folkhälsomyndigheten.

- Escherichia coli: Resistens hos blodisolat mot ceftazidim och cefotaxim var 8,0 respektive 9,2 procent. Antalet anmälningar av E. coli ESBL från blod 2024 var 842. Resistens mot ciprofloxacin är nu 15,6 respektive 11 procent hos isolat från blod respektive urin, ett observandum vid val av empirisk behandling av febril urinvägsinfektion.
- Vid ålders- och könsfördelning av resultat för E. coli från urin ses vissa skillnader mellan grupperna. Speciellt tydligt är den höga ciprofloxacinresistensen (17–20 procent) hos män, 20 år och äldre.
- Klebsiella pneumoniae: Resistens hos blodisolat mot cefotaxim och ceftazidim var 8,8 respektive 9,3 procent. Antalet anmälningar av K. pneumoniae ESBL från blod 2024 var 180. Liksom för E. coli är resistensen mot ciprofloxacin nu relativt hög, 14 respektive 11 procent hos isolat från blod och urin.
- Staphylococcus aureus: Resistens mot cefoxitin (som indikerar MRSA) hos isolat från blod och prover från hud- och mjukdelar var 2,6 respektive 2,7 procent. Antalet anmälningar av MRSA från blod 2024 var 123.
- Enterococcus faecalis och Enterococcus faecium: Vankomycinresistensen hos isolat från blod är fortsatt låg (0,1 respektive 1,1 procent) och höggradig aminoglykosidresistens är fortfarande på en lägre nivå jämfört med 2017.
- Clostridioides difficile: Incidensen har legat relativt stabilt sedan 2018 och ligger nu på 59 fall per 100 000 invånare och år. Antibiotikaresistens har inte undersökts 2024.

Resistens hos kliniska isolat från djur

Bakterier som orsakar sjukdom hos djur är fortfarande oftast känsliga för de antibiotika som vanligen används. Till exempel är bakterier som orsakar luftvägsinfektioner hos lantbrukets djur och hästar generellt känsliga för bensylpenicillin men resistens förekommer exempelvis hos Pasteurella multo-

cida och Mannheimia haemolytica från kalv. Penicillinresistens är däremot vanligt hos Staphylococcus pseudintermedius från hundar och förekommer hos S. aureus från hästar samt S. felis från katter, men är ovanligt hos S. schleiferi från hundar. Resistens hos E. coli från olika djurslag förekommer också och är vanligast hos isolat från träckprover från unga grisar. Resistensundersökning är motiverat för val av lämpligt antibiotikum vid behandling, särskilt för E. coli och Brachyspira spp.

Indikatorbakterier från friska djur

Resistens hos E. coli i tarmfloran hos friska djur kan användas som indikator för utbredningen av antibiotikaresistens hos bakteriefloran i en djurpopulation och indirekt som indikator på omfattningen av antibiotikaanvändning till djuren. I Sverige är förekomsten av resistens hos dessa indikatorbakterier låg hos de flesta undersökta djurslagen och situationen är gynnsam ur ett internationellt perspektiv. Till exempel var 79 respektive 73 procent av E. coli från friska slaktkycklingar och slaktgrisar i de senast gjorda undersökningarna känsliga för alla testade substanser.

Summary

For a long time, Sweden has had a favourable situation compared to many other countries regarding antibiotic resistance in bacteria from humans. This continues to be true. One contributing factor is our effective strategies to promote the responsible use of antibiotics and limit the spread of antibiotic resistance.

Despite the favourable situation, continuously increasing antibiotic resistance and the spread of resistant bacteria in healthcare is concerning. Important examples are the recurrent outbreaks of vancomycin-resistant enterococci in hospitals and an increasing number of healthcare-associated clusters of $ESBL_{CARBA}$. This emphasises the importance of continuous work with antibiotic stewardship and infection prevention and control, in healthcare as well as in the community, to prevent increasing antibiotic resistance.

Antibiotic sales in human medicine in Sweden decreased sharply during the pandemic, but began to increase in 2022 and continued in 2023. In 2024, the increase has slowed and sales are essentially unchanged compared to the previous year. The sales remain below pre-pandemic levels. Antibiotic sales have generally decreased since the peak in 1992. The greatest decrease during this period was observed in children aged 0-4 years.

In veterinary medicine, sales of antibiotics have decreased markedly since the mid-1980s, and in recent years sales seem to have stabilised at a comparatively low level. The occurrence of resistance among bacteria from animals has generally been stable at low or moderate levels. For some substances and in some bacteria, the occurrence of resistance is even declining. One example of this is a significant decline in the occurrence of ESBL-producing *Escherichia coli* among broilers. There are, however, exceptions. For example, resistance to ampicillin, sulphonamides and trimethoprim has increased in indicator *E. coli* from both broilers and pigs.

Key findings 2024

- Total sales of antibiotics for humans in Sweden are at almost the same level in 2024 as the previous year, with an increase of 0.2% in 2024 compared to 2023.
- Antibiotic sales in dentistry decreased by 1.0% during the same period.
- Antibiotic sales in outpatient care are at approximately the same level as the previous year and antibiotic sales in inpatient care decreased during the same period.
- Since 2020, the proportions of cefotaxime-resistant *Escherichia coli* and methicillin-resistant *Staphylococcus aureus* (MRSA) in blood isolates have been used as indicators of antibiotic resistance in Sweden. Both the proportion of MRSA and cefotaxime-resistant *E. coli* in blood isolates have gradually increased over the last decade, reaching 2.6% and 9.2%, respectively. These indicators are related to the EU Council recommendation's targets for Sweden for 2030. Sweden's targets, as described in the Council recommendation, include a 3% reduction of the incidence of MRSA sepsis

and a 10% reduction for the incidence of *E. coli* ESBL sepsis, compared to 2019. Considering the observed trend for the indicators used since 2020, these are ambitious targets.

- The number of cases of notifiable antibiotic resistance increased, except for pneumococci with decreased susceptibility to penicillin. For $ESBL_{CARBA}$, 410 cases were reported, compared to 314 in 2023. Fifty-seven clusters, with between two and nine cases each, have been identified by whole-genome sequencing in 2024. For 27 of the 57 clusters, at least one of the cases is reported as healthcare-related and occurring in Sweden.
- Thirty hospital outbreaks of vancomycin-resistant enterococci were reported in 2024. Of these, eight were larger (10-37 cases) and twenty-two smaller (2-8 cases).
- Sales of antibiotics for animals are stable at a low level and are dominated by narrow-spectrum penicillin.
- MRSA was isolated from pigs and sporadically from dogs, horses and cats during 2024.
- ESBL-producing *E. coli* is generally uncommon among farm and companion animals as well as meat.
- $ESBL_{CARBA}$-producing bacteria have not been confirmed in domestic animals in Sweden.

Sales of antibiotics

Sales of antibiotics for humans

The total sales of antibiotics for humans in Sweden increased by 0.2% in 2024 and was estimated at 11.0 DDD per 1 000 inhabitants per day. This figure encompasses all antibiotics sold within human medicine. This includes all antibiotics sold on prescription to individuals and all antibiotics sold to hospitals and other health- and social care facilities.

Outpatient care

In 2024, 271 prescriptions per 1 000 inhabitants were dispensed at pharmacies in Sweden, an increase of 0.3% compared to 2023. Of the 21 regions in Sweden, three regions achieved the national long-term target of 250 or fewer prescriptions per 1 000 inhabitants and year. Sales decreased in the age groups 0-4 years and 5-14 years. The largest decrease was in the group of children aged 0-4 years where prescriptions decreased by 13.5% compared to the previous year. Prescriptions in other age groups increased, most in the group 15-64 years with a 1.9% increase compared to the previous year.

The sales of antibiotics in dentistry decreased by 1.0% in 2024, and accounted for 7.0% of all outpatient antibiotic prescriptions during the year. Since 2007, the prescription of antibiotics by dentists has decreased by nearly half.

Hospitals and other health- and social care facilities

In 2024, the sales of antibiotics on requisition, including all antibiotics sold to hospitals and other health- and social care facilities, decreased by 3.9% compared to 2023. Sales decreased in 20 of 21 regions during the same period. As in previous years, there were large regional variations in the sale of antibiotics on requisition.

Sales of antibiotics for animals

In 2024, reported sales of antibiotics for animals from pharmacies in Sweden were 9 088 kg. Since 2015, sales of all classes of antibiotics, except aminoglycosides, have decreased or remained stable. Compared to earlier years, sales of aminoglycosides increased notably in 2022 and 2023, followed by a modest decrease in 2024. This is explained by an increased use of aminoglycosides for treatment of post-weaning diarrhoea in pigs following the withdrawal of veterinary medicinal products with high levels of zinc oxide in 2022.

Of the total sales in 2024, around 58% were narrow-spectrum penicillins. Sales of antibiotics subject to special restrictions (fluoroquinolones, third generation cephalosporins and polymyxins) have decreased considerably since 2015. During the same decade, the proportion of products for the treatment of individual animals has been around or over 90% of the total sales.

Since the withdrawal of growth-promoting antibiotics from the Swedish market in 1986, the total sales of antibiotics corrected for population sizes over time have decreased by more than two thirds. During the 1990s, sales of veterinary products for medication of groups of animals decreased, and in the past decade there has also been a decrease in sales of products for use in individual animals.

Comparing sales of antibiotics in human and veterinary medicine

In 2024, a total of 63.5 tonnes of antibiotics were sold for human use and 9.0 tonnes were sold for animal use (excluding products for intramammary or intrauterine use). Measured as milligrams of active substance per kilogram biomass, the corresponding sales were 96.4 and 11.9 milligrams per kilogram, respectively.

Notifiable resistance

ESBL-producing Enterobacterales, humans

ESBL-producing Enterobacterales in humans has been subject to mandatory notification since 2007. It is the most common type of notifiable antibiotic resistance.

Results 2024, Enterobacterales with ESBL

- Number of reported cases: 12 527 (previous year 10 895), relative change +15%.
- Number of bloodstream infections: 1 055 (previous year 897).
- As in previous years, *Escherichia coli* was the most common species (83%), followed by *Klebsiella pneumoniae* (12%).
- The proportion of *E. coli* from blood cultures that are resistant to third-generation cephalosporins were 9.2%.

Results 2024, Enterobacterales with $ESBL_{CARBA}$

- Number of reported cases: 410 (previous year 314), relative change +31%.
- Number of bloodstream infections: 22 (previous year 21).
- Among Enterobacterales with $ESBL_{CARBA}$, *E. coli* was the most common species (67%), followed by *Klebsiella pneumoniae* (33%).

- Fifty-seven clusters or pairwise linked cases of $ESBL_{CARBA}$ were identified by whole-genome sequencing in 2024 (2-9 cases per cluster). Of the 57 clusters, 33 clusters had at least one case prior to 2024. For 27 of the 57 clusters, there was one or more cases reported as healthcare-related infections in Sweden 2024, compared to 16 clusters related to healthcare in 2023.
- The number of isolates of *E. coli* from blood cultures resistant to meropenem was 5 out of 10 499, compared to 3 out of 10 719 in 2023.
- For the first time in Sweden, a carbapenemase-producing Salmonella strain was detected. It was typed to Salmonella Agona and carried an IMP-gene.

ESBL-producing Enterobacterales, animals

ESBL-producing Enterobacterales are generally rare among animals in Sweden. Previously, the occurrence in intestinal samples from broilers was high but it has decreased in recent years. In 2024, the occurrence of ESBL-producing *E. coli* in intestinal samples from broilers, turkeys and cattle under one year of age, as well as samples of broiler and turkey meat, was investigated with selective methods. These bacteria were isolated from 3% of the intestinal samples from broilers and 4% of the samples of broiler meat, but these bacteria were not isolated from any intestinal samples from turkeys or cattle under one year of age or from turkey meat.

Bacteria that produce $ESBL_{CARBA}$ have not been confirmed in domestic animals in Sweden.

Methicillin-resistant Staphylococcus aureus (MRSA), humans

Community-acquired infection has long been the most common type of MRSA infection in humans, accounting for half of the cases. In 2015, community-acquired infection was divided into family/household-related infection and community-acquired infection. Family/household-related infections and community-acquired infections accounted for 25% and 21% of the cases, respectively.

Results 2024

- Number of reported cases: 3 937 (previous year 3 547), relative change +11%.
- Number of bloodstream infections: 123 (previous year 103).
- The proportion of MRSA among *Staphylococcus aureus* isolated from blood has increased to 2.6%, compared to 2.1% in 2023.

Methicillin-resistant Staphylococcus aureus (MRSA), animals

During the year, MRSA was isolated from pigs and sporadically from dogs, horses and cats. The prevalence in pigs is insufficiently studied, but in 2025 a baseline study is being carried out with sampling at slaughterhouses. In dogs and cats, the number of cases was six and eight respectively. The predominant strains in dogs and cats are the same as those found in humans, indicating a human source of MRSA in these animals. In horses there were 14 MRSA cases, which is lower than in 2020 and 2021 (27 and 23 cases), when MRSA outbreaks occurred at equine hospitals.

Methicillin-resistant Staphylococcus pseudintermedius (MRSP), animals

The number of reported cases of methicillin-resistant *Staphylococcus pseudintermedius* (MRSP) in animals was around the same level in 2024 as in previous years. In total, 57 cases of MRSP were notified to the Swedish Board of Agriculture, including 49 from dogs, seven from cats and one from horse. All but two isolates were available for further investigations. When MRSP first occurred among animals in Sweden, the sequence type ST71 dominated. However, for several years the isolates of MRSP have been more diverse, with several sequence types occurring.

MRSP in humans is not notifiable.

Streptococcus pneumoniae with reduced susceptibility to penicillin (PNSP), humans

Results 2024

- Number of reported cases: 148 (previous year 152), relative change -3%.
- Number of bloodstream infections: 12 (previous year 7).
- The proportion of *S. pneumoniae* with reduced susceptibility to penicillin (PNSP) among bloodstream infections decreased to 5.5% from 5.8% 2023.

Vancomycin-resistant enterococci (VRE), humans

Results 2024

- Number of reported cases: 390 (previous year: 260), relative change +50%.
- The number of cases of VRE can vary greatly between years depending on the number and magnitude of hospital outbreaks.
- Number of reported cases of *E. faecium* with vancomycin resistance: 372 (previous year: 250), relative change +49%
- Number of reported cases of *E. faecalis* with vancomycin resistance: 18 (previous year: 10)
- There were seven cases infected with both *E. faecium* and *E. faecalis*.
- Number of bloodstream infections: 6 (previous year: 5)
- Thirty clusters were reported during the year with 2-37 cases each. Out of these, eight were large hospital-related outbreaks with 10-37 cases each. In 2023, seventeen hospital-related outbreaks were reported.
- The proportion of VRE among bloodstream infections is low, at 1.1% for *E. faecium* resistant to vancomycin and 0.1% for *E. faecalis* resistant to vancomycin.

Zoonotic pathogens

Salmonella is rare in animals in Sweden. Furthermore, only a few of the notified cases involve antibiotic resistant strains. Resistance to fluoroquinolones is rare. Among 101 isolates from animals in 2024, 83% were susceptible to all antibiotics tested.

For *Salmonella* species isolated from human faeces, the highest occurrence of resistance was to fluoroquinolones, (21%). No resistance to carbapenems was reported in animals. Resistance is more common in isolates from human invasive infections with *Salmonella* compared to *Salmonella* isolated from animals. This is probably due to the large proportion of cases acquired abroad or via imported food. For the first time in Sweden, a carbapenemase-producing *Salmonella* strain was detected. It was typed to *Salmonella* Agona and carried an IMP-gene.

Campylobacter from animals in Sweden are generally susceptible to relevant antibiotics, and resistance to erythromycin, for example, is uncommon. In *Campylobacter jejuni* from humans in 2024, resistance to ciprofloxacin was 47%, resistance to tetracycline was 29% and 2.2% of the isolates were resistant to erythromycin.

Infections caused by *Salmonella* and *Campylobacter*, whether in humans or in animals, are usually not treated with antibiotics. In humans, only a small proportion of the isolates, most of which are related to serious infections, are tested for antibiotic susceptibility.

Human clinical isolates

All data for these compilations are collected automatically via the national surveillance system Svebar, a collaboration between the clinical microbiology laboratories and the Public Health Agency of Sweden.

Escherichia coli: Resistance in blood isolates to ceftazidime and cefotaxime was 8.0% and 9.2%, respectively. The number of reported ESBL-producing *E. coli* from blood in 2024 was 842 cases. Resistance to ciprofloxacin is now 15.6% and 11%, respectively, in isolates from blood and urine. These resistance levels should be considered when choosing empirical treatment for febrile urinary tract infection.

When *E. coli* from urine is divided by age and gender, some differences in resistance are seen. The most prominent difference is the high ciprofloxacin resistance (17-20%) seen among men 20 years and older.

Klebsiella pneumoniae: resistance in blood isolates to cefotaxime and ceftazidime was 9.6% and 8.6%, respectively. The number of reported ESBL-producing *K. pneumoniae* from blood in 2024 was 180 cases. As for *E. coli*, resistance to ciprofloxacin is now relatively high, at 11% and 14% in isolates from urine and blood, respectively.

Staphylococcus aureus: Resistance to cefoxitin (which is indicative of MRSA) in isolates from blood and samples from skin and soft tissue was 2.6% and 2.7%, respectively. The number of reported MRSA from blood in 2024 was 123 cases.

Enterococcus faecalis and *Enterococcus faecium*: Vancomycin resistance in isolates from blood remains low (0.1% and 1.1%, respectively) and high-level aminoglycoside resistance is still at a low level compared to 2017.

Clostridioides difficile: The incidence has been relatively stable since 2018 and is now 59 cases per 100 000 inhabitants and year. No isolates were tested for antibiotic resistance in 2024.

Animal clinical isolates

Bacteria causing clinical disease in animals are mostly susceptible to antibiotics relevant for treatment. Respiratory pathogens from farm animals and horses are generally susceptible to benzylpenicillin but resistance occurs, for example in *Pasteurella multocida* and *Mannheimia haemolytica* from calves. Penicillin resistance is common in *Staphylococcus pseudintermedius* from dogs and occurs in *S. aureus* from horses and *S. felis* from cats. However, in *S. schleiferi* from dogs, penicillin resistance is uncommon. Resistance to commonly used antibiotics in *E. coli* occurs in all animals but is most prominent in enteric isolates from young pigs. Susceptibility testing for guidance in antibiotic therapy is warranted, especially for *E. coli* and *Brachyspira* spp.

Indicator bacteria from healthy animals

Antibiotic resistance in *E. coli* from the intestinal flora of healthy animals serves as an indicator of the presence of resistance in an animal population. The prevalence of acquired resistance in such commensal bacteria also indirectly indicates the magnitude of the selective pressure from the use of antibiotics in an animal population. The prevalence of resistance in indicator bacteria from animals in Sweden is low, and the situation is favourable from an international perspective. For example, in the latest investigations of indicator *E. coli* from broilers and pigs, 79% and 73%, respectively, were susceptible to all tested substances.

Guidance for readers

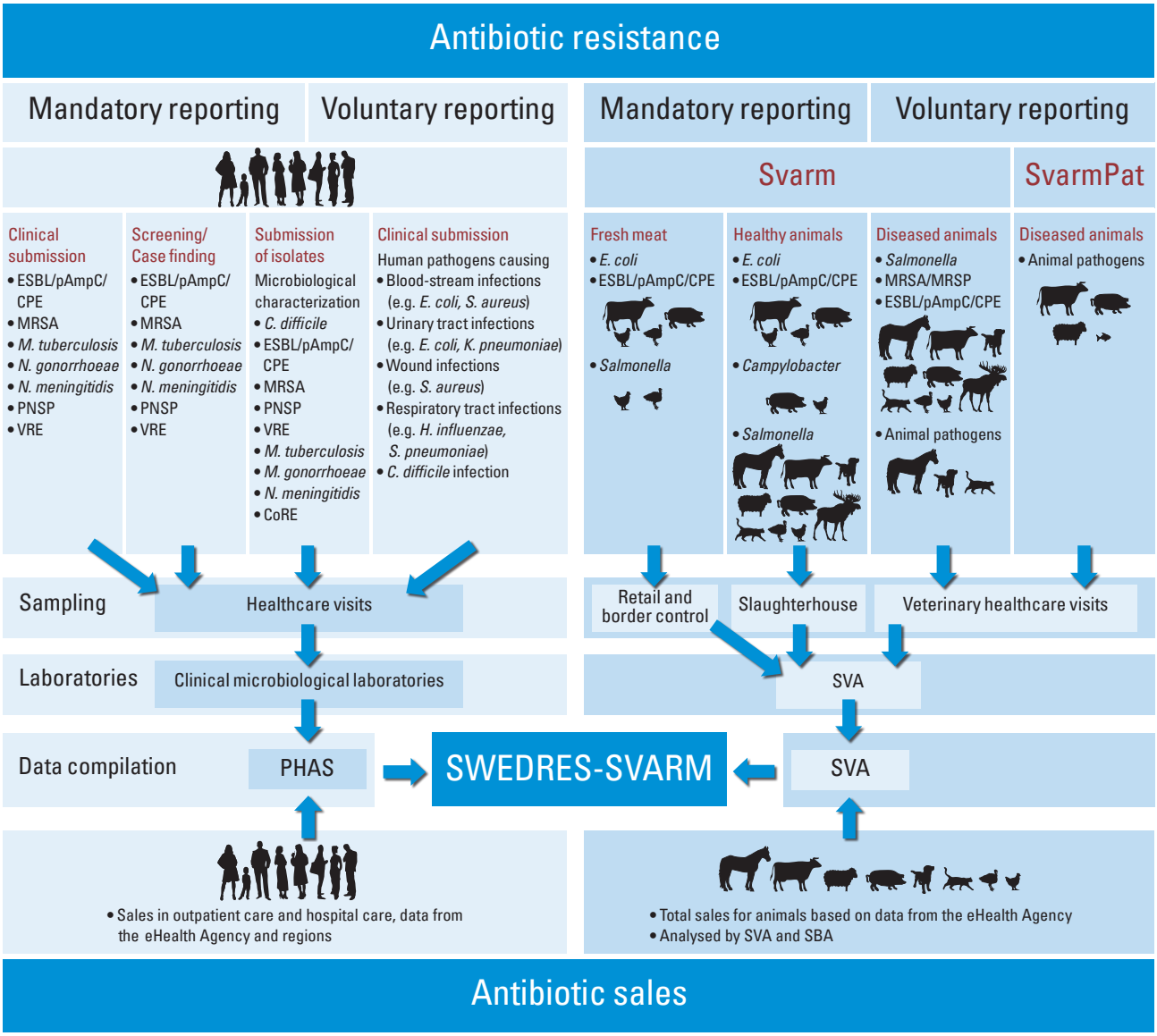
The Swedres-Svarm report is the result of a cooperation between the Public Health Agency of Sweden and the Swedish Veterinary Agency with the aim to present data relating to both humans and animals on the sales of antibiotics and on antibiotic resistance in a joint report.

Data on occurrence of notifiable antibiotic resistance in bacteria as well as data on resistance in zoonotic bacteria and in bacteria from clinical submissions are presented. Additionally, the report includes data on sales of antibiotics and resistance in so-called indicator bacteria from healthy animals and from food of animal origin.

Data on resistance in bacteria from humans are mainly obtained from clinical microbiology laboratories and in addition via notifications from clinicians. They are compiled by the Public Health Agency of Sweden in Swedres. In contrast, data on animals and food, compiled by the Swedish Veterinary Agency, are from the national monitoring program in the veterinary field Svarm. This program is specifically designed to monitor resistance in bacteria from animals and food and is organised and run at the Swedish Veterinary Agency. Data in the veterinary field also emanate from other sources, such as the SvarmPat project and specific research projects. For details on data sources see respective bacteria in Antibiotic resistance in animals and Background data, material, methods and references.

Schematic view of antimicrobial sales and resistance monitored in Sweden 2024

Resistance in bacteria from humans and sales for humans to the left and resistance in bacteria from animals and food and sales for animals to the right.



Embedded files in the PDF-file version of the report

The data from many of the tables and figures in Swedres-Svarm can be accessed from embedded Excel-files. To access the embedded files, indicated with paperclips, we recommend using Adobe Acrobat Reader.

Antibiotic sales

Swedres - Humans

Antibacterials for systemic use in humans are indexed as J01 in the Anatomical Therapeutic Chemical classification system. The J01 group also includes the antiseptic substance methenamine, which is not an antibiotic and is not a driver of antibiotic resistance. Throughout this report, methenamine is excluded whenever antibiotics are referred to or presented as a group. Statistics for dentistry includes oral metronidazole (P01AB01) in addition to antibiotics in the J01 group.

All pharmacies in Sweden are required to provide statistics on sales of all products on a regular basis to the Swedish eHealth Agency (eHälsomyndigheten), which maintains a national database with sales statistics for all drugs. The database includes statistics on prescriptions to individuals issued by healthcare providers from all 21 regions in Sweden and encompasses primary healthcare centres, outpatient specialist clinics, hospitals and dental clinics. In addition, statistics on medicines sold on requisition to hospitals, nursing homes and other health- and social care facilities are also accessible through the database. While prescription data accurately reflects antibiotic use, procurement data based on requisitions are impacted by procurement-related factors that may over- or underestimate antibiotic use. For detailed description of the pharmaceutical system in Sweden, please refer to the *Materials and methods, sales of antibiotics* section.

Comparison of sales of antibiotics between regions and to the elderly population over time is complicated by the fact that there are differences in how drugs are distributed to residents in nursing homes. In Sweden, most people living in nursing homes still receive their medication by prescription, whereby data are included in outpatient sales. However, there are also nursing homes where medicines are procured by the facility and then dispensed to the residents. These sales are included in inpatient care data. Since routines differ between regions and over time, the estimation of antibiotic use to the elderly population is not entirely reliable.

Wherever sales of antibiotics to a certain population group are displayed (children aged 0-6 years, women aged 15-79 years, inhabitants in a region), the denominator is the total number of individuals in the same population group.

In this report the term 'outpatient care' includes all antibiotic sales on prescription to individuals. 'Inpatient care' includes antibiotic sales to hospitals, nursing homes and other health- and social care facilities. Since national data on antibiotic sales to hospitals in Sweden are combined with sales to some nursing homes and other facilities, the figures are not suitable for evaluation of antibiotic use in acute care hospitals.

As data on antibiotic sales to humans are not linked to treatment indications, this report has grouped antibiotics frequently prescribed for treatment of common infections in Sweden in order to estimate the prescription rates for these diagnoses. All figures and tables referring to these treatment indications are based on the following antibiotics:

Oral antibiotics commonly prescribed for specific therapeutic areas in Sweden

Indication	Antibiotics included
Respiratory tract infections (RTIs)	Doxycycline (J01AA02; excluding packages larger than 50 tablets), penicillin V (J01CE02), amoxicillin (J01CA04), amoxicillin with enzyme inhibitor (J01CR02), cephalosporins (J01DB-DE; excluding ceftibuten J01DD14) and macrolides (J01FA).
Urinary tract infections (UTIs)	Pivmecillinam (J01CA08), trimethoprim (J01EA01), ciprofloxacin (J01MA02), norfloxacin (J01MA06) until 2020 and nitrofurantoin (J01XE01).
Skin and soft tissue infections (SSTIs)	Clindamycin (J01FF01) and flucloxacillin (J01CF05).
Acne vulgaris	Doxycycline (J01AA02; packages over 50 tablets), lymecycline (J01AA04), oxytetracycline (J01AA06) and tetracycline (J01AA07).

Antibiotic resistance

Swedres - Humans

Most of the data on resistance in Swedres is derived from routine diagnostic samples sent for testing at clinical microbiological laboratories. The results are mostly presented as proportion of resistance in tables or graphs. The methods used for antibiotic susceptibility testing, whether MIC determination or disk diffusion method, are standardised by European Committee on Antimicrobial Susceptibility Testing (EUCAST) and available online at www.eucast.org.

The methods and breakpoints routinely used in Sweden are available at www.nordicast.org. EUCAST also presents yearly updated interpretative criteria for clinical use in human medicine, i.e. clinical breakpoints, also available at www.eucast.org.

Svarm - Animals and food

Data on resistance in Svarm are from MIC determinations performed at the Swedish Veterinary Agency using broth microdilution following the standards of the Clinical and Laboratory Standards Institute (CLSI, 2024a). Results for isolates of zoonotic and indicator bacteria are interpreted according to ECOFFs from EUCAST (www.eucast.org). Clinical isolates from animals are generally classified by ECOFFs when such values are available. Interpretive criteria used are given in the section Materials and methods resistance in bacteria from animals.

ECOFFs classify isolates with acquired reduced susceptibility as non-wild type. In Svarm, non-wild type isolates are called “resistant”. This classification is relevant for monitoring purposes, but it should be understood that resistance defined in this manner not always implies clinical resistance.

Since the first report from Svarm, the interpretive criteria for some combinations of bacteria and substance have been changed. To facilitate comparisons when retrospect data are presented, levels of resistance have been recalculated using current interpretive criteria if not otherwise stated.

Indicator bacteria in animals

In Svarm, *Escherichia coli*, and sometimes *Enterococcus faecalis* and *E. faecium* serve as indicators for presence of antibiotic resistance in the enteric flora of healthy animals and in the flora contaminating food. The prevalence of acquired resistance in such commensal bacteria in animals indicates the magnitude of the selective pressure from use of antibiotics in an animal population. Most bacteria of the enteric flora are unlikely to cause disease, but they can be reservoirs for resistance genes that can spread to bacteria that cause infections in animals or humans. Prevalence of resistance in indicator bacteria contaminating meat indicates the magnitude of the potential human exposure to such reservoirs in food producing animals.

Presentation of MIC distributions in bacteria from animals

Results from MIC determinations in Svarm are presented as distributions of MICs in tables of a uniform design as below. Distributions are given as percentages of isolates tested. In the tables, white fields denote range of dilutions tested for each antibiotic and vertical bold lines indicate cut-off values used to define resistance.

The percentage of isolates with a certain MIC of an antibiotic is given in the corresponding white field. For MICs above the range tested of an antibiotic (>X mg/L) the percentage is given in the field closest to the range, i.e. in the first shaded field to the right of the tested range. For MICs equal to or lower than the lowest concentration tested for an antibiotic (≤Y mg/L) the percentage is given as the lowest tested concentration, i.e. in the first white field of the tested range.

Multidrug resistance

The terms multidrug resistance (MDR), multiresistance and multiresistant are in Svarm generally used for isolates with acquired resistance to three or more antibiotic classes. However, for aminoglycosides every substance is considered separately because of the complexity of the resistance mechanisms against this class. Furthermore, for staphylococci each subclass of beta-lactams is considered separately but for Enterobacterales all beta-lactams are considered as one class.

Presentation of MIC distributions in bacteria from animals

Antibiotic	Resistance (%)	Distribution (%) of MICs (mg/L)											
		≤ 0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	>64
Ciprofloxacin	21	21.0	52.0	6.0			1.0			20.0			
Erythromycin	0				93.0	4.0	3.0						
Tetracycline	2		75.0	22.0	1.0			1.0	1.0				

Abbreviations of generic antibiotic names

When abbreviations for antibiotics were needed in tables or graphs the following were used.

Amk	Amikacin	Ctx	Cefotaxime	Nit	Nitrofurantoin
Amp	Ampicillin	Enr	Enrofloxacin	Sul	Sulphonamide
Azm	Azithromycin	Ery	Erythromycin	Tet	Tetracycline
Caz	Ceftazidime	Fus	Fusidic acid	Tgc	Tigecycline
Chl	Chloramphenicol	Gen	Gentamicin	Tmp	Trimethoprim
Cip	Ciprofloxacin	Lzd	Linezolid	Sxt	Trimethoprim-sulphamethoxazole
Cli	Clindamycin	Mem	Meropenem		
Cst	Colistin	Nal	Nalidixic acid		

Abbreviations

AST	Antimicrobial susceptibility testing
ATC	Anatomical Therapeutic Chemical classification system
BSI	Bloodstream infection
CDI	*Clostridioides difficile* infection
CSF	Cerebrospinal fluid
DDD	Defined daily dose
ECDC	European Centre for Disease Prevention and Control
ECOFF	Epidemiological cut-off value for non-susceptibility
EARS-Net	European Antimicrobial Resistance Surveillance Network
ESAC-Net	European Surveillance of Antimicrobial Consumption Network
EMA	The European Medicines Agency
ESC	Extended spectrum cephalosporin
ESBL	Extended spectrum beta-lactamase
$ESBL_A$	Extended spectrum beta-lactamase, plasmid-mediated, inhibited by clavulanic acid (A = classical)
$ESBL_M$	Extended spectrum beta-lactamase inhibited by cloxacillin, also called plasmid-mediated AmpC (M = miscellaneous)
$ESBL_{CARBA}$	Extended spectrum beta-lactamase with activity against carbapenems
EUCAST	European Committee on Antimicrobial Susceptibility Testing
GBS	*Streptococcus agalactiae* (Group B streptococci)
GES	Guiana extended-spectrum beta-lactamase
GLASS	Global Antimicrobial Resistance and Use Surveillance System
HLAR	High-level aminoglycoside resistance (e.g. in *Enterococcus*)
IMI	Imipenem-hydrolysing beta-lactamase
IMP	Imipenemase
KPC	*Klebsiella pneumoniae* carbapenemase
MALDI-TOF MS	Matrix-assisted-laser-desorption/ionisation time-of-flight mass spectrometry
MDR	Multidrug resistance, i.e. phenotypic resistance to three or more antibiotic classes
MIC	Minimal inhibitory concentration
MLST	Multilocus sequence typing
MRSA	Methicillin-resistant *Staphylococcus aureus*
MRSP	Methicillin-resistant *Staphylococcus pseudintermedius*
NDM	New Delhi metallo-beta-lactamase
NordicAST	Nordic Committee on Antimicrobial Susceptibility Testing
OXA-48	Oxacillinase-48
PHAS	Public Health Agency of Sweden
PNSP	*Streptococcus pneumoniae* with reduced susceptibillity to penicillin
PVL	Panton-Valentine leukocidin
ResNet	Webb application for Resistance surveillance and quality control programme
RSV	Respiratory syncytial virus
RTI	Respiratory tract infection
spa	*Staphylococcus aureus* protein A gene
SSTI	Skin and soft tissue infection
ST	Sequence type
Strama	Swedish strategic programme against antibiotic resistance
SVA	Statens veterinärmedicinska anstalt (Swedish Veterinary Agency)
TB	Tuberculosis
UTI	Urinary tract infection
VIM	Verona integron-encoded metallo-beta-lactamase
VRE	Vancomycin-resistant enterococci
XDR	Extreme drug resistance (used for *Mycobacterium tuberculosis*)

Sales of antibiotics for humans

After the exceptional changes to antibiotic sales in Sweden observed during 2020 and 2021 due to the COVID-19 pandemic, the increase due to the rebound effect seen after the pandemic appears to have slowed down as the sales remain substantially unchanged during 2024 compared to the previous year. Recommendations issued to reduce the spread of COVID-19 resulted in changed behaviour in the general population, which in turn led to a reduced spread of communicable diseases in general. Healthcare-seeking behaviour appears to have been affected, and the management of the COVID-19 pandemic forced health care to reprioritise resources, leading to, for example, cancelling or postponing some planned healthcare visits and elective surgeries (National Board of Health and Welfare, 2021). These factors affected the sales of antibiotics during this period.

Total sales of antibiotics started to increase in 2022 and continued to increase during 2023, while remaining lower than before the pandemic. More social interactions contributed to the increased spread of communicable diseases, as evidenced by surveillance data on common viral and bacterial infections; surges in infections with respiratory syncytial virus (RSV), influenza virus, COVID-19 and a particular increased incidence in group A streptococci were reported during 2023. During 2023, infections with invasive group A streptococci reached the highest reported incidence since reporting became mandatory in 2004 (Public Health Agency, 2025a-d).

An increase was observed during 2024 for antibiotics commonly used to treat respiratory tract infections compared to the previous year that can be explained by an increase in respiratory tract infections caused by *Mycoplasma pneumoniae* seen during 2024. An increase in the number of reported cases of pertussis during 2024 could also have contributed to this increase in sales (Public Health Agency, 2025e).

The data sources and methodology underlying the statistics presented in this chapter are described in the Materials and methods, sales of antibiotics section. Due to regulations regarding the confidentiality of sales data, detailed data for substances and substance groups cannot be shown measured in DDD per 1 000 inhabitants. This affects the section for total sales as well as inpatient care.

Total sales of antibiotics

Results

- Total sales of antibiotics (J01 excl. methenamine) remained substantially unchanged with a slight increase by 0.2% compared to 2023 (from 10.95 DDD to 10.97 DDD per 1 000 inhabitants per day), Figure 1.1.
- Total sales of antibiotics varied between regions, ranging from 9.4 DDD per 1 000 inhabitants per day in Jönköping region to 12.2 DDD per 1 000 inhabitants per day in Gotland region, Figure 1.1.
- Beta-lactamase sensitive penicillins (J01CE) and tetracyclines (J01AA) remain the two most sold antibiotic classes measured in DDD per 1 000 inhabitants in Sweden during 2024 (data not shown). The sales in outpatient care and inpatient care constitute 85.9% and 14.1% of the total sales, respectively.

Comments

Nationally, the sales of antibiotics in 2024 and remained below the sales volumes observed in 2019, prior to the COVID-19 pandemic. The sale levels in 2024 are at approximately the same level as the previous year. Regionally, the slowing down of the rebound effect is also seen as antibiotic sales volumes in 2024 increased on a smaller scale in twelve of 21 regions compared to the increase seen in 2022 and 2023. The sales were higher in ten of 21 regions compared to sales volumes observed in 2019. A comparison with the population-weighted mean of the EU/EEA countries from 2012-2022 (ECDC, 2023) confirms Sweden's restrictive position regarding antibiotic prescribing. Due to regulations regarding the confidentiality of sales data, detailed data for substance groups cannot be shown.

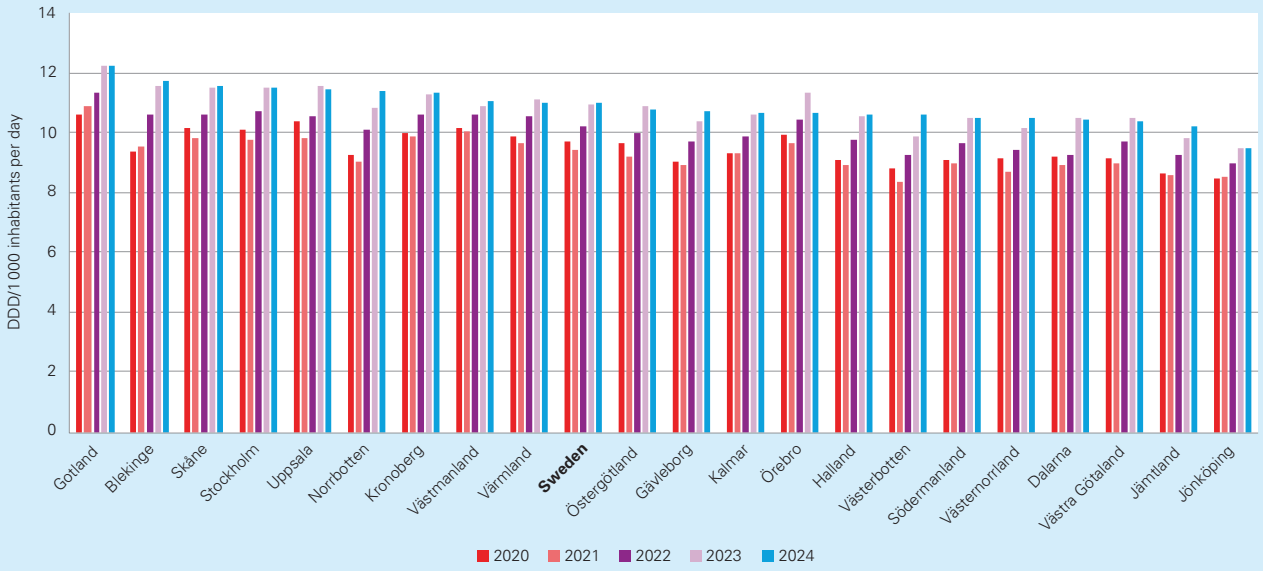
Antibiotics in outpatient care

Total sales in outpatient care

Results

- In 2024, 271 prescriptions per 1000 inhabitants were sold in Sweden – which is a similar level as the previous year with a slight increase of 0.3%.
- Sales of antibiotics decreased in the younger age groups (0-4) and (5-14) in 2024, with the largest decrease observed for children aged 0-4 years (13.5% decrease compared to 2023, Figure 1.2). Compared to 2019, all age groups showed a decrease in sales except for those aged 5-14, showing an increase of 6%.
- An increase in sales was observed for many of the antibiotic classes in 2024, but a decrease was observed for beta-lactamase sensitive penicillins (J01CE), beta-lactamase resistant penicillins (J01CF), cephalosporins (J01DB - J01DE), trimethoprim (J01EA), lincosamides (J01FF) and fluoroquinolones (J01MA), Figure 1.3. Sales in the group other antibacterials (J01XX) consisted mainly of metenamin (J01XX05).
- Beta-lactamase sensitive penicillins (J01CE) and beta-lactamase resistant penicillins (J01CF) were the most commonly sold antibiotics in 2024 measured in number of prescriptions.
- The number of prescriptions per 1 000 inhabitants varied between 242 in Västerbotten region to 300 in Skåne region in 2024. Antibiotic sales increased in 13 regions during 2024, Figure 1.4.
- In 2024, 15.8% of the Swedish population was treated with at least one course of antibiotics, ranging from 17.2% in Skåne region to 13.8% in Västerbotten region, Figure 1.5.

Figure 1.1. Total sales of antibiotics (J01 excl. methenamine) in 2020-2024, by region.

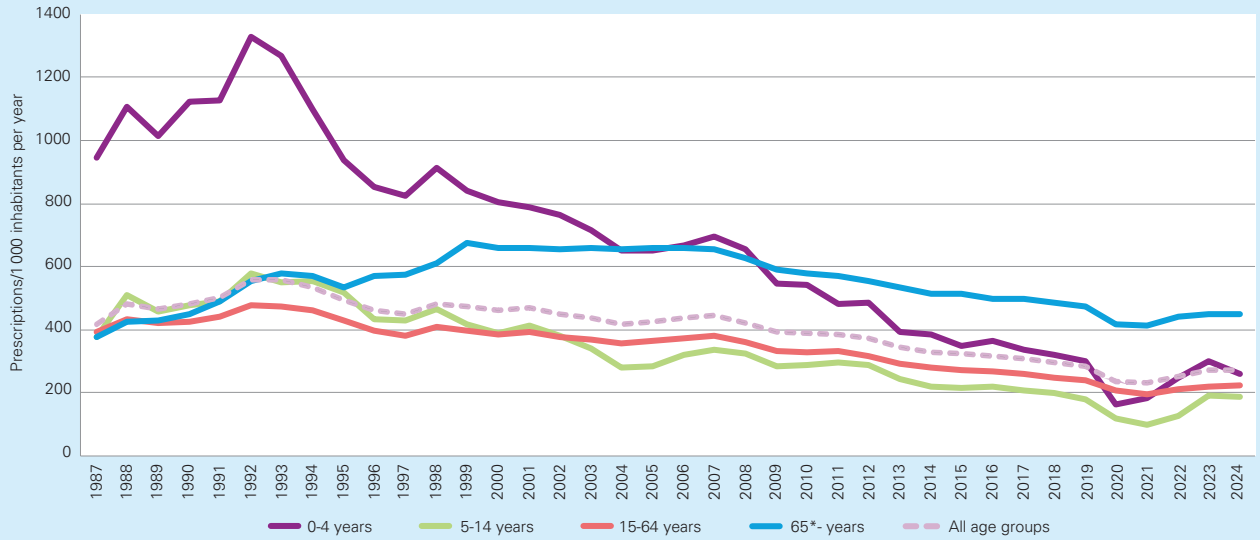


Source: The Public Health Agency of Sweden

Comments

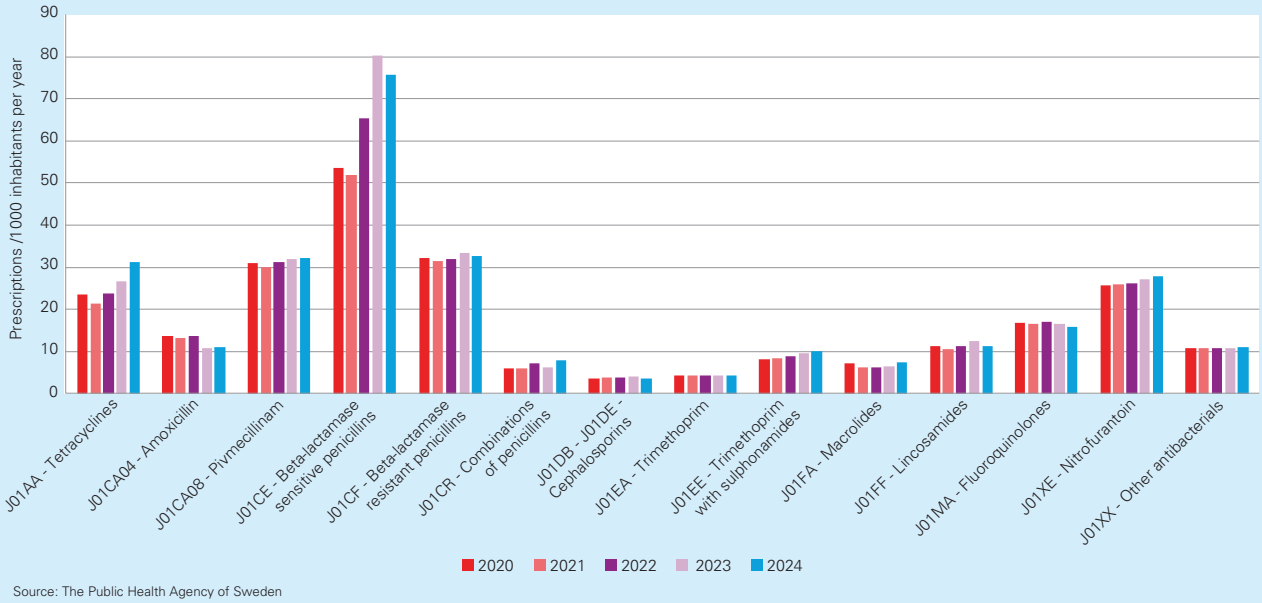
The sales of antibiotics have decreased by 52% since 1992, when the prescription of antibiotics peaked. The greatest decrease during this period was observed in children aged 0-4 years, dropping from 1 328 prescriptions per 1 000 inhabitants in 1992 to 259 in 2024, a decrease of 81%. In 2018, the national annual average sales of antibiotics were below 300 prescriptions per 1 000 inhabitants for the first time since national monitoring started. The COVID-19 pandemic led to a steep decrease in sales of antibiotics in 2020 and 2021, which was most noticeable for children aged 0-4 years. In 2020 and 2021 the national long-term target of 250 prescriptions per 1 000 inhabitants per year was achieved nationally (Strama, 2016). Sales started to increase in 2022 and continued to do so thereafter. The increase seen in 2022 and 2023 has slowed down in 2024 and the sales remained substantially unchanged compared to the previous year. The national annual average of sales has returned to above the target of 250 prescriptions per 1 000 inhabitants post pandemic. This indicates that this temporary national achievement was a consequence of the COVID-19 pandemic and emphasises the continued need for antibiotic stewardship efforts. Three of 21 regions reached this annual target in 2024. The sales of fluoroquinolones (J01MA) decreased in 2023 and continued to decrease in 2024, compared to both 2023 and 2019, which is in line with recommendations for restrictive use due to known risks of side effects (EMA, 2019).

Figure 1.2. Sales of antibiotics (J01 excl. methenamine) in outpatient care by age group in 1987-2024.



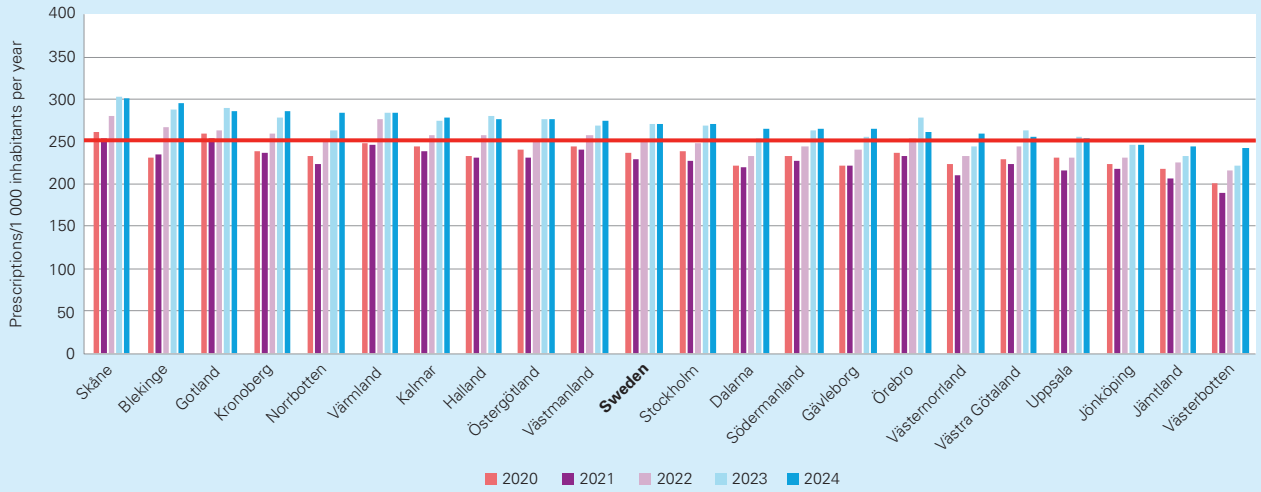
Source: The Public Health Agency of Sweden

Figure 1.3. Sales of selected antibiotic classes (ATC level 4 and 5) in outpatient care between 2020 and 2024.



Source: The Public Health Agency of Sweden

Figure 1.4. Sales of antibiotics (J01 excl. methenamine) in outpatient care in 2020-2024, by region[a].



[a]The red line indicates the national target of 250 prescriptions or less per 1 000 inhabitants per year.

Source: The Public Health Agency of Sweden

Figure 1.5. Percentage (%) of inhabitants treated with at least one course of antibiotics (J01 excl. methenamine) in outpatient care from 2020 to 2024, by region.

Source: The Public Health Agency of Sweden

Antibiotics commonly used to treat certain infections in outpatient care

Results

- The sales of antibiotics commonly used to treat respiratory tract infections (RTIs) were higher in the first and last quarters during 2024, similarly to sales in 2023. Sales of antibiotics commonly used to treat urinary tract infections (UTIs), skin and soft tissue infections (SSTIs) and acne remained relatively stable and followed the expected periodic fluctuations, Figure 1.6.
- Overall sales of antibiotics commonly prescribed against RTIs increased by 1.4% in 2024 compared to 2023.
- At a regional level, the number of prescriptions per 1 000 inhabitants for RTIs varied between 148 in Skåne region to 102 in Västerbotten region in 2024, Figure 1.7.

Comments

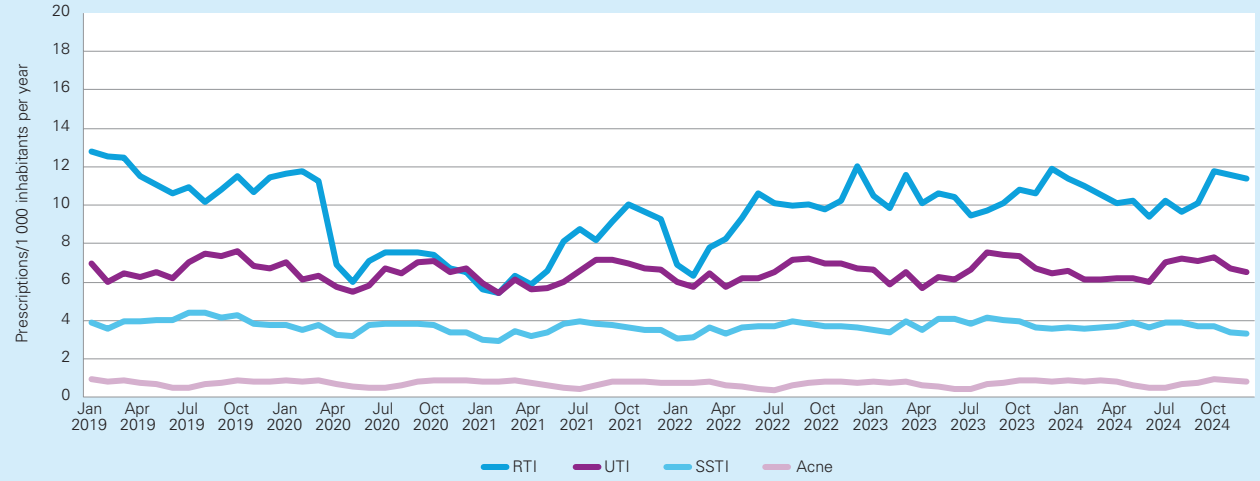
The effect of the decrease in sales due to the COVID-19 pandemic, primarily observed for antibiotics commonly used to treat RTIs and to a smaller degree UTIs. While sales for antibiotics commonly used to treat RTIs increased during 2023 and continued to do so during 2024, the sales levels remain under pre-pandemic levels. The pandemic had a small or negligible effect on antibiotics sales commonly used for SSTIs and acne. For all regions, the majority of antibiotic prescriptions during 2024 were for antibiotics commonly used to treat RTIs. In line with observations of antibiotic sales over many years, antibiotics commonly used to treat RTIs show larger regional variations than the remaining groups.

Respiratory tract infections (RTIs)

Results

- Beta-lactamase sensitive penicillins (J01CE02) were the most frequently prescribed of antibiotics commonly prescribed for RTIs in outpatient care in 2024, however a decreased by 5.7% was observed compared to 2023, Figure 1.8.
- The greatest relative increase in 2023 was observed for amoxicillin with clavulanic acid (J01CR02), followed by doxycycline (J01AA02) with an increase of 25.3% and 22.5%, respectively compared to 2023. Sales of cephalosporins (J01DB-DE, ceftibuten excluded) decreased by 10.4% compared to 2023, Figure 1.8.
- Sales of antibiotics commonly used to treat RTIs increased for all age groups except for children aged 0-6 years, where a 15.5% decrease in 2024 was observed compared to 2023. Sales increased most for the age group 7-19 years, with an increase of 13.1% compared to the previous year, Figure 1.9.

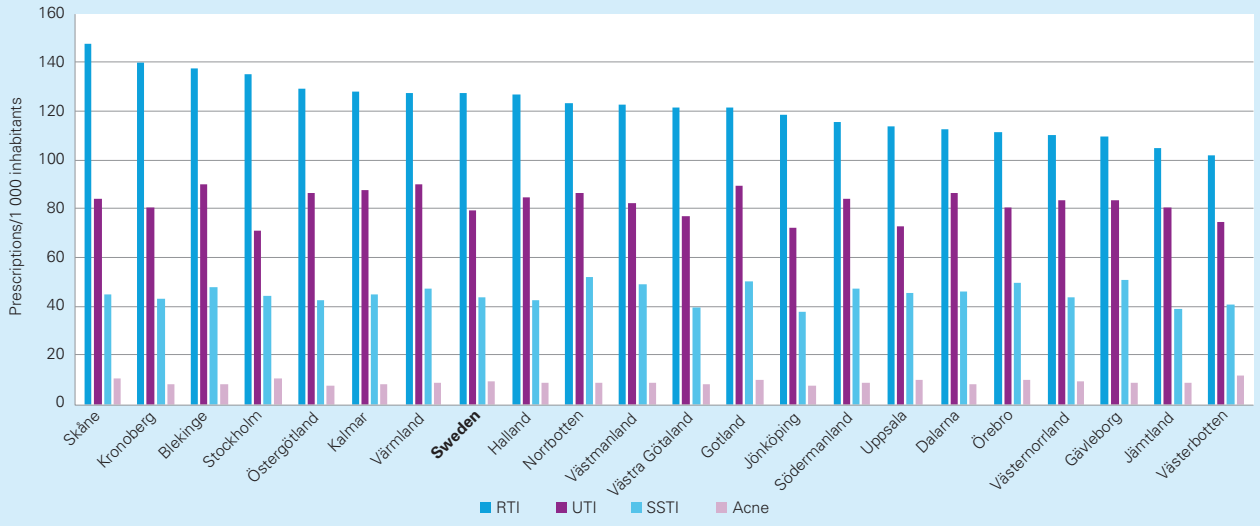
Figure 1.6. Sales of antibiotics commonly used to treat respiratory tract infections (RTI), urinary tract infections (UTI), skin and soft tissue infections (SSTI) and acne vulgaris in outpatient care from 2019 to 2024, by month[a].



[a]RTI:doxycycline (J01AA02); excluding packages larger than 50 tablets, penicillin V (J01CE02), amoxicillin (J01CA04), amoxicillin with enzyme inhibitor (J01CR02), cephalosporins (J01DB-DE, excluding ceftibuten J01DD14), and macrolides (J01FA); UTI: pivmecillinam (J01CA08), trimethoprim (J01EA01), ciprofloxacin (J01MA02), norfloxacin (J01MA06) until 2020, and nitrofurantoin (J01XE01); SSTI: clindamycin (J01FF01) and flucloxacillin (J01CF05); acne vulgaris: doxycycline (J01AA02; packages over 50 tablets), lymecycline (J01AA04), oxytetracycline (J01AA06) and tetracycline (J01AA07).

Source: The Public Health Agency of Sweden

Figure 1.7. Sales of antibiotics commonly used to treat respiratory tract infections (RTI), urinary tract infections (UTI), skin and soft tissue infections (SSTI) and acne vulgaris in outpatient care 2024, by region[a].



[a]RTI:doxycycline (J01AA02, excluding packages larger than 50 tablets), penicillin V (J01CE02), amoxicillin (J01CA04), amoxicillin with enzyme inhibitor (J01CR02), cephalosporins (J01DB-DE, excluding ceftibuten J01DD14), and macrolides (J01FA); UTI: pivmecillinam (J01CA08), trimethoprim (J01EA01), ciprofloxacin (J01MA02), norfloxacin (J01MA06) until 2020, and nitrofurantoin (J01XE01); SSTI: clindamycin (J01FF01) and flucloxacillin (J01CF05); acne vulgaris: doxycycline (J01AA02; packages over 50 tablets), lymecycline (J01AA04), oxytetracycline (J01AA06) and tetracycline (J01AA07).

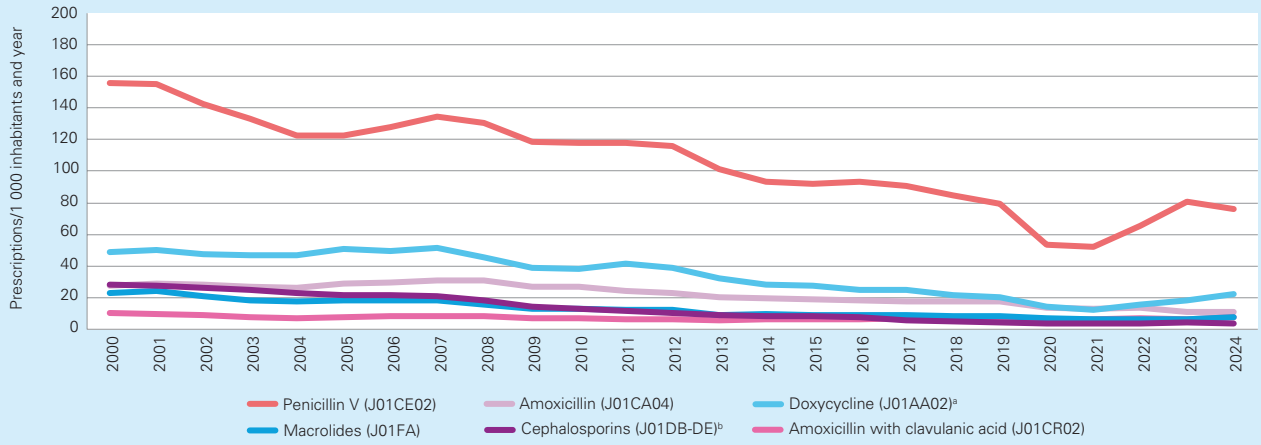
Source: The Public Health Agency of Sweden

Comments

The recommended first-line treatment for lower RTIs in Sweden is penicillin V (J01CE02) (Medical Products Agency, 2008). In 2024, the sales of antibiotics commonly used to treat RTIs were higher than in 2023, but the total sales did not reach pre-pandemic levels. Trend analysis based on data since the 2000s showed a significant decrease ($p < 0.001$) in the sales of all RTI antibiotics in the recent years, except for amoxicillin with enzyme inhibitor (J01CR02), for which trend analysis showed an increase since 2017.

The sales of antibiotics commonly used to treat RTIs increased most in the beginning and the end of the year. The increase in sales of antibiotics commonly prescribed against RTIs was largely driven by an increase in prescription to children aged 7-19 years. Increased number cases of by mycoplasma pneumoniae and reported cases of pertussis during 2024 could also have contributed to this increase in sales.

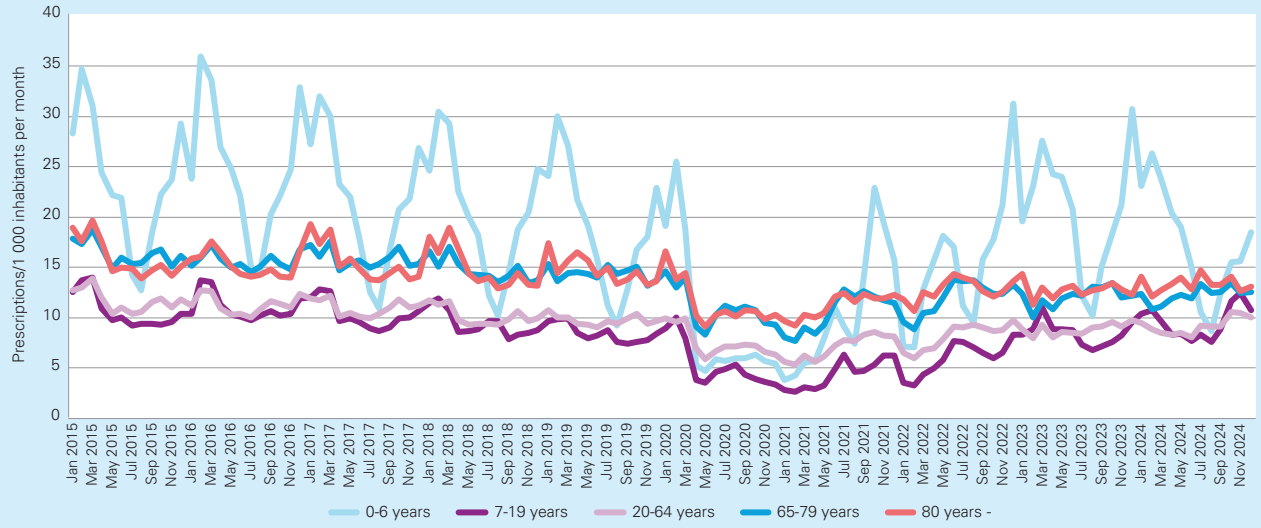
Figure 1.8. Sales of antibiotics commonly used to treat respiratory tract infections in outpatient care between 2000 and 2024.



[a]Doxycycline (J01AA02) excluding packages with more than 50 tablets.
[b]Ceftibuten (J01DD14) excluded.

Source: The Public Health Agency of Sweden

Figure 1.9. Sales of antibiotics commonly used to treat respiratory tract infections[a] in outpatient care from 2015 to 2024, per month.



[a]Includes doxycycline (J01AA02), penicillin V (J01CE02), amoxicillin (J01CA04), amoxicillin with enzyme inhibitor (J01CR02), cephalosporins (J01DB-DE), and macrolides (J01FA).

Source: The Public Health Agency of Sweden

Urinary tract infections (UTIs)

Results

- Sales of antibiotics commonly used to treat UTIs decreased by 0.3% in 2024 among women aged 15-79 compared to 2023. Sales of pivmecillinam (J01CA08), ciprofloxacin (J01MA02) and trimethoprim (J01EA) decreased by 0.8%, 5.6% and 2.1%, respectively, whereas nitrofurantoin (J01XE) increased by 2.1%, Figure 1.10.
- In men aged 65 or older, the sales of antibiotics commonly used to treat UTIs increased by 0.3% in 2024 compared to 2023. The greatest relative change was observed for trimethoprim (J01EA01), which increased by 7%, and for trimethoprim with sulphonamides (J01EE), which increased by 5.9%, Figure 1.11.
- At the national level, 10% of the antibiotics commonly prescribed for UTIs in women aged 18-79 in 2024 consisted of ciprofloxacin. This proportion ranged from 6.9% in Jönköping region to 13.9% in Västerbotten region, Figure 1.12.

Comments

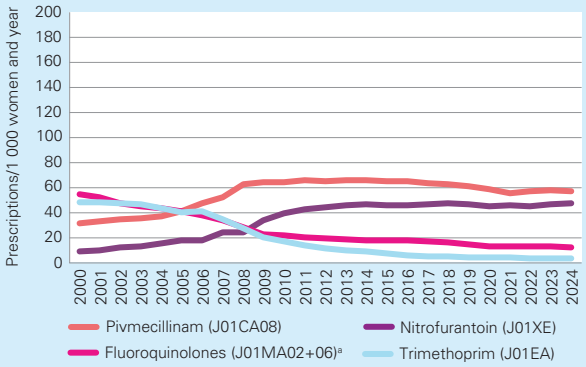
According to national treatment recommendations, pivmecillinam and nitrofurantoin are first-line treatments for UTIs in women aged 15 or older and in men with afebrile symptomatic UTIs (Medical Products Agency, 2017).

In line with treatment recommendations, 87% of the UTI antibiotics sold to women aged 15-79 in 2023 consisted of these two antibiotics.

In men aged 65 or older, fluoroquinolones made up 35% of the UTI antibiotics sold in 2024. In this group, the trend analysis shows a significant increase in the sales of nitrofurantoin and trimethoprim with sulphonamides. Sales of fluoroquinolones and trimethoprim show a significant decrease since the begning of the-2000s. Sales of pivmecillinam increased in this population, according to trend analysis, since the mid-2000s. Note that since 2021, norfloxacin (J01MA06) has been removed from the market and only ciprofloxacin (J01MA02) remains among the fluoroquinolones.

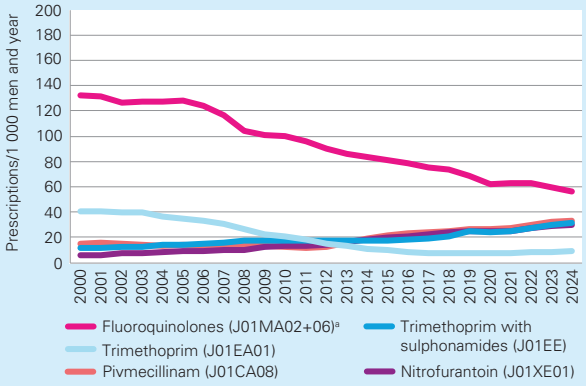
Strama has proposed a number of quality indicators in outpatient care, including that a maximum of 10% of antibiotics prescribed to treat UTIs in women aged 18-79 years consist of fluoroquinolones (Strama, 2016). This target was achieved by 5 of 21 regions in 2024.

Figure 1.10. Sales of antibiotics commonly used to treat urinary tract infections in women aged 15-79 years in outpatient care between 2000 and 2024.



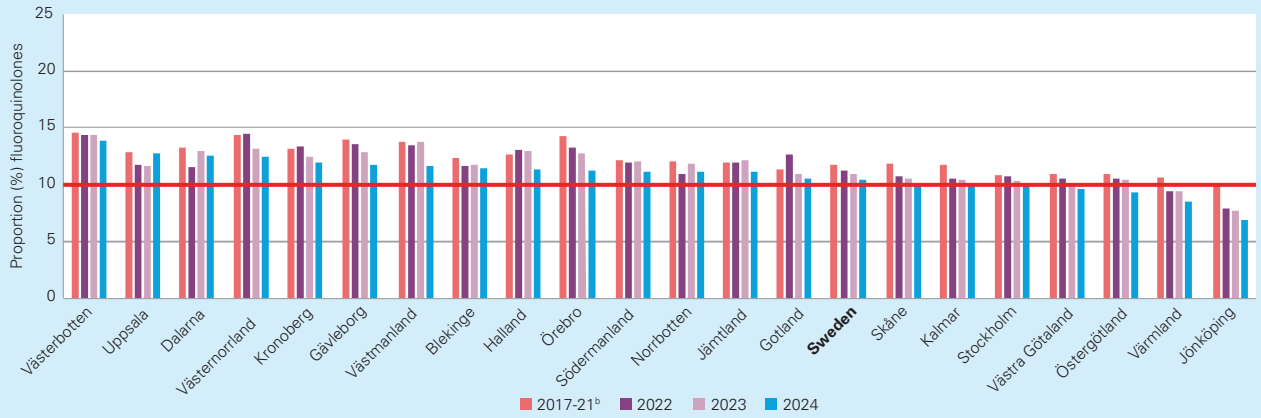
[a]From 2021, only ciprofloxacin (J01MA02) is represented in the group fluoroquinolones.
Source: The Public Health Agency of Sweden

Figure 1.11. Sales of antibiotics commonly used to treat urinary tract infections in men aged 65 years or older in outpatient care between 2000 and 2024.



[a]From 2021, only ciprofloxacin (J01MA02) is represented in the group fluroquinolones.
Source: The Public Health Agency of Sweden

Figure 1.12. Proportion of fluoroquinolones (ciprofloxacin, J01MA02; norfloxacin, J01MA06, until 2020) among antibiotics commonly used to treat urinary tract infections[a] in women aged 18-79 years in outpatient care from 2017 to 2024, by region.



[a]Pivmecillinam (J01CA08), trimethoprim (J01EA01), ciprofloxacin (J01MA02), norfloxacin (J01MA06) until 2020, and nitrofurantoin (J01XE01).
[b]Average proportion is presented for the time period 2016-20. The red line indicates Strama's target of maximum 10% fluoroquinolones.
Source: The Public Health Agency of Sweden

Age and gender comparisons

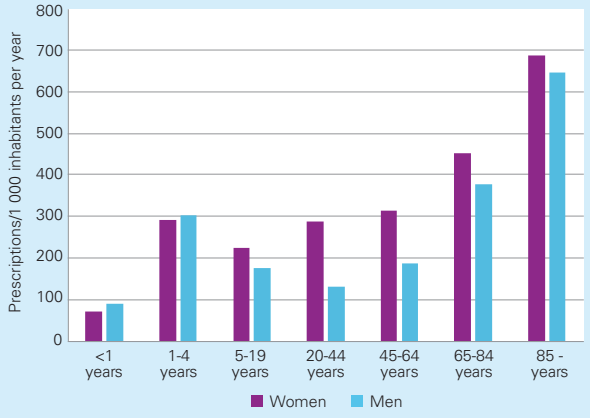
Results

- The rate of antibiotic prescriptions in outpatient care remains substantially unchanged during 2024 and followed the same pattern as during 2023, i.e. the highest prescription rates were observed for people aged 85 years or older: 688 prescriptions per 1 000 inhabitants in women and 649 prescriptions per 1 000 inhabitants in men in 2024, Figure 1.13. 60% of all antibiotic prescriptions during 2024 were issued to women.
- The most frequently prescribed antibiotics to children aged 1-4 were antibiotics commonly used to treat RTIs, representing 82% of the total antibiotic sales in this age group. RTI antibiotics were prescribed more to women than to men, except in the youngest and oldest age groups, Figure 1.14.
- Antibiotics commonly used to treat UTIs are mostly prescribed to women, and the prescription rate increases with age, Figure 1.15.
- Sales of antibiotics commonly used to treat SSTIs were highest for the oldest age groups, and prescriptions to men exceed those to women in these age groups, Figure 1.16.
- Antibiotics commonly used to treat acne are mainly used in the age groups 5-44 years and predominately by women, Figure 1.17. Most of the prescriptions are found among 15-19 year-olds (data not shown).

Comments

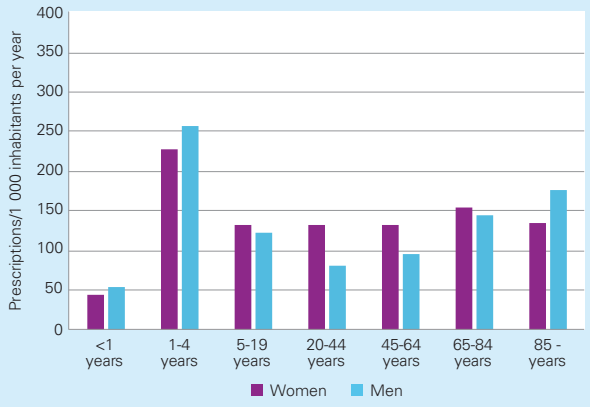
Concerning antibiotics commonly used to treat SSTIs and acne or similar skin conditions, older patients are more often prescribed longer treatments, which impacts the amount of antibiotics used. In general, comparisons across age groups show that antibiotics are used more in the older age groups. As mentioned in the *Guidance for readers*, some of the antibiotics used among the elderly population are not included in the outpatient care statistics as some medicines are sold on requisition and included in inpatient care statistics. Therefore, a possible underestimation in the oldest age groups cannot be ruled out.

Figure 1.13. Sales of antibiotics (J01 excl. methenamine) in outpatient care in 2024, by age and gender.



Source: The Public Health Agency of Sweden

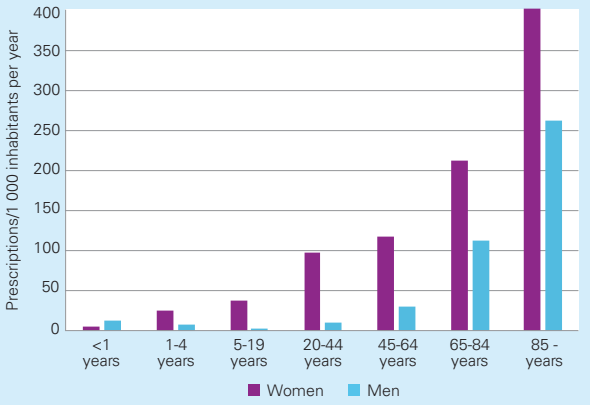
Figure 1.14. Sales of antibiotics commonly used to treat respiratory tract infections[a] in outpatient care in 2024, by age and gender.



[a]Doxycycline (J01AA02; excluding packages larger than 50 tablets), penicillin V (J01CE02), amoxicillin (J01CA04), amoxicillin with enzyme inhibitor (J01CR02), cephalosporins (J01DB-DE, excluding ceftibuten), and macrolides (J01FA).

Source: The Public Health Agency of Sweden

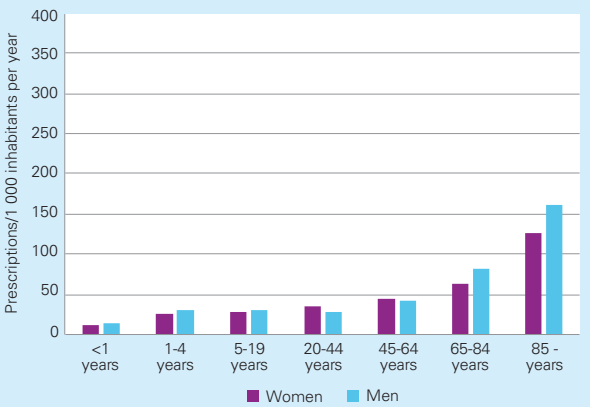
Figure 1.15. Sales of antibiotics commonly used to treat urinary tract infections[a] in outpatient care in 2024, by age and gender.



[a]Pivmecillinam (J01CA08), trimethoprim (J01EA01), ciprofloxacin (J01MA02), norfloxacin (J01MA06) until 2022, and nitrofurantoin (J01XE01).

Source: The Public Health Agency of Sweden

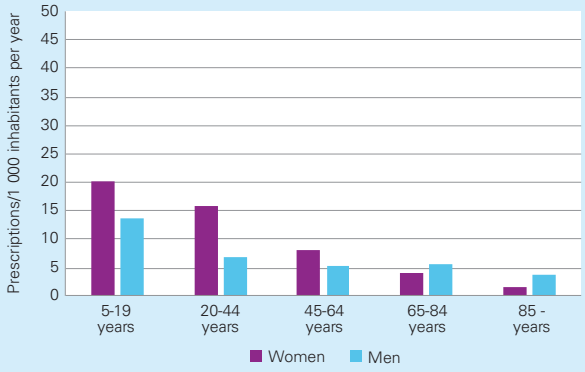
Figure 1.16. Sales of antibiotics commonly used to treat skin and soft tissue infections[a] in outpatient care in 2024, by age and gender.



[a]Clindamycin (J01FF01) and flucloxacillin (J01CF05).

Source: The Public Health Agency of Sweden

Figure 1.17. Sales of antibiotics commonly used to treat acne vulgaris[a] in outpatient care in 2024, by age and gender.



[a]Doxycycline (J01AA02); packages over 50 tablets, lymecycline (J01AA04), oxytetracycline (J01AA07) and tetracycline (J01AA07).

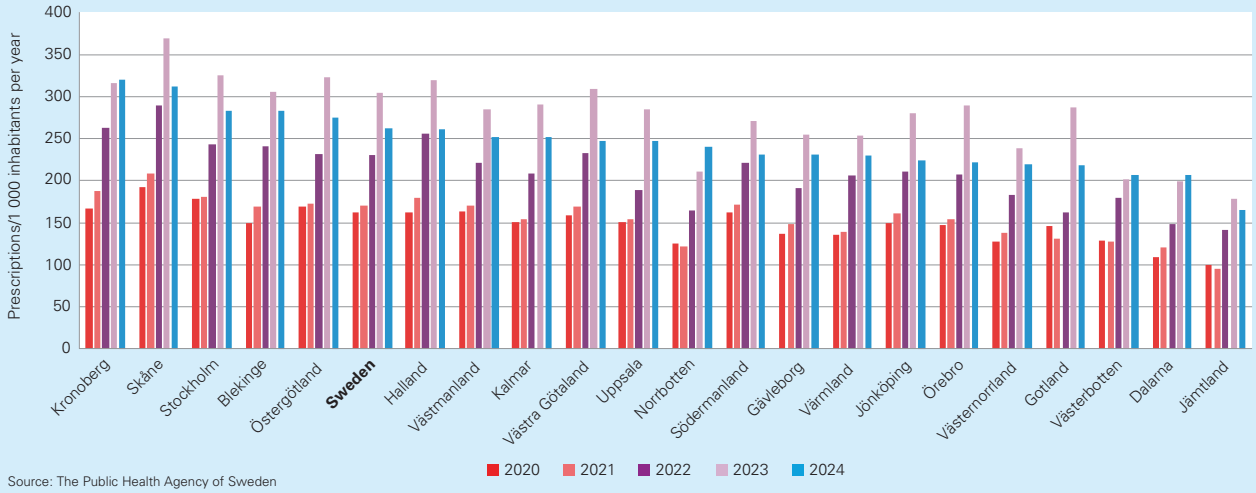
Source: The Public Health Agency of Sweden

Antibiotic sales in children

Results

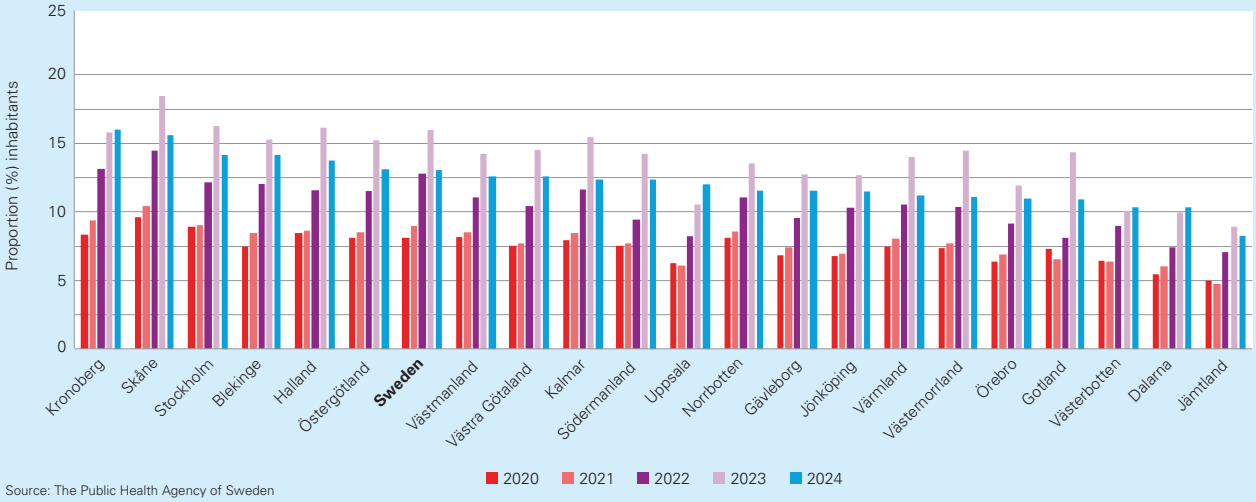
- Sales of antibiotics for children aged 0-6 years were 13.8% lower in 2024 than in 2023.
- The sales of antibiotics for children aged 0-6 years decreased in 17 out of 21 regions in Sweden. There were large variations between regions, from 320 prescriptions per 1 000 children in Kronoberg region to 165 in Jämtland region in 2024, Figure 1.18.
- The most sold antibiotics for children aged 0-6 years were beta-lactamase sensitive penicillins (J01CE), which constituted 59% of the sales measured as prescriptions/1 000 inhabitants (data not shown).
- The proportion of children aged 0-6 years treated with at least one course of antibiotics decreased in 2024 compared to 2024 and was estimated to 15.9%, Figure 1.19.

Figure 1.18. Sales of antibiotics (J01 excl. methenamine) to children aged 0-6 years in outpatient care between 2020 and 2024, by region.



Source: The Public Health Agency of Sweden

Figure 1.19. Proportion (%) of children aged 0-6 years treated with at least one course of antibiotics (J01 excl. methenamine) in outpatient care between 2020 and 2024, by region.



Source: The Public Health Agency of Sweden

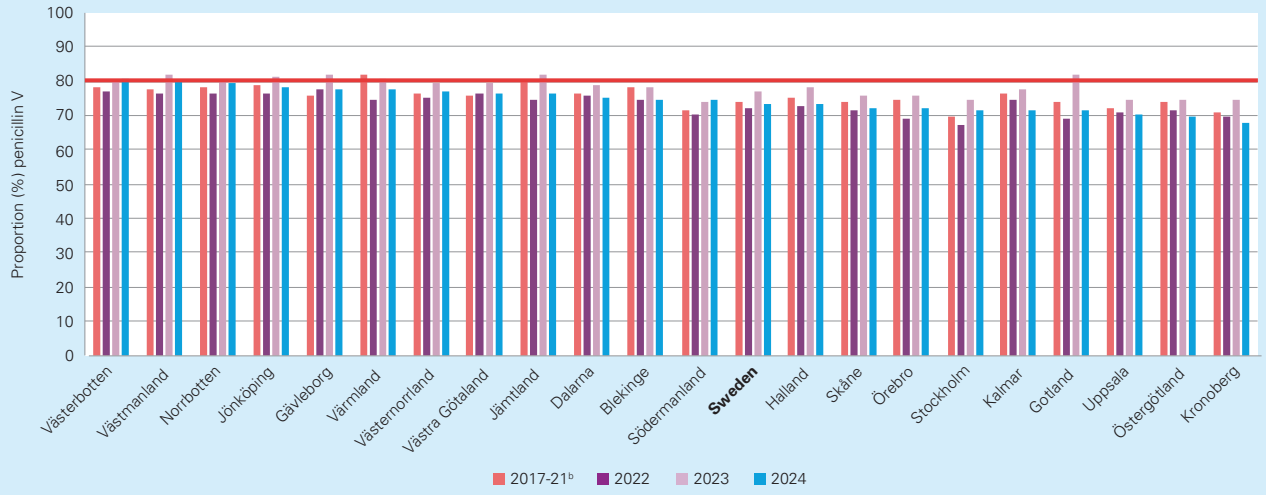
- At the national level, 74% of antibiotics commonly used to treat RTIs in children aged 0-6 consisted of penicillin V. This proportion ranged from 68% in Kronoberg region to 81% in Västerbotten region, Figure 1.20.

Comments

The sales of antibiotics to children aged 0-6 years have decreased in 17 of the regions in Sweden during 2024 compared to 2023. Prescriptions rates in this group are have also decreased nationally and in 17 regions than levels observed prior to the COVID-19 pandemic.

According to Strama's proposed quality indicator for outpatient care, at least 80% of antibiotics prescribed for RTIs in children aged 0-6 years should consist of penicillin V (Strama, 2016). To calculate this indicator, the following antibiotics are included in the denominator: amoxicillin (J01CA04), penicillin V (J01CE02), amoxicillin with clavulanic acid (J01CR02), cephalosporins (J01DB-DE excl. ceftibuten J01DD14), doxycycline (J01AA02; excluding packages larger than 50 tablets) and macrolides (J01FA). In 2024, 3 of the 21 regions achieved this target.

Figure 1.20. Proportion (%) penicillin V (J01CE02) of antibiotics commonly used to treat respiratory tract infections[a] in children aged 0-6 years in outpatient care between 2017 and 2024, by region.



[a]Doxycycline (J01AA02, excluding packages larger than 50 tablets), penicillin (J01CE02), amoxicillin (J01CA04), amoxicillin with enzyme inhibitor (J01CR02), cephalosporins (J01DB-DE, excluding ceftibuten) and macrolides (J01FA). [b]Average proportion is presented for the time period 2015-2019. The red line indicates Strama's target of at least 80% penicillin V.

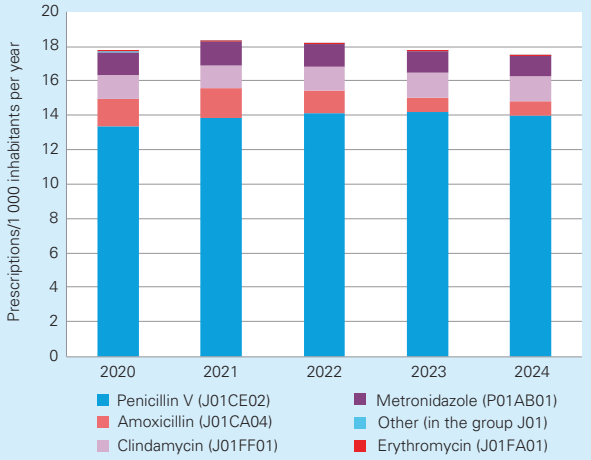
Source: The Public Health Agency of Sweden

Antibiotics in dentistry

Results

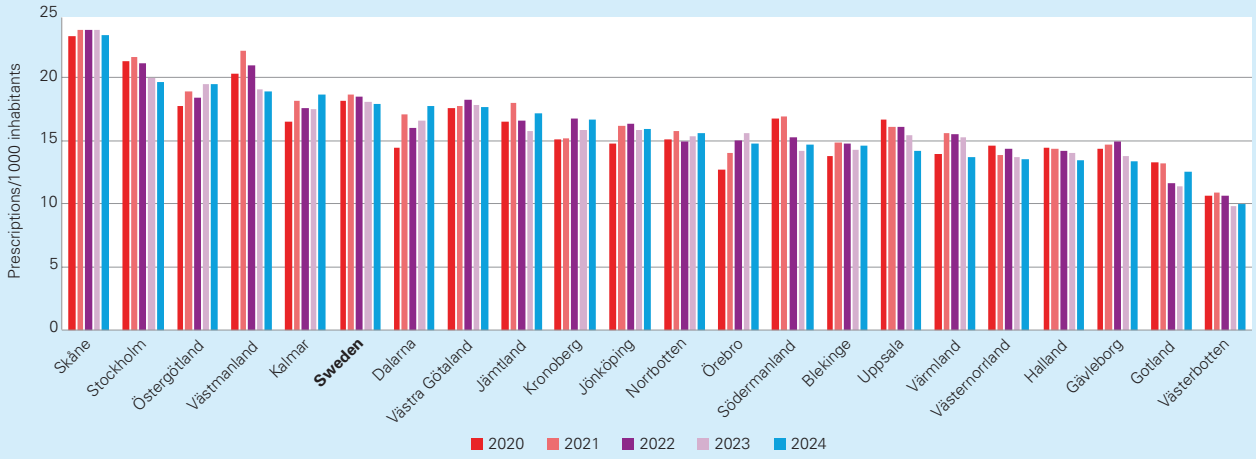
- Dentists accounted for 6% of all systemic antibiotics (J01 excl. methenamine) prescribed in Sweden in 2024, which is a similar level as the previous year (6.1% in 2023).
- Antibiotics (J01 excl. methenamine; metronidazole P01AB01) prescribed by dentists in 2024 was estimated to 17.9 prescriptions per 1 000 inhabitants, a decrease by 1% compared to the year before, Figure 1.21.
- The most commonly prescribed antibiotic by dentists was penicillin V (78.2% of total sales in dentistry), Figure 1.21. Compared to 2023, the sales of penicillin V decreased by 1.4%. The sales of amoxicillin (J01CA04) and other antibiotics (in the group J01) increased by 3% and 17.3%, respectively during 2024 compared to the previous year. Sales of other antibiotics groups decreased, with the largest decrease observed for erythromycin (J01FA01), by 50.6%. Clindamycin (J01FF01) sales account for 8% of the total sales of antibiotics (J01 excl. methenamine; metronidazole P01AB01) prescribed by dentists in 2024. The sales of clindamycin in dentistry account for 12% of the total sales of clindamycin in the country.

Figure 1.21. Antibiotics prescribed by dentists in outpatient care between 2020 and 2024.



Source: The Public Health Agency of Sweden

Figure 1.22. Antibiotics (J01 incl. methenamine; metronidazole P01AB01) prescribed by dentists in outpatient care between 2020 and 2024, by region.



Source: The Public Health Agency of Sweden

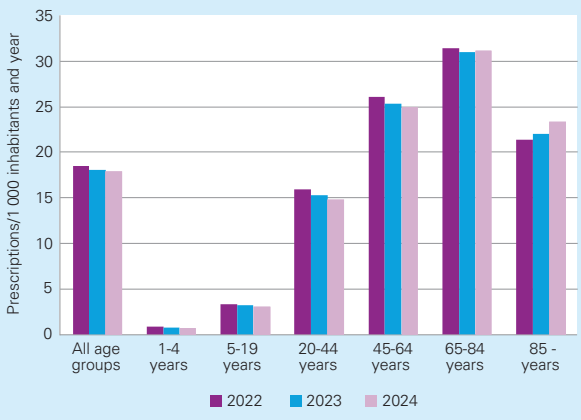
- Sales of antibiotics prescribed by dentists decreased in 11 of 21 regions during 2024.
- There were notable regional differences; dentists in Skåne region issued 23.4 prescriptions per 1 000 inhabitants, more than double that of dentists in Västerbotten region which had 10 prescriptions per 1 000 inhabitants, Figure 1.22.
- Prescriptions decreased for all age groups except for patients in the age groups 65-84 and 85+ years of age, where sales increased by 0,4% and 5.9%, respectively. Sales decreased the most for patients aged 1-4 years (4.9%). Most antibiotics were prescribed to those aged 65-84 years, followed by the age group 45-64 years, Figure 1.23.

Comments

The decline in antibiotic prescriptions observed in 2020 may have been the result of fewer dental care visits, especially among the elderly (National Board of Health and Welfare, 2022). Following this decrease in antibiotic prescribing by dentists, prescription levels appear to have returned to a pre-pandemic level and stabilised during 2024 with smaller changes observed. This effect of the pandemic was most apparent in antibiotic prescriptions for the two oldest age groups. However, for patients older than 85 years of age, antibiotic prescribing by dentists remains higher than levels observed in 2019. Prescriptions to patients below the age of 1 are not shown, as no antibiotics were prescribed by dentists to patients in this age group during 2024.

Penicillin V was the most commonly prescribed antibiotic by dentists, which is in line with treatment recommendations (Medical Products Agency, 2014). Metronidazole is also recommended as first-line treatment in combination with penicillin V to attain a broader anaerobic spectrum and is therefore included in the measure of sales. The low levels of erythromycin prescription continue to decrease. The sales of clindamycin are considered to be high as the only indication for prescribing clindamycin in dentistry is expected penicillin allergy (Medical Products Agency, 2014).

Figure 1.23. Antibiotics (J01 incl. methenamine; metronidazole P01AB01) prescribed by dentists in outpatient care between 2022 and 2024, by age group.



Source: The Public Health Agency of Sweden

Antibiotics in inpatient care

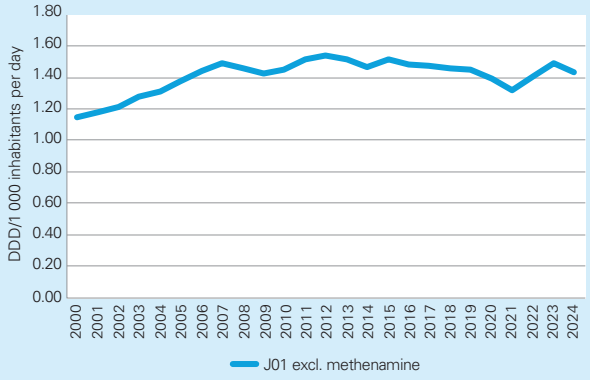
Data in this section include sales to all Swedish hospitals, some but not all nursing homes, and other institutions within health- and social care that procure antibiotics for dispensing to patients or residents. Of the total sales in inpatient care, the proportion of antibiotics dispensed to acute care hospitals varies from region to region. Some challenges associated with this procurement data are further described in *Guidance to readers*. Due to regulations regarding confidentiality of sales data, detailed data for specific substances and groups cannot be shown. However, relevant trends over time are described in the text.

Antibiotic sales in hospitals and other health- and social care facilities

Results

- Total sales of antibiotics (J01 excl. methenamine) to hospitals and other health- and social care facilities were 1.4 DDD/1 000 inhabitants per day in 2024, a 3.9% decrease compared to 2023, Figure 1.24.
- Sales of antibiotics in inpatient care decreased in 20 of 21 regions during 2024, ranging from 1.2 DDD/1 000 inhabitants per day in Skåne region to 1.7 DDD/1 000 inhabitants per day in Kronoberg region, Figure 1.25.

Figure 1.24. Sales of antibiotics (J01 excl. methenamine) to hospitals and other health- and social care facilities between 2000 and 2024.



Source: The Public Health Agency of Sweden

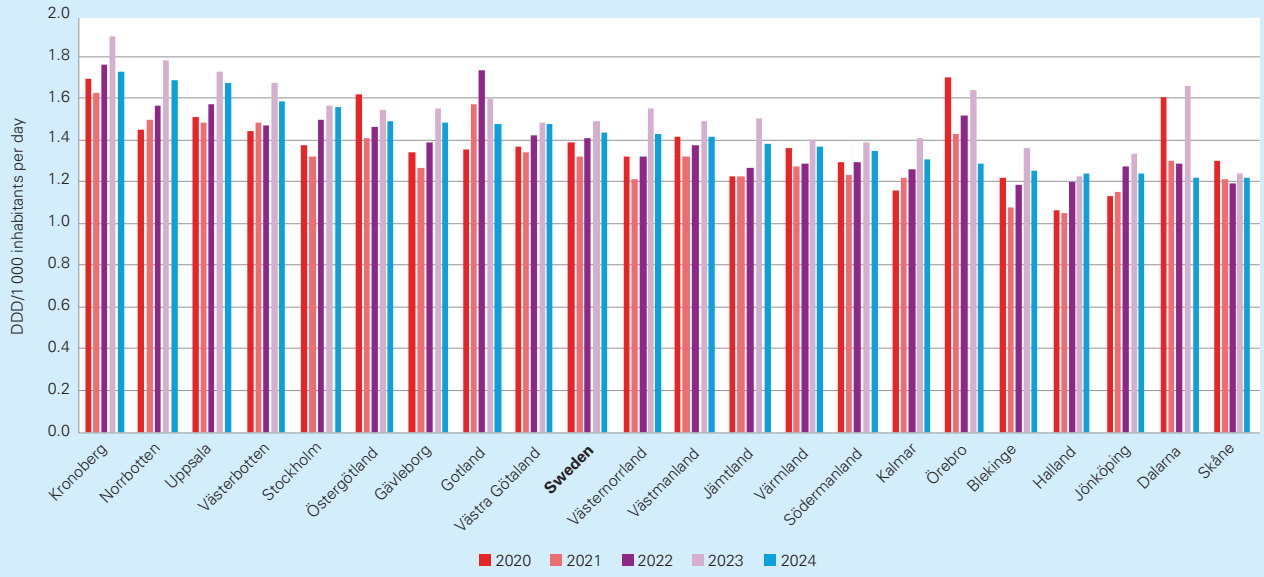
Comments

While antibiotic sales to hospitals and other health- and social care facilities have been relatively stable over the last decade before the COVID-19 pandemic, the observed increase in 2022 and 2023 could be due in part to effects of the pandemic during 2020 and 2021. Substances such as penicillins (J01CE and J01CF) are often used as prophylaxis (Skoog et al., 2016) and a decreased number of surgeries during the COVID-19 pandemic may have reduced the use of these substances (National Board of Health and Welfare, 2021). This disruption could explain why a trend of annual increase in sales of beta-lactamase resistant penicillins was broken after 2020.

Sales of all antibiotics to hospitals and other health- and social care facilities decreased in 2024. However, trends in sales varied for different antibiotic classes. For example, sales of combinations of penicillins (J01CR), specifically piperacillin-tazobactam, have shown a significant increase through the years 2000-2024 (data not shown). An annual decrease was observed for aminoglycosides during the period 2012-2024.

Regional differences in sales of antibiotics in inpatient care can reflect a variety of factors influencing sales. How regions procure antibiotics for nursing homes and other institutions within health- and social care that procure antibiotics for dispensing to patients or residents varies. There are also variations in the type of hospitals, case mix and patient demographics in the regions, and these factors should be taken into account when comparisons are made. For example, the regions Uppsala, Stockholm, Västerbotten, Västra Götaland, Skåne, Östergötland and Örebro all have tertiary referral hospitals with more advanced care.

Figure 1.25. Sales of antibiotics (J01 excl. methenamine) to hospitals and other health- and social care facilities between 2020 and 2024, by region.



Source: The Public Health Agency of Sweden

International recommended targets for antibiotic consumption

Swedish antibiotic prescribing according to the WHO AWaRe classification

WHO AWaRe classification

The World Health Organization (WHO) introduced the AWaRe Classification of Antibiotics in 2017 as a tool to support antibiotic stewardship efforts locally and globally. Since then, it has been updated twice and most recently in 2021 (WHO, 2021).

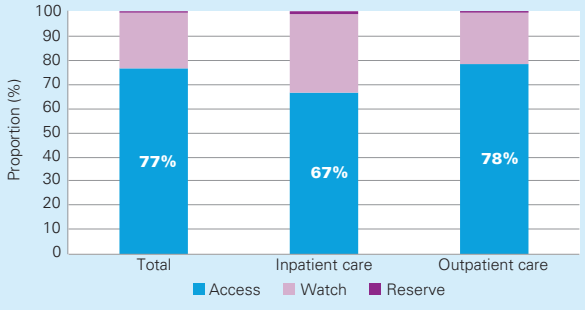
AWaRe classifies antibiotics into three groups based on their impact on antibiotic resistance, i.e. Access, Watch, and Reserve. The Access group includes first- and second-line treatments for common infections, and should be made widely accessible. The Watch group consists of broad-spectrum antibiotics that are used for specific, limited indications. This group includes most of the "highest priority" antibiotics on the WHO list of critically important antimicrobials for human medicine and veterinary use. Finally, the Reserve group includes last-resort antibiotics that should only be used for life-threatening infections caused by multi-drug resistant bacteria where other treatments have failed.

Watch and Reserve group antibiotics are recommended as targets for monitoring and stewardship programs, and the overall goal is to reduce their use. According to a target set by the WHO, at least 60% of all antibiotics consumed in each country should belong to the Access group by 2023. There are no separate targets for hospital and community consumption based on the AWaRe classification. In 2023, the Council of the European Union (EU) has adopted new recommendations aimed to increase efforts to combat antimicrobial resistance, more information in the In Focus section (Council of the European Union, 2023). The recommendation included a slightly more ambitious national target for the percentage of consumption of Access group antibiotics of all the antibiotics listed in the AWaRe classification of at least 65%.

Consumption of Access, Watch, and Reserve antibiotics in Sweden

Based on data from electronic prescribing (outpatient care) and requisitions (inpatient care), 77% of antibiotics (J01 excluding methenamine J01XX05) sold in 2024 were Access antibiotics according to the most recent version of the AWaRe classification. Watch group antibiotics made up 23% of all antibiotics sold, and the remaining 0.3% consisted of Reserve group antibiotics. As expected, the proportion of Watch antibiotics was higher in inpatient care than in outpatient care, i.e. 32% versus 22% (Figure 1.26). Most Reserve antibiotics were sold to inpatient care, but a small proportion was also prescribed in outpatient care and consisted mainly of linezolid, aztreonam and ceftolozane/tazobactam. The sector classified as "inpatient care" also includes antibiotics supplied to other care providers than hospitals, such as some elderly homes and dental care. Thus, it is reasonable to assume that the proportions of Watch and Reserve antibiotics used in hospitals may be higher in reality than the estimates presented here. In addition, due to the inability to include certain antibiotics prescribed and sold on license (see Methods section), it is reasonable to assume that the overall proportions of prescription for these antibiotics may be somewhat underestimated.

Figure 1.26. Relative consumption of Access, Watch and Reserve antibiotics in Sweden in 2024, total and divided by health-care sector.



Source: The Public Health Agency of Sweden

Figure 1.27 A. Relative consumption of Access antibiotics in Sweden between 2000-2024, total and divided by health-care sector.

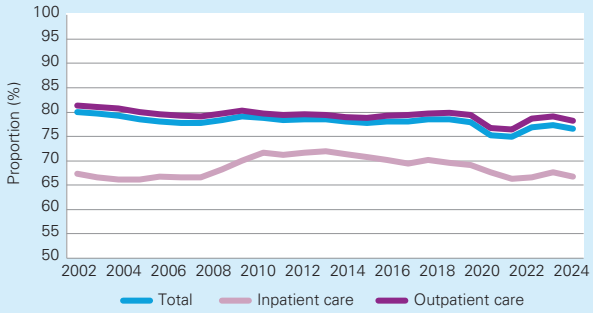


Figure 1.27 B. Relative consumption of Watch antibiotics in Sweden between 2000-2024, total and divided by health-care sector.

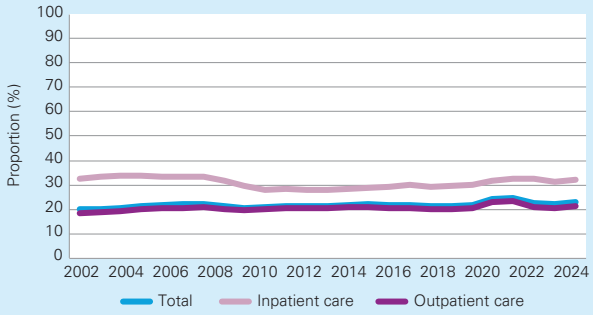
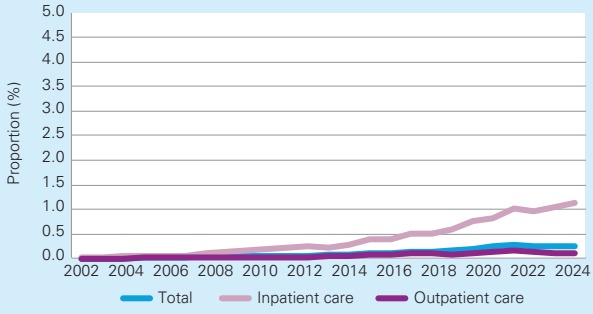


Figure 1.27 C. Relative consumption of Reserve antibiotics in Sweden between 2000-2024, total and divided by health-care sector.



Over the last 20 years, the proportion of Access antibiotics has stayed stable between 77-80%, but a drop was observed during 2020 and 2021 in both outpatient and inpatient care as an effect of the COVID-19 pandemic (Figure 1.27a). Simultaneously, the proportion of Watch antibiotics increased, while the prescribing of Reserve antibiotics has gradually increased since the early 2000s (Figures 1.27b and 1.27c). Therefore, while the total consumption of antibiotics decreased during the COVID-19 pandemic, there seems to have been a shift towards broader spectrum antibiotics. In 2024, there was a slight decrease in the proportion of Access antibiotics sold, as well as a slight increase in the proportion of both Watch and Reserve antibiotic total sales.

Notably, the decrease observed for the proportion of Reserve antibiotics was observed only in outpatient care and the sales for both outpatient and inpatient care have not returned to levels observed before the pandemic. Further analysis over the following years is required to fully observe the effects of the COVID-19 pandemic on antibiotic prescribing according the AWaRe classification.

Sweden exceeds the WHO minimum target for Access antibiotics of 60% and the Council of the EU recommended national target for Access group antibiotics of at least 65%. Note that the Council of the EU used data from ESAC-Net, which includes methenamine (J01XX05) in AWaRe analysis (ECDC, 2023). Including methenamine, Sweden continues to exceed the Council of the EU recommended target of at least 65% Access group antibiotics. Although the consumption of Reserve group antibiotics seems to be low, the increased prescribing of these substances merits further review.

Swedish antibiotic consumption based on the EU Council recommendation on stepping up EU actions to combat antimicrobial resistance in a One Health approach

EU Council recommendations

In June 2023, the Council (EPSCO) adopted the Council Recommendation on stepping up EU action to combat antimicrobial resistance, based on the proposal presented by the European Commission. The Council Recommendation aims to encourage the prudent use of antimicrobials in human and animal health through a series of voluntary measures and to reduce the risk of microorganisms becoming resistant to microbial treatment, including recommended targets for antimicrobial consumption and resistance.

One of the targets included in the recommendation regards ensuring that by 2030, at least 65% of the total consumption of antibiotics in humans belongs to the Access group of antibiotics as defined in the AWaRe classification of the WHO. Antibiotic consumption according to the WHO AWaRe classification in Sweden is described in the previous section.

Consumption of antibiotics in Sweden from 2019-2024

The Council recommendation includes the target that by 2030, the total consumption of antibiotics in humans (in Defined Daily Dose (DDD) per 1 000 inhabitants per day), in the community and hospital sectors combined, is reduced by 20% in the Union compared with the baseline year 2019. The national target for Sweden is a 3% reduction by 2030. Since 2019, the total consumption of antibiotics in humans has decreased by 1.2%. Note that the inclusion criteria and methods used in this report and by ESAC-Net differ (see methods section). For example, this report excludes methenamine (J01XX05) while methenamine is included in ESAC-Net reporting.

Adverse reactions related to antibiotic use

Reported drug-related adverse reactions are continuously entered into BiSi, a national database administered by the Swedish Medical Products Agency. The reports originate both from healthcare professionals and patients. Adverse reactions related to antibiotics between 2020 and 2024 were analysed for various classes of agents.

There were 3 027 reports of side effects caused by the use of antibiotics during this period. The following organ system groups received most reports related to the use of systemic antibiotic drugs: skin- and subcutaneous tissue disorders (n=1 261), gastrointestinal disorders (n=876), general disorders and administration site conditions (n=495), nervous system disorders (n=486), musculoskeletal and connective tissue disorders (n=211), respiratory, thoracic and mediastinal disorders (n=190), immune system disorders (n=134), infections and infestations (n=130), investigations (n=117), reproductive system and breast disorders (n=121), renal and urinary disorders (n=115), psychiatric disorders (n=107) and hepatobiliary disorders (n=106).

The majority of the reports during the five years period (67%) concern female patients, which corresponds to the gender difference seen in sales of antibiotics. The ten antibiotic substances most commonly associated with adverse reactions in the last five years, unadjusted for sold substances and regardless of the cause of the report, are presented in Table 1.1.

Table 1.1. Substances most commonly associated with adverse reactions reported to the Swedish Medical Products Agency 2020-2024.

Antibiotic	Total number of adverse drug reaction reports 2020-2024	Number of 'serious' reports	Number of fatal cases
Penicillin V (J01CE02)	397	63	0
Flucloxacillin (J01CF05)	273	121	1
Ciprofloxacin (J01MA02)	244	142	2
Nitrofurantoin (J01XE01)	231	57	2
Trimethoprim and sulphamethoxazole (J01EE01)	217	114	3
Clindamycin (J01FF01)	206	67	2
Doxycycline (J01AA02)	163	20	1
Amoxicillin (J01CA04)	150	43	0
Pivmecillinam (J01CA08)	109	20	0
Piperacillin and beta-lactamase inhibitor (J01CR05)	108	64	2

Antibiotic Smart Sweden – A collaborative and innovative approach for engaging the whole society

Antibiotic Smart Sweden is an innovation initiative where different stakeholders drive change together to prevent infections and promote responsible use of antibiotics. The work draws on experience and practices developed in Sweden over many years, including those of the Swedish Strategic Programme Against Antibiotic Resistance (Strama) and efforts within Infection Prevention and Control (IPC), and has been developed to reinforce, complement and spread those efforts. For the initial five years, Antibiotic Smart Sweden was funded by the Swedish innovation agency, Vinnova, under the funding call "Vision-driven health".

The vision of Antibiotic Smart Sweden is a society where everyone helps to keep antibiotics working and saving lives.

During 2019-2025, Antibiotic Smart Sweden was led by the Public Health Agency of Sweden and RISE – Research Institutes of Sweden in collaboration with Strama – the Strategic Program Against Antibiotic Resistance, ReAct – Action on Antibiotic Resistance, and several Swedish municipalities and regions.

At the beginning of the initiative in 2019, Antibiotic Smart Sweden identified and analysed gaps in the Swedish work against antimicrobial resistance. The findings revealed that while good working methods exist, they are not sufficiently disseminated or systematically implemented. The analysis also showed that actors in society with a potential to contribute, often do not fully understand their possible role in tackling antimicrobial resistance, and collaboration between those who are already working on the issue is often inadequate.

Finally, the analysis revealed that stakeholders within target groups are not sufficiently involved in design and development of local interventions.

In response to these gaps and to get closer to its vision, Antibiotic Smart Sweden aims to:

- Inspire and motivate all parts of Swedish society to participate in efforts to address antibiotic resistance
- Assist everyone in understanding their role and how they can contribute
- Build knowledge and create structures and opportunities for collaboration to support change in individuals and organisations

Grounded in implementation and behavioural sciences, the initiative builds on three overarching goals with the aim to create synergies: Antibiotic Smart People, Antibiotic Smart Municipalities & Regions, and improved National and International Collaboration. Activities under these three goals are briefly described below.

Antibiotic Smart People

Within this goal, the initiative explores ways to involve citizens more actively through community engagement, using participatory processes and systematic approaches to behaviour change. It also provides adapted support for target groups to help residents understand the problem and contribute to solutions. Activities include collaboration with different organisations to create opportunities for dialogue, for instance in pharmacies, through patient organisations, immigrant networks and in educational settings.

Antibiotic Smart Municipalities & Regions

At the core of Antibiotic Smart Sweden is the framework for criteria for regions and municipalities. The criteria aim to inspire action and encourage commitment from Swedish regions, municipalities and their societal services. They provide a structured approach and serve as a guide to help integrate actions against antibiotic resistance in routines and everyday work, such as preventing infections and using antibiotics responsibly. Examples include integrating antibiotic stewardship and IPC in health care through organisational development, collaboration and professional development. In preschools, this could be done by involving both personnel and children in hygiene routines and education. The criteria are now available for municipal and regional governance levels as well as for preschools, schools, long-term care, water & wastewater treatment plants, primary healthcare centres and hospitals. Once the criteria have been fulfilled, the organisation becomes "Antibiotic Smart" and receives a diploma. The criteria were developed in a collaborative process together with professionals and stakeholders within different societal sectors. Almost 100 organisations participated in pilots to test the criteria.

The criteria were launched in 2024 and so far, 19 organisations have received a diploma and another 90 are working towards this goal.

National and International Collaboration

The Swedish Intersectoral Coordinating Mechanism is led by the Public Health Agency of Sweden and the Swedish Board of Agriculture and consists of 26 authorities and organisations. In addition to these authorities and organisations, there are several other actors with an interest in antibiotic resistance. Through regular digital meetings, Antibiotic Smart Sweden offers a complementary forum for networking and the exchange of ideas among Swedish stakeholders.

Antibiotic Smart Sweden engages in international exchange to share experiences and inspiration. The framework for developing criteria is flexible and can be applied to other geographical contexts, and be used as a tool to help countries implement aspects of their National Action Plans. In 2024, Antibiotic Smart Sweden launched the website *Overview of Sweden's One Health response to Antibiotic Resistance*, with the aim to share information about the broad national collaborative efforts among Swedish stakeholders.

Antibiotic Smart Sweden moving forward

From May 2025, The Public Health Agency of Sweden assumed responsibility for coordinating Antibiotic Smart Sweden in continued collaboration with several actors. This involves management, communication, dissemination and development of the criteria framework. It also includes engaging facilitators that can provide local support to implement the criteria. When everyone in society knows what kind of contribution they can make, and has the ability and incentive to act, we are one step closer to achieving our vision of a society resilient against infections and resistant bacteria.

Figure 1. Antibiotic Smart Sweden – a society where everyone helps to keep antibiotics working and saving lives

Källa: ©Antrop/Antibiotic Smart Sweden

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Antibiotic use in humans in Sweden without a prescription

In Sweden, antibiotics are to be sold by prescription or requisition only. Laws and regulations make it possible to follow up antibiotic sales from pharmacies and to healthcare centers such as hospitals in Sweden. There are, however, other ways for individuals to acquire antibiotics. For example, people can purchase antibiotics while traveling abroad in countries with fewer restrictions regarding antibiotic sales, purchase antibiotics online or use leftover antibiotics from a previous treatment without being instructed by a doctor to do so. These acquisitions are by their nature more challenging to quantify and follow up. This article will summarise information from relevant sources regarding antibiotic acquisition and/or use without a prescription in humans in Sweden.

Various studies and surveys have looked into use of antibiotics without a prescription in Sweden. A 2017 survey from the Public Health Agency of Sweden looked into antibiotic use without a prescription in respondents representative of the Swedish population (PHAS, 2017). Of the respondents who answered that they had taken antibiotics in the last year, 7% reported using leftover antibiotics that had previously been prescribed and 2% reported using antibiotics prescribed for someone else. Fewer than 2% of respondents reported having purchased antibiotics without a prescription online or abroad.

According to the Eurobarometer results from 2022, approximately 11% of Swedish respondents that had taken antibiotics during the last year had not obtained them from a medical practitioner (European Union, 2022). This proportion was both higher than the EU average (8%) and the result from 2018 (2%). The total proportion of respondents who had taken antibiotics in the last year regardless of how the antibiotics were acquired decreased.

A Swedish study from 2021 found that 2% of the respondents had acquired antibiotics in the last five years without a prescription from a Swedish doctor (Munthe et al, 2022). Less than half of these respondents had a prescription from a doctor outside of Sweden. In addition, 4% of respondents stated that they would be likely to obtain antibiotics without a prescription from a Swedish doctor in the future. This study found an association between a lack of trust in healthcare and the likelihood of acquiring antibiotics without a prescription.

While the volume of imported antibiotics from online sales and/or travel abroad is unknown, an anecdotal report from a customs inspector at Arlanda international airport in April 2025 indicates that antibiotics are regularly found in custom checks, for example at airports (Ericson, 2025). These antibiotics are generally not confiscated since it is permitted to bring at least a three-month supply of a medication in to the country (MPA, 2023). It is possible to purchase antibiotics without a prescription online from illegitimate providers. The Swedish Medical Products Agency (MPA) warns of potential dangers of purchasing antibiotics online on their website.

In summary, the various data sources regarding the acquisition of antibiotics without a prescription provide varied results. Therefore, approximating the extent of the problem is a continuous challenge. Further studies regarding the acquisition of antibiotics, including motives for doing so, can improve efforts to reduce such behaviors. A group of general practitioners is planning a research study for the fall of 2025, to document the intake of antibiotics found during routine customs checks at airports. The issue is also being discussed in different forums for broad collaboration in how to move forward.

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Sales of antibiotics for animals

Brief on data sources, methodology and confidentiality

In Sweden, all veterinary medicinal products are sold by pharmacies. All pharmacies are obliged to report all sales of medicinal and veterinary medicinal products to the Swedish eHealth Agency which maintains a database of sales from pharmacies to animal owners (prescriptions dispensed) and to veterinarians (requisition for use in practice).

For confidentiality reasons, sales of classes of antibiotics with less than three products on the market have been aggregated as "others" in Table 2.1.

The sales of veterinary medicinal products for mixing into feed used for aquaculture for food production are not included in the data referred to above, as such feed is traded from other countries. Data on prescriptions for fish are collected through a separate system, see Comments by animal species, Fish.

Further details on data sources and inclusion criteria are given in Materials and methods, sales of antibiotics.

Trends in animal populations

Changes in the numbers of animals may affect trends in statistics on sales of antibiotics. Compared to 2015, the number of pigs slaughtered in 2024 was approximately equal, while the number of broilers increased by 16%. The number of dairy cows decreased by 15% during the same period. The number of horses was estimated to 355 500 in 2016.

The number of dogs was estimated to 784 000 in 2012 and 881 000 in 2017.

Further details on animal numbers and data sources are found in the subchapter Demographics and denominator data in this report.

Completeness of data

Until 2009, pharmacies in Sweden were run as a monopoly by a state-owned co-operation. In July 2009, the Swedish pharmacy market was re-regulated and today, there are many pharmacies competing on the market. Some of those have niched in veterinary medicinal products, and they are allowed to sell on distance to animal owners and to veterinarians.

At the time of the re-regulation, the responsibility to collect sales data from pharmacies was transferred from the monopoly to a state-owned infrastructure company, and a few years later, in 2014, to the newly formed Swedish eHealth Agency. All pharmacies are obliged to report all sales of medicinal and veterinary medicinal products to the Swedish eHealth Agency and are supervised by the Medical Products Agency.

Between 2010 and 2015, there were two different problems resulting in lack of completeness of data. Sales of products sold on special license were incomplete between 2011 and 2013 due to system change. In 2013, concerns were also raised about a more general lack of completeness in the sales reported by pharmacies. The overall lack of completeness was estimated by SVA in collaboration with Marketing authorization holders and was in the range of 5 to 10%. The problem persisted until 2015.

A lack of completeness was also identified for 2017-2021. The cause was identified and corrected. Consequently, data for that period have been updated as from Swedres-Svarm 2022. Furthermore, the difference between 2021 and 2022 was inexplicably large (-12%). Despite a thorough search, no errors were identified, and there was no indication of a corresponding decrease in sales of non-antibiotic veterinary medicinal products. (For more information, see Swedres-Svarm 2022).

Overall sales

The total yearly sales of antibiotics for animals over the last decade are presented in Table 2.1. The potencies of different antibiotics are not equal and therefore, each class should be evaluated separately.

Of the overall sales expressed as kg active substance, around 90% are products formulated for treatment of individual animals (injectables, tablets, intramammaries etc) and around 10% for treatment of groups or flocks (premixes, oral powders, solutions for in-water medication). In 2024, the total reported sales from Swedish pharmacies of antibiotics authorised for veterinary use were 9 088 kg, of which 58% was benzylpenicillin. The corresponding figures for 2015 were 10 086 kg and 54%, respectively.

Since 2015, sales of all classes of antibiotics, except aminoglycosides, have decreased or remained stable (Table 2.1). Compared to earlier years, sales of aminoglycosides increased notably in 2022 and 2023, followed by a modest decrease in 2024. This is explained by an increased use of aminoglycosides for treatment of post-weaning diarrhoea in pigs following the withdrawal of veterinary medicinal products with high levels of zinc oxide in 2022, see Comments on data by animal species, Pigs.

Figure 2.1. Proportion (%) of sales on special license of total sales of antibiotics for animals (as kg active substance).

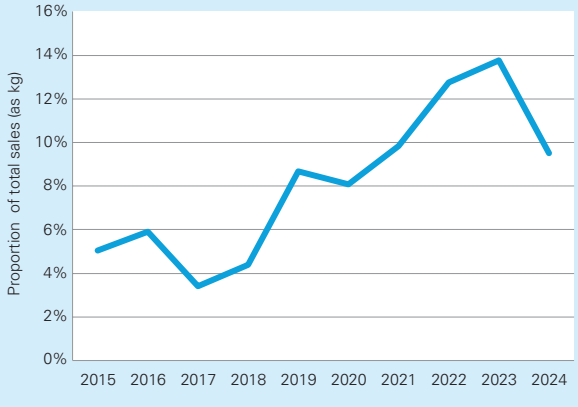


Table 2.1. Yearly sales of antibiotic veterinary medicinal products expressed as kg active substance per class[a].

ATCvet code	Class or subclass	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
QJ01AA, QG01A	Tetracyclines	685	515	529	516	524	638	748	573	661	594
QJ01CE,-R, QJ51	Benzylpenicillin[b]	5 479	5 620	5 591	5 597	5 525	5 795	5 872	5 130	5 024	5 315
QJ01CA, QJ01CR	Aminopenicillins	642	677	638	670	643	759	664	612	652	644
QJ01D	Cephalosporins	267	242	210	187	161	163	164	150	114	132
QA07AA, QJ01G,-R, QJ51R	Aminoglycosides	322	312	302	376	343	404	366	506	661	514
QA07AB, QJ01E	Trimethoprim-sulphonamides	1 947	1 961	2 009	1 839	1 739	1 803	1 715	1 417	1 494	1 461
QJ01F	Macrolides & lincosamides	485	472	527	581	486	449	419	400	407	353
QJ01MA	Fluoroquinolones	34	30	25	30	21	28	22	16	16	15
QA07AA,QJ01BA, QJ01XQ	Others[c]	224	337	149	220	114	137	69	60	45	60
Total sales		**10 086**	**10 165**	**9 981**	**10 016**	**9 557**	**10 175**	**10 039**	**8 865**	**9 074**	**9 088**

[a]Data from 2015 are uncertain because of a lack of completeness mainly affecting injectable products; [b]Also includes small amounts of phenoxymethylpenicillin and penicillinase stable penicillins; [c]Others: amphenicols, pleuromutilins and polymyxins.

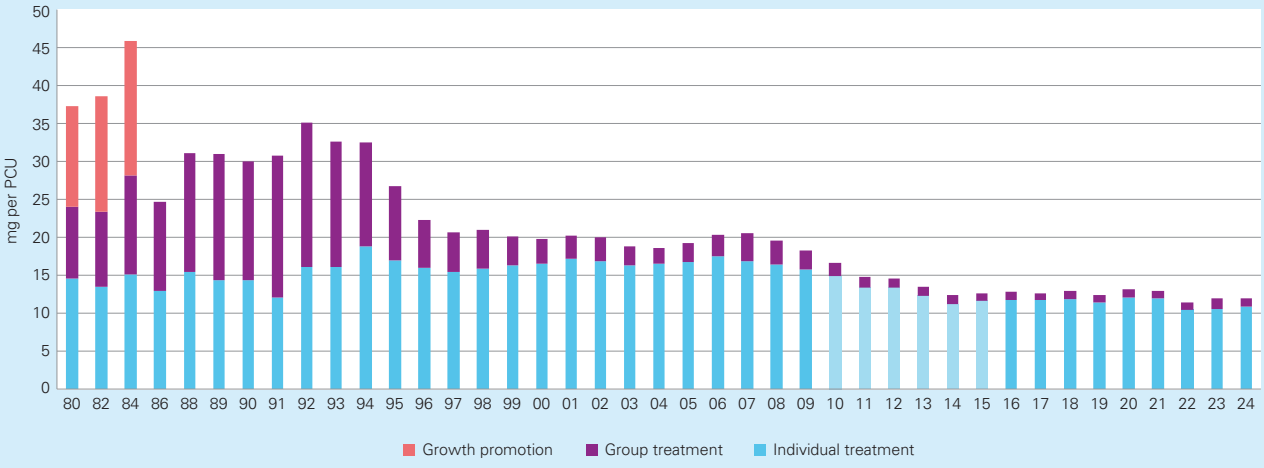
The proportion of sales of products on special license (in accordance with article 116 of Regulation (EU) 2019/6) of the total sales in kg active substance increased from between 4% and 6% in 2014-2018 to 14% in 2023, followed by a decrease to 10% in 2024 (Figure 2.1). The Swedish market for veterinary antibiotics is small, and for some therapy areas there are no suitable products authorised nationally. An example of that is products for treatment of post-weaning diarrhoea in pigs via water, where today products with aminoglycosides from other countries are sold on special license. Furthermore, for some substance-formulation types there are only one or two products with general marketing authorisation. When there are shortages of such products on the Swedish market, sales of similar products on special license are used to supplement. One example is that the two nationally authorised injectable products with trimethoprim-sulphonamides were unavailable on the market from 2019 until late 2024. The renewed availability of products with marketing authorisations in that class reduced the proportion of products sold on special license in 2024.

Population corrected data

To correct for changes in the numbers of animals over time, a population correction unit (PCU) described in a publication from the European Medicines Agency was applied (EMA, 2011). The PCU is a purely technical term representing an approximation of the summed live weight of the major animal populations, excluding companion animals.

In Figure 2.2, the total sales of antibiotics for animals (including sales for companion animals) from 1980 and onward are presented as mg active substance per PCU, using figures for 2023 as a proxy for PCU in 2024. As sales for use in aquaculture are not included in the data presented, fish

Figure 2.2. Yearly sales of antibiotics for animals expressed as mg per population correction unit (PCU)[a]. Uncertain figures are indicated with a lighter shade.



[a]Data from 2010-2015 are uncertain because of a lack of completeness mainly affecting injectable products. In the present figure, no attempts have been made to exclude products authorised for companion animals only, in contrast to data presented as mg per PCU in reports published by the European Medicines Agency.

have been excluded from the PCU given in the reports from ESVAC. Another difference from data published in the ESVAC-reports is that in Figure 2.2, data on products for use in companion animals are included.

Measured as mg per PCU, the overall sales were around 70% lower in 2024 compared to the average figures for 1980-1984 (i.e. before the Swedish ban on growth-promoting antimicrobials in 1986). This is explained first by the removal of growth-promoting antimicrobials in 1986, followed from the mid-90s onward by a major gradual decrease in the sales of veterinary products for medication via feed or water (group medication). A decrease in sales of products for individual medication was also noted in the past decade.

The Antimicrobial ad hoc expert group (AMEG) of EMA considers 3rd generation cephalosporins, fluoroquinolones and polymyxins as classes of antibiotics for which there should be special restrictions regarding their use in animals (category B, restrict) (EMA, 2019). Since 2015, the sales of these antibiotics, expressed as mg/PCU, have decreased considerably and have been below or much below 0.1 mg/PCU. For the 3rd generation cephalosporins and fluoroquinolones, the decrease is explained by a Swedish regulation that since 2013 limits veterinarians' rights to prescribe or use these types of antimicrobials (SJVFS 2023:21). As to polymyxins, the findings of transferable resistance to colistin were communicated to stakeholders during 2016 and onwards. An awareness among prescribers of the importance of this class of antimicrobials for public health, and of the potential consequences of transferable resistance, is a probable explanation for the observed decrease. Use of colistin has increasingly been replaced with use of antibiotics in other classes, e.g. aminoglycosides. From late 2023, veterinarians' right to prescribe polymyxins is also restricted by regulation SJVFS 2023:21.

Comments on data by animal species

Pigs

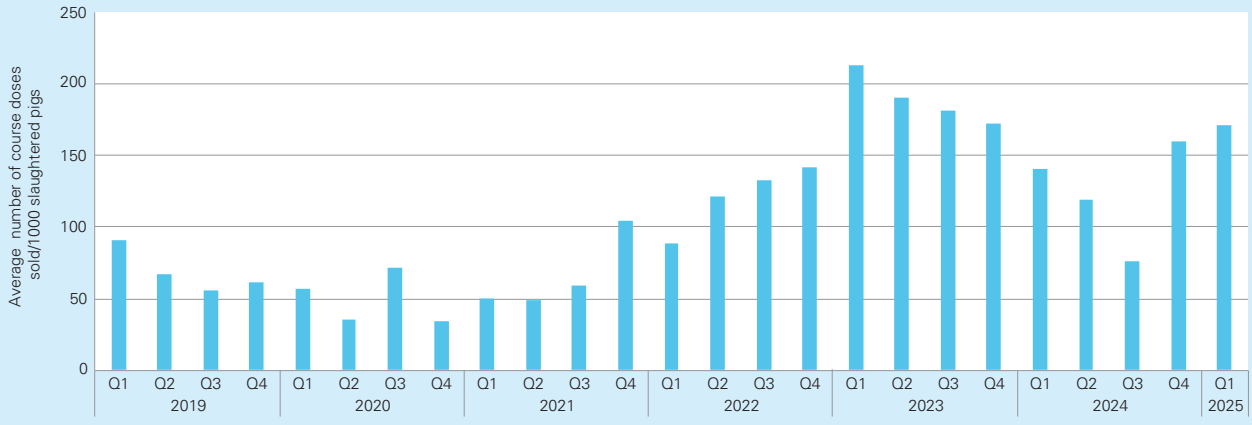
Antibiotics for pigs are predominantly sold on veterinary prescription by pharmacies to the animal owner, and information on species is recorded by the pharmacy. Sales reported by pharmacies as prescriptions for pigs are therefore believed to closely reflect sales in commercial herds.

In 2015 and 2024 the sales of antibiotics for pigs (pet pigs included) were 2 732 and 3 316 kg active substance, respectively, or 11,7 and 13,5 mg/kg slaughtered pig. The apparent increase is largely explained by an increased need to treat post-weaning diarrhoea after the 2022 withdrawal of products with high levels of zinc oxide formerly used for prevention. The sales of relevant products, containing neomycin, paromomycin, or colistin for oral group treatment, classified under ATCvet code QA07AA and all sold on special license, have been explored. Course doses were calculated by multiplying the dosage indicated in the product information of each product by an assumed standard weight of 12 kg for weaner pigs and a treatment duration of 3 days. The number of course doses sold one month was divided by the number of pigs slaughtered five months later, and the average number of course doses per 1000 slaughtered pigs quarterly for 2019-2023 is shown in Figure 2.3. When interpreting the data, it is important to note that actual use of the products may take place later than the sales.

Of the total sales for pigs in kg active substance in 2024, around 76% were products for use in individual animals, and of those 68% were products containing benzylpenicillin.

Sales of fluoroquinolones for use in pigs were negligible, and no cephalosporins were sold for pigs in 2024. In Sweden,

Figure 2.3. Quarterly (Q) sales of products for group medication of diarrhoea in weaner pigs, expressed as course doses for pigs divided by number of pigs slaughtered five months later.



The withdrawal of high dose zinc products occurred between the second and third quarters of 2022.

products with polymyxins (colistin) for oral use are only used for pigs. As noted under Population corrected overall sales, a marked decrease in sales has been noted since 2016 and sales are today most likely limited to cases where no alternatives are available.

Chickens

Antibiotics are rarely used for treatment of bacterial diseases in commercially reared *Gallus gallus*. Localised outbreaks can therefore have a major influence on the sales in a specific year. Over the last ten years, the yearly sales of fluoroquinolones for slaughter chickens and hens have been below or much below 0.25 kg. Cephalosporins or colistin have never been used in broiler production in Sweden.

From 2011, the Swedish poultry meat association requests all treatments of broilers, parents, and grandparents to be reported as part of the Poultry health control programme. The programme covers more than 98% of the broilers reared in commercial production. The number of treated flocks and number of flocks produced per year are shown in Table 2.2.

The reported use in 2024 corresponds to 0.05 mg active substance/kg slaughtered chicken. Of the seven flocks reported as treated, four were administered phenoxymethylpenicillin against necrotic enteritis, and three received trimethoprim-sulphonamides against colibacillosis. In addition, parent flocks were treated with phenoxymethylpenicillin on two occasions. No grand-parent flock was treated.

Table 2.2. Number of flocks treated with antibiotics and total number of flocks produced per year.

Year	Number of flocks produced	Number of flocks treated
2013	3 133	4
2014	3 138	4
2015	3 191	28
2016	3 300	14
2017	3 300	1
2018	3 223	4
2019	3 368	54
2020	3 557	11
2021	3 684	13
2022	3 470	10
2023	3 490	9
2024	3 621	7

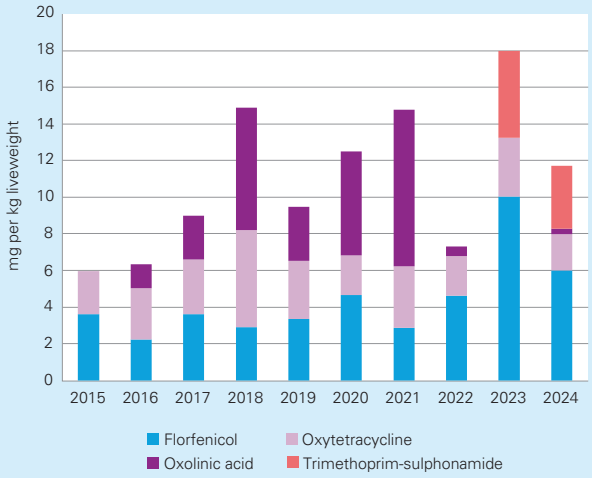
Coccidiostats of the ionophore group are used as feed additives to control coccidiosis in the production of chickens for slaughter and for turkeys. Since the late 80s, narasin is by far the most widely used substance for broilers.

Fish

Medicated feed for fish is always traded from other Nordic countries. Therefore, the quantities sold are not captured by the national pharmacy sales collected by the Swedish eHealth Agency. Records of prescription of veterinary medicines for fish are collected annually by the veterinarian co-ordinating the limited number of veterinarians that deal with farmed fish and results are reported annually to the Board of Agriculture.

The occurrence of bacterial disease in farmed fish is influenced by water temperatures in summer, and the amounts prescribed may therefore vary between the years. Antibiotics prescribed in 2024 were products with florfenicol, oxolinic acid, oxytetracycline, and trimethoprim-sulphonamide.

Figure 2.4. Prescription of antibiotics for fish as mg per kg live weight of slaughtered fish.



In Figure 2.4, the prescription of antibiotics for fish is shown as mg per kg biomass produced (liveweight fish slaughtered). Florfenicol is primarily used for treatment of flavobacteriosis *(Flavobacterium psychrophilum)*, a disease mainly affecting juveniles (with a very low weight). Oxolinic acid and oxytetracycline are used to treat diseases caused by *Aeromonas salmonicida* and *F. columnare*. These are diseases affecting production fish, i.e. of a higher weight. Therefore, the relations between the antibiotics shown in Figure 2.4 do not translate to treatment frequencies or actual exposure of individual fish.

Horses

In 2024, sales of trimethoprim-sulphonamides formulated for oral use in horses (paste or powder) was 11% of the total sales, and 69% of the sales of all products with trimethoprim-sulphonamides. Since 2015, there has been a decrease in sales of trimethoprim-sulphonamides formulated for oral use in horses by 6%, measured as kg active substance. It is unclear if this decrease reflects increased adherence to guidelines or simply a decreasing number of horses, given that the latest population estimate is from 2016.

The sales of other antibiotics for horses cannot be estimated, as such products are frequently sold on requisition and administered by the veterinarian in connection with a clinical examination in ambulatory practice, in clinics, or in hospitals.

Dogs and cats

In 2024, the overall sales of veterinary medicinal products for oral medication of dogs were 489 kg compared to 804 kg in 2015. The corresponding figures for cats were 84 and 75 kg, respectively. As in previous years, aminopenicillins (with and without clavulanic acid), first generation cephalosporins and lincosamides were the classes with largest sales for dogs in 2024. For cats, products with aminopenicillins were by far the most sold (80%).

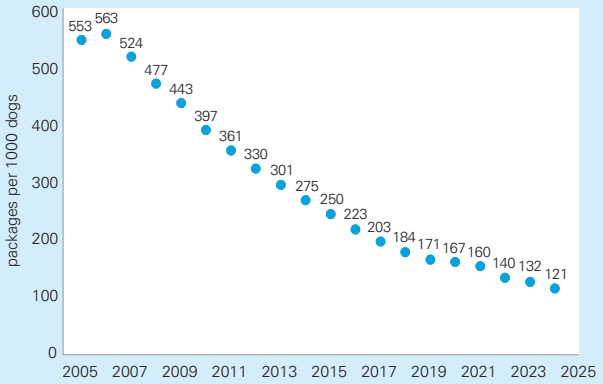
The total number of packages, including both veterinary antibiotics and those authorised for use in humans, dispensed in 2024 for dogs were 123 713, and for cats 66 307. The corresponding figures for 2006 were 410 732 and 140 067, respectively.

In 2006, sales for dogs corresponded to 563 packages per 1000 dogs. Since then, sales have decreased to 121 packages per 1000 dogs (-78%) in 2024 (Figure 2.5). The latest estimate of number of dogs is from 2017, and population growth thereafter has been estimated based on rate of change since the previous estimate in 2012. The most prominent changes relative to 2006 are noted for first generation cephalosporins (-91%), fluoroquinolones (-95%) and aminopenicillins with clavulanic acid (-87%).

As described in Svarm 2008, the emergence of infections with multiresistant methicillin-resistant *Staphylococcus pseudintermedius* and methicillin-resistant *S. aureus* triggered several national and local initiatives. This has most likely led to changes in prescribers' behaviour, which in turn explains the downward trend in sales of antibiotics for dogs shown in Figure 2.5.

The estimated numbers of cats are old and uncertain, hence no calculations to correct for population size were made.

Figure 2.5. Sales of antibiotics for oral medication of dogs expressed as packages per 1 000 dogs. Data include antibiotics authorised for veterinary use as well as antibiotics for human use.



Antibiotic resistance in humans

Overview of surveillance systems and methods for antibiotic susceptibility testing

All surveillance of antibiotic resistance in Sweden relies on results from the clinical microbiology laboratories. The laboratories use the methods and breakpoints recommended by NordicAST for susceptibility testing. This Nordic organisation supports the implementation of EUCAST recommendations in the Nordic countries. National resistance surveillance is based on data from different sources and collections (Table 3.1).

Table 3.1. Summary of species and types of resistance included in national sureveillance of antibiotic resistance in Sweden.

Species, group or type	Sampling
Mandatory reporting (SmiNet)	
Enterobacterales with ESBL Enterobacterales with $ESBL_{CARBA}$ *Staphylococcus aureus* resistant to methicillin *Streptococcus pneumoniae* with reduced susceptible to penicillin G *Enterococcus faecium* or *Enterococcus faecalis* resistant to vancomycin *Mycobacterium tuberculosis*[a] *Neisseria gonorrhoeae*[a]	Samples of all types for clinical, screening or case finding purposes
Neisseria meningitidis[a]	Invasive disease (blood, CSF, or other normally sterile sample)
Voluntary surveillance (Svebar)	
Escherichia coli	Clinical sampling from blood and urine
Klebsiella pneumonia	Clinical sampling from blood and urine
Staphylococcus aureus	Clinical sampling from blood and skin and soft tissue infections
Streptococcus pneumoniae	Clinical sampling from blood
Enterococcus faecalis *Enterococcus faecium*	Clinical sampling from blood
Pseudomonas aeruginosa	Clinical sampling from blood and non respiratory infections
Acinetobacter spp.	Clinical sampling from blood
Haemophilus influenza	Clinical sampling from blood and nasopharynx
Streptococcus pyogenes *Streptococcus agalacticae*	Clinical sampling from blood
Clostridioides difficile[b]	Clinical sampling from faeces
Salmonella spp[c]	Clinical sampling from blood, faeces and urine
Campylobacter jejuni[c]	Clinical sampling from faeces
Shigella spp[c]	Clinical sampling from faeces
Microbiological characterisation programme	
Enterobacterales with $ESBL_{CARBA}$	All isolates from clinical, screening or case finding samples producing $ESBL_{CARBA}$
Enterobacterales with resistance to cefiderocol, ceftazidim-avibactam, colistin, imipenem-relebactam or meropenem-vabrobactam	Isolates from clinical, screening or case finding samples[d]
Acinetobacter spp. with $ESBL_{CARBA}$	All isolates from clinical, screening or case finding samples with reduced susceptibility to meropenem
Acinetobacter spp. with resistance to cefiderocol	Isolates from clinical, screening or case finding samples
Pseudomonas spp. with $ESBL_{CARBA}$	All isolates from clinical, screening or case finding samples producing $ESBL_{CARBA}$
Pseudomonas spp. with resistance to cefiderocol	Isolates from clinical, screening or case finding samples[d]
Staphylococcus aureus resistant to methicillin	All isolates from clinical samples
Streptococcus pneumoniae with reduced susceptible to penicillin G (MIC ≥ 0.5)	All isolates from clinical, screening or case finding samples
Enterococcus faecium or *Enterococcus faecalis* resistant to vancomycin or linezolid	All isolates from clinical, screening or case finding samples
Shigella sonnei resistant to cefotaxim/ceftazidim and ciprofloxaccin	All isolates
Haemophilus influenzae with cephalosporin resistance	All isolates from clinical, screening or case finding samples

[a]All infections with these bacteria are mandatory to report. Antibiotic resistance data are acquired from these surveillance programs. [b]A separate voluntary surveillance programme based on reports from laboratories. [c]All infections with these bacteria are mandatory to report. However, the antibiotic resistance data are acquired through voluntary reporting in Svebar. [d]With some exceptions, plese see www.folkhalsomyndigheten.se for details.

Indicators of antibiotic resistance

Since 2020, the proportions of cefotaxime resistant *Escherichia coli* (ESBL) and methicillin-resistant *Staphylococcus aureus* (MRSA) in blood isolates have been used as indicators of antibiotic resistance in Sweden. The results for these are presented under their respective section. In 2023, the EU Council issued recommendations on tackling AMR. Targets to be reached by 2030 were set for each member state. Sweden's targets, as described in the Council recommendation, include a 3% reduction of the incidence of MRSA sepsis, a 10% reduction for the incidence of ESBL-producing *E. coli* sepsis and an unchanged incidence of carbapenem resistant *Klebsiella pneumoniae* sepsis, compared to 2019. Considering the observed trends for the indicators used since 2020, these are ambitious targets.

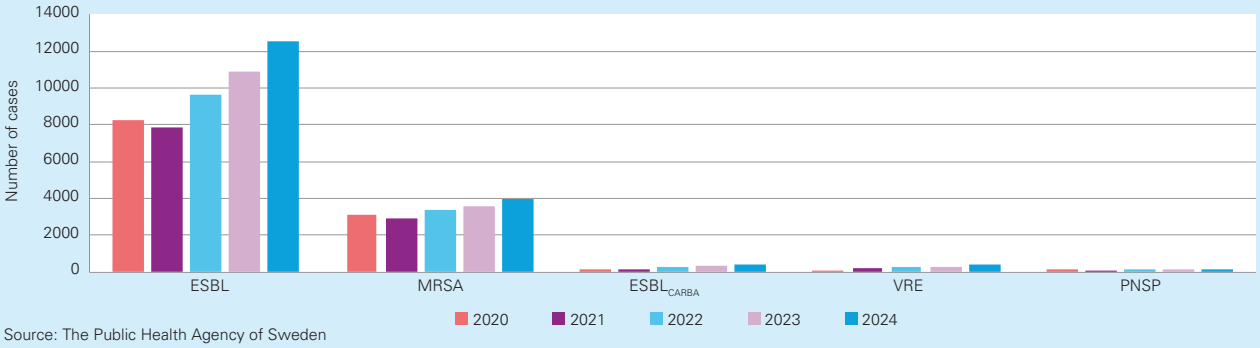
Notifiable diseases

Four types of antibiotic resistance in bacteria are included in the Swedish Communicable Diseases Act. These are *Staphylococcus aureus* resistant to methicillin (MRSA), *Streptococcus pneumoniae* with reduced susceptibility or resistance to penicillin (PNSP), *Enterococcus faecalis* and *Enterococcus faecium* resistant to vancomycin (*van*A or *van*B, VRE), and Enterobacterales with ESBL (including AmpC) or $ESBL_{CARBA}$. However, ESBL and $ESBL_{CARBA}$ are reported separately. As in previous years, the notifications of ESBL have greatly exceeded the other three (Figure 3.1 and Table 3.2).

Voluntary surveillance based on clinical samples

This surveillance uses results collected from the regional clinical microbiology laboratories. From 2015 and onwards, all data on clinical isolates from humans have been collected through Svebar. This is a system that automatically collects all culture results from participating clinical microbiology laboratories. Currently, 22 laboratories deliver data to Svebar (May 2025). It is not possible to deduplicate data from Svebar since personal identification is not included in the system. Consequently, duplicate findings from blood and other samples are included. Patients with highly resistant isolates tend to be sampled more frequently, which could overestimate the resistance levels in some cases (Table 3.3). Most antibiotic resistance levels presented in this report are based on non-selective susceptibility testing from at least five laboratories, thus avoiding bias from hierarchical testing and regional differences. When data presented are based on selective testing, this will be indicated in the graphs and tables. The number of AST isolates for each species and antibiotic combination is given in the attached file. The 95% confidence intervals

Figure 3.1. Number of mandatory reported cases 2020-2024.



Source: The Public Health Agency of Sweden

Table 3.2. Summary of results for mandatory reported antibiotic resistance 2024.

	ESBL	$ESBL_{CARBA}$	MRSA	PNSP	VRE
Number of cases (incidence)	12 527 (118)	410 (3.9)	3 937 (37)	148 (1.4)	390 (3.7)
Proportion clinical infection	72%	39%	54%	53%	8%
Gender	66% women	53% men	52% women	55% men	58% men
Median-age (range)	60 years (0-100+)	61 years (0-98)	35 years (0-100+)	51 years (0-93)	75 years (13-99)
Proportion of domestic cases	No information	37% (8% no data)	62% (12% no data)	45% (44% no data)	63% (5% no data)
Short epidemiological information	Community and health-care	Hospital abroad	Community	Community	Hospital, domestic spread
Bloodstream infections	1 055 (790 new cases 2024, 265 cases known from previous years)	22 (16 new cases 2024, 6 cases known from previous years)	123 (102 new cases 2024, 21 cases known from previous years)	12	6

Table 3.3. Number of laboratories used for antibiotic resistance calculations among clinical cases during 2015-2024.

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Number of clinical microbiology laboratories	9	9	10	9	20	21	22	22	22	22
Coverage of population (%)	52	52	55	52	78	86	89	89	89	89

are presented in figures showing resistance. The confidence intervals are given from 2015 and onwards.

Data from Svebar are used for reporting both to EARS-Net (an ECDC surveillance system) and to GLASS (a WHO surveillance system). Prior to 2015, ResNet, a national surveillance programme on antibiotic resistance, was used to collect data. From 2015 and onwards, these yearly data are based on SIR reported by the clinical microbiology laboratories to Svebar.

Microbiological characterisation program

The Public Health Agency of Sweden provides microbiological characterisation programs for verification and characterisation of isolates that participating laboratories send in. An overview is given in Table 3.1.

Overview of sampling and culture results

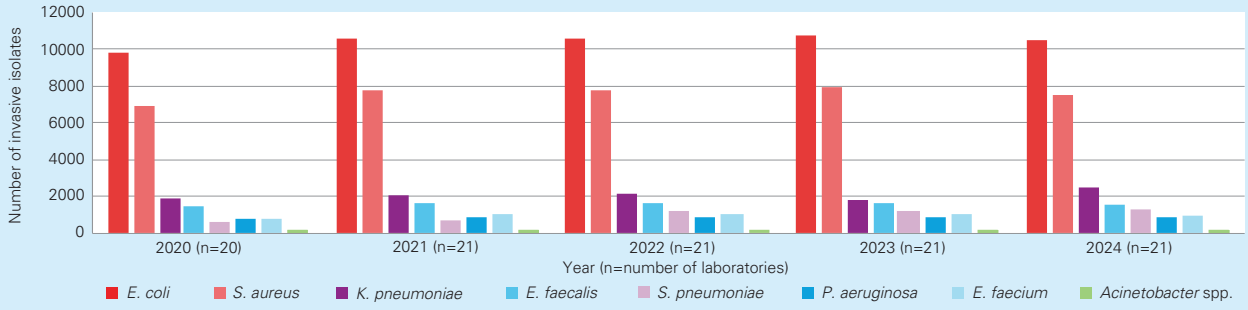
Denominator data is derived from Svebar. For the last six years, denominator data from twelve clinical laboratories covering around 60% of the population in Sweden were included. In Figure 3.2, the annual numbers of analyses are presented for: total number of cultures (A), blood cultures (B), urine cultures (C), nasopharyngeal cultures (D) and throat cultures (E). Marginal decreases were noted compared to 2023 for number of cultures, blood cultures and urine cultures. Although there was a small increase in the number of nasopharyngeal cultures (3%) and throat cultures (10%), these are still fewer than in 2019.

The number of bacteria reported to EARS-Net yearly is shown in Figure 3.3.

Figure 3.2 A to E. Number of analyses are presented for different and total number of cultures, year 2019-2024. Data from one laboratory is excluded in the calculation for number of all cultures and blood cultures due to a change in laboratory information system in 2021.

Source: The Public Health Agency of Sweden

Figure 3.3. Number of isolates, collected from blood during 2020-2024, reported to EARS-Net.



Source: The Public Health Agency of Sweden

Escherichia coli, Klebsiella pneumoniae, and other Enterobacterales with ESBL and ESBL$_{CARBA}$

Mandatory reporting of ESBL-producing Enterobacterales

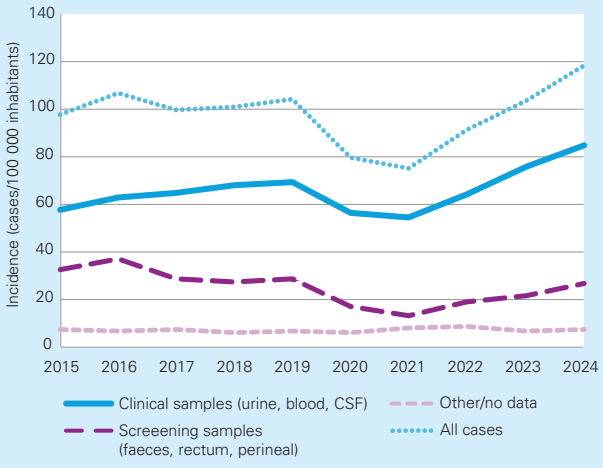
- Number of reported cases: 12 527 (previous year 10 895), relative change +15%.
- Number of bloodstream infections: 1 055 (previous year 897).

Trends

The ESBL incidence increased to 118 new cases per 100 000 inhabitants in 2024, see Figure 3.4. The increase was seen in clinical samples (urine, blood and cerebrospinal fluid (CSF)) and in samples taken for screening purposes (faeces, rectum and perineal). The number of bloodstream infections (BSI) with ESBL-producing Enterobacterales has increased steadily and 1 055 cases were notified in 2024 (Figure 3.5). Of these, 25% (n=265) were cases previously known as carriers. *E. coli* was the most common cause of BSI at 80%, followed by *K. pneumoniae* at 17%.

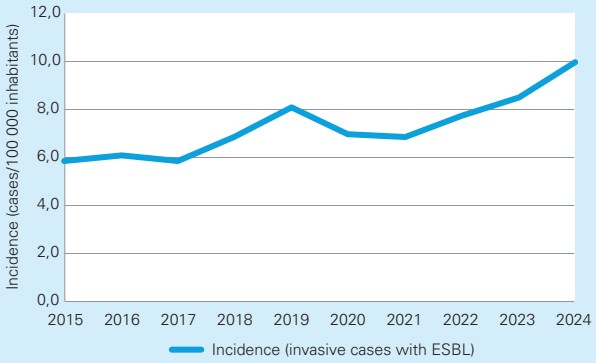
The gender and age distribution has not changed much since the surveillance started and reflects the expected occurrence of urinary tract infections in the different groups. The elderly, 85 years and older (n=1 278, incidence 435) had the highest incidence, followed by children under one year of age (n=378, incidence 382). The high incidence in neonates is probably a result of screening and contact tracing at neonatal units. Among the elderly, urinary tract infections are common bacterial infections explaining the high incidence in this group. As in previous years, the most commonly reported species was *E. coli*, found in 83% of all cases, followed by *K. pneumoniae* with 12%. The remaining cases comprised of several other species of Enterobacterales (for detailed information see attached file (Figure 3.4).

Figure 3.4. The incidence (cases/100 000 inhabitants) of cases with ESBL-producing Enterobacterales in relation to type of infection, year 2015–2024.



Source: The Public Health Agency of Sweden

Figure 3.5. The incidence (cases/100 000 inhabitants) of invasive cases with ESBL-producing Enterobacterales, reported during year 2015–2024.



Source: The Public Health Agency of Sweden

Clusters and outbreaks

ESBL-producing Enterobacterales are not included in the Public Health Agency's national microbiological surveillance program, but samples are accepted for typing on behalf of the regions, often in cases of suspected local outbreaks. In 2024, more than five percent of all cases were whole genome sequenced at the Agency and among these, 15 clusters or pairwise related cases (2–39 cases) of ESBL were detected based on whole genome sequencing and subsequent SNP-based analysis. The 15 clusters include 11 clusters that had one or more cases prior to 2024. Nine clusters with ESBL-producing Enterobacterales were caused by *E. coli*, three by *K. pneumoniae*, two by *Enterobacter hormaechei*, one by *Proteus mirabilis* and one by *Klebsiella oxytoca*. Six of the clusters were healthcare-related and two of these were linked to neonatal wards. The largest cluster, with a total of 39 cases, is related to an outbreak of *K. oxytoca* carrying a CTX-M-15 gene, where the first isolates were detected in 2022, with a continuous spread during 2023 and 2024. Additional isolates have been found from patients linked to the outbreak where the bacteria no longer produce ESBL.

Comments

The incidence of ESBL increased during 2024 and is now at a higher level than before the COVID-19 pandemic. Continued increased travel outside of Sweden is believed to have contributed to the increase.

Mandatory reporting of ESBL$_{CARBA}$-producing Enterobacterales

- Number of reported cases: 410 (previous year 314), relative change 31%
- Number of bloodstream infections: 22

Trends

In 2024, the incidence for ESBL$_{CARBA}$-producing Enterobacterales was 3.9 cases per 100 000 inhabitants, an increase with 31% compared to 2023. A majority, 57% of the cases, were carriers (Figure 3.6). Most cases reported as acquired abroad (55%, n=226) were identified in connection with screening of patients after healthcare abroad (n=102). Of the 150

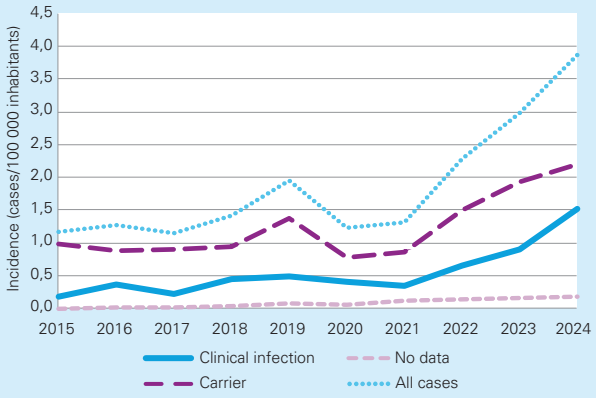
domestic cases, 99 were identified by investigation of clinical infection. The proportion of domestic cases with healthcare-acquired ESBL$_{CARBA}$ remained mainly at the same level as previous years (32%, n=48). For 73 domestic cases, information of acquisition was missing. The most common countries of infection in the notifications were Egypt (n=23), Turkey (n=21), Iraq (n=16), Ukraine (n=15) and India (n=14).

Microbiological surveillance program, ESBL$_{CARBA}$-producing Enterobacterales

Nearly all ESBL$_{CARBA}$ isolates from notified cases in 2024 have been characterised using whole genome sequencing (WGS). The most common carbapenemase-producing Enterobacterales was *E. coli*, accounting for 67% of all cases, followed by *K. pneumoniae* (33%). During 2024, the number of cases of clinical infection with carbapenemase-producing *E. coli* and *K. pneumoniae* increased sharply. A smaller increase was seen for carriers with carbapenemase-producing *E. coli* and *K. pneumoniae* (Figure 3.7). Genes encoding for carbapenem resistance have also been detected in several other species of Enterobacterales. Multiple species, resistance genes and/or sequence types could be identified in several cases. The most abundant carbapenemase genes in these isolates were variants of *bla*$_{NDM}$ and *bla*$_{OXA-48-like}$. In addition to these genes, *bla*$_{KPC}$, *bla*$_{VIM}$, *bla*$_{IMP}$, *bla*$_{IMI}$ and *bla*$_{GES}$ were also detected, but to a lesser extent (Figure 3.8). The most frequent sequence types for *K. pneumoniae* were ST147, followed by ST307 and ST395. For *E. coli*, ST167 was most abundant, followed by ST69 and ST648.

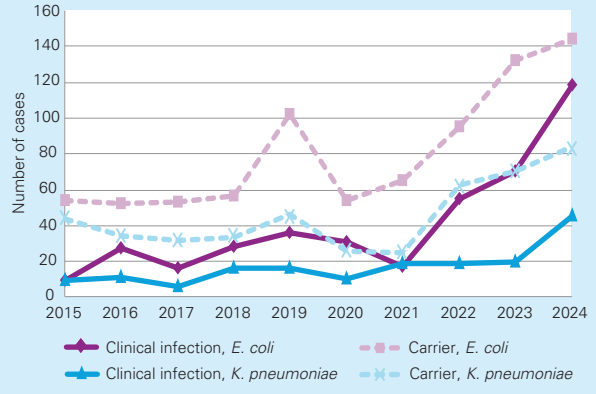
Apart from the genotypic analysis, isolates from notified cases in 2024 were tested for antibiotic susceptibility using broth microdilution (BMD) and disk diffusion. The phenotypic resistance shows a high degree of carbapenem resistance in metallo beta-lactamase (MBL)-producing isolates. However, in *bla*$_{OXA-48}$-producing *E. coli*, meropenem and imipenem resistance is low. This contrasts with *K. pneumoniae*, where meropenem and imipenem resistance is higher and about 50% of the isolates are sensitive. The high degree of resistance to the novel antibiotic cefiderocol is also notable, especially for *bla*$_{NDM}$-producing isolates (Figure 3.9).

Figure 3.6. The incidence (cases/100 000 inhabitants) of cases with ESBL$_{CARBA}$ producing Enterobacterales in relation to type of infection, year 2015-2024.



Source: The Public Health Agency of Sweden

Figure 3.7. Number of cases with clinical infecrtion and carriers with carbapenemase-producing *E. coli* and *K. pneumoniae*, year 2015-2024.



Source: The Public Health Agency of Sweden

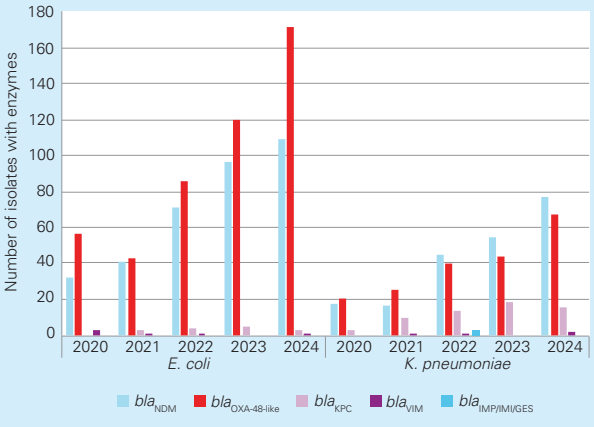
Clusters and outbreaks

A total of 57 clusters or pairwise linked cases of ESBL$_{CARBA}$ were identified in 2024 (2-9 cases per cluster), confirmed by SNP analysis. Of the 57 clusters, 33 clusters had at least one case prior to 2024. Thirty-two clusters of ESBL$_{CARBA}$-producing Enterobacterales were caused by *E. coli*, 22 by *K. pneumoniae*, two by *Enterobacter* species and one by *Citrobacter freundii*. For 27 clusters, one or more of the cases were reported as a healthcare-related infection within Sweden in 2024. *K. pneumoniae* ST147 and *E. coli* ST648 were the most common ST-types and occurred in five clusters each. The most common form of ESBL$_{CARBA}$ among clusters in 2024 was *bla*$_{OXA-244}$ (n=16) and *bla*$_{NDM-5}$ (n=11) for *E. coli* and for *K. pneumoniae bla*$_{OXA-48}$ (n=6) and *bla*$_{NDM-1}$ (n=4).

Comments

In summary, the incidence of ESBL$_{CARBA}$ increased during 2024, particularly for cases infected in Sweden and among cases with clinical infections of E. coli with ESBL$_{CARBA}$. The number of clusters reported as healthcare-related increased from 16 to 27 between 2023 and 2024.

Figure 3.8. Number of isolates and enzyme types of ESBL$_{CARBA}$ in Enterobacterales in Sweden 2020-2024.



Source: The Public Health Agency of Sweden

In summary, the incidence of ESBL$_{CARBA}$ increased during 2024, particularly for cases infected in Sweden and among cases with clinical infections of E. coli with ESBL$_{CARBA}$. The number of clusters reported as healthcare-related increased from 16 to 27 between 2023 and 2024.

Figure 3.9 A to D. Proportion of isolates with resistance from $ESBL_{CARBA}$ producing *E. coli* and *K. pneumoniae* collected among notified cases in 2023 (blue) and 2024 (purple), divided by $ESBL_{CARBA}$-enzyme (A=*E. coli* with bla_{NDM}, B=*E. coli* with $bla_{OXA-48-like}$, C=*K. pneumoniae* with bla_{NDM}, D=*K. pneumoniae* with $bla_{OXA-48-like}$). Isolates have been classified as resistant (R) according to EUCAST breakpoint table 15.0 (meropenem=indications other than meningitis, amikacin/gentamicin/tobramycin/fosfomycin=urinary tract infections (UTI), nitrofurantonin=uncomplicated UTI).

Source: The Public Health Agency of Sweden

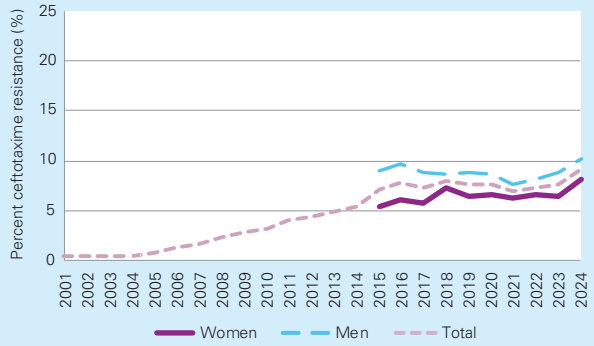
Escherichia coli, from blood and urine cultures

The proportion of ESBL-producing *E. coli* among invasive isolates, one of two AMR indicators, has increased continually over the years to 9.2% (Figure 3.10 and Figure 3.11). While the resistance to carbapenems remains very low, the proportion of resistance is higher among men in general. The resistance levels remained largely stable among isolates from urine. Cefadroxil resistance, which can be used as an indicator for ESBL production, has been increasing slowly and is now 7.6% (Figure 3.12).

For invasive isolates, resistance to piperacillin-tazobactam is presented based on the current breakpoints and historical data has been recalcutaled. Resistance to commonly prescribed oral antibiotics for treatment of urinary tract infections (UTI) caused by *E. coli* remained stable (Figure 3.11). Resistance to ciprofloxacin is still high, and is now at approximately 15,6% and 11% for blood and urine isolates, respectively (Table 3.4, Figure 3.11 and Figure 3.12). The age and gender distributions among patients with *E. coli* isolated from urine reflects the expected occurrence of UTI in the different groups. The high level of ciprofloxacin resistance must be considered when choosing empirical treatment for febrile UTI, especially for men over 20 years of age (Figure 3.13). Colistin resistance is occasionally seen in *E. coli* and is mainly tested in multiresistant isolates, most of which have a connection with healthcare abroad. It is important to determine colistin susceptibility with broth microdilution, as recommended by EUCAST.

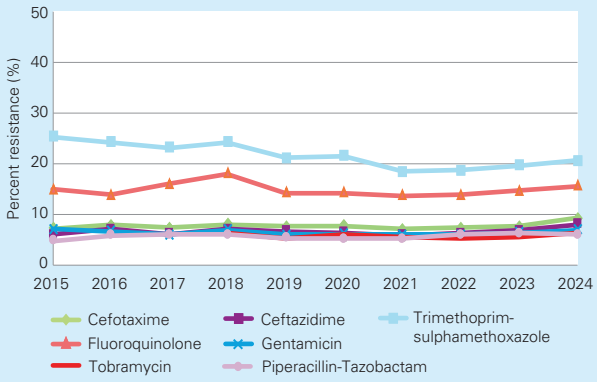
The proportion of cefotaxime-resistant *E. coli* (ESBL) in blood isolates is used, since 2020, as an indicator of antibiotic resistance in Sweden. The proportion of cefotaxime resistant *E. coli* in blood isolates have gradually increased over the last decade, reaching 9.2%. This indicator is related to the EU Council recommendation's targets for Sweden for 2030. Sweden's targets include a 10% reduction for the incidence of ESBL sepsis, compared to 2019. Considering the observed trend for the indicator used since 2020, this is an ambitious target.

Figure 3.10. Antibiotic resistance indicator displaying resistance to cefotaxime in *E. coli* (ESBL) isolated from blood from women and men during 2001-2024.



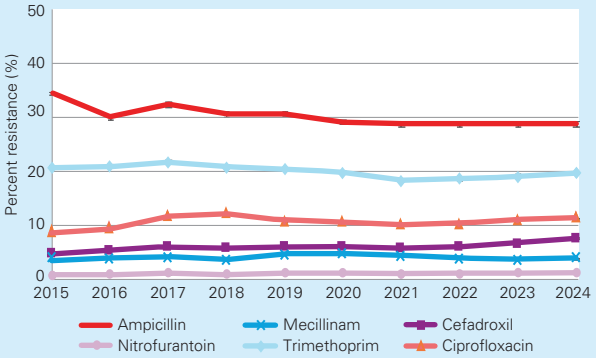
Source: The Public Health Agency of Sweden

Figure 3.11. Antibiotic resistance in *E. coli* isolated from blood during the years 2015-2024. The numbers of AST isolates for all years and antibiotics ranges from 5 183 to 10 730. The exact numbers are given in the attached file.



Source: The Public Health Agency of Sweden

Figure 3.12. Antibiotic resistance in *E. coli* isolates from urine during the years 2015-2024. The numbers of AST isolates for all years and antibiotics ranges from 103 223 to 227 259. The exact numbers are given in the attached file.



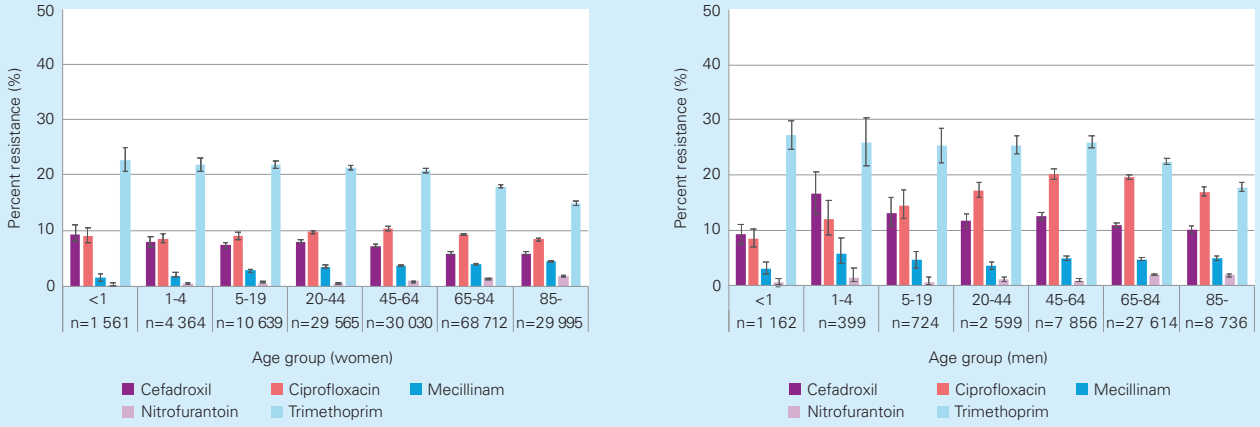
Source: The Public Health Agency of Sweden

Table 3.4. Proportion (%) of antibiotic resistant *E. coli* from blood or urine 2024. NA: Not Applicable.

Antibiotic	Blood isolates, % R (n=10 503)	Urine isolates, % R (n=223 902)
Ampicillin	NA	28.8
Cefadroxil	NA	7.6
Cefotaxime	9.2	NA
Ceftazidime	8.0	NA
Ciprofloxacin	15.6	11.4
Gentamicin	6.9	NA
Tobramycin	6.3	NA
Mecillinam	NA	4.0
Meropenem	0.0	NA
Nitrofurantoin	NA	1.2
Piperacillin-tazobactam	6.1[a]	NA
Trimethoprim	NA	19.6
Trimethoprim-sulphamethoxazole	20.6	NA

[a]The resistance to piperacillin-tazobactam is presented based on the current breakpoints and historical data has been recalcutaled (NordicAST breakpoint table v 12.0).

Figure 3.13. Antibiotic resistance in *E. coli* from urine in women and men divided in age groups during 2024.



Source: The Public Health Agency of Sweden

Klebsiella pneumoniae, from blood and urine cultures

For invasive isolates, the resistance levels have slowly increased over a ten-year period except for piperacillin-tazobactam. The carbapenem resistance remains low. The resistance to piperacillin-tazobactam is presented based on the current breakpoints and historical data has been recalcutaled. The resistance to cefotaxime was 8.8% (Table 3.5 and Figure 3.14).

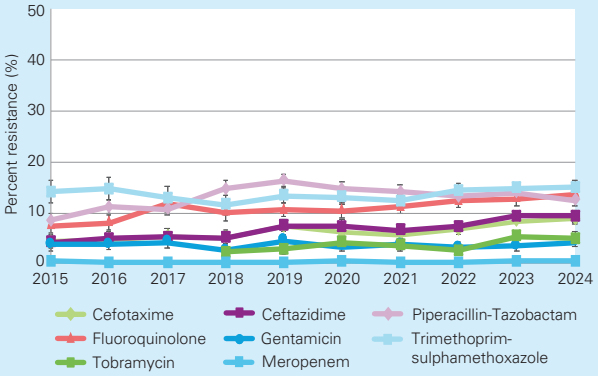
Resistance to commonly prescribed oral antibiotics for treatment of urinary tract infections caused by *K. pneumoniae* has remained relative stable during the last years (Figure 3.15). Cefadroxil resistance, which can be used as an indicator for ESBL production, was 8.1%. As for *E. coli*, the high levels of resistance to ciprofloxacin must be taken into account when choosing empiric treatment for febrile UTI. Colistin resistance is occasionally seen in *K. pneumoniae* and is mainly tested in multiresistant isolates, most of which have a connection with health-

Table 3.5. Proportion (%) of antibiotic resistant *K. pneumoniae* from blood or urine 2024. NA: Not Applicable.

Antibiotic	Blood isolates, % R (n=2 483)	Urine isolates, % R (n=27 863)
Cefadroxil	NA	8.1
Cefotaxime	8.8	NA
Ceftazidime	9.3	NA
Ciprofloxacin	13.6	10.9
Gentamicin	4.1	NA
Tobramycin	4.6	NA
Mecillinam	NA	8.2
Meropenem	0.4	NA
Piperacillin-tazobactam[a]	12.5	NA
Trimethoprim	NA	19.4
Trimethoprim-sulphamethoxazole	14.9	NA

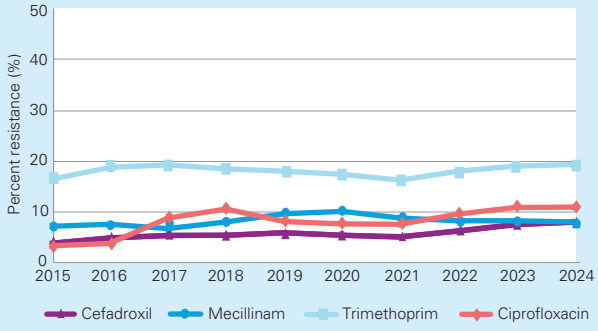
[a]The resistance to piperacillin-tazobactam is presented based on the current breakpoints and historical data has been recalcutaled (NordicAST breakpoint table v 12.0).

Figure 3.14. Antibiotic resistance in *K. pneumoniae* isolated from blood during the years 2015-2024. The numbers of AST isolates for all years and antibiotics ranges from 973 to 2 483 The exact numbers are given in the attached file.



Source: The Public Health Agency of Sweden

Figure 3.15. Antibiotic resistance in *K. pneumoniae* isolates from urine during the years 2015-2024. The numbers of AST isolates for all years and antibiotics ranges from 9 901 to 27 863. The exact numbers are given in the attached file.



Source: The Public Health Agency of Sweden

care abroad. It is important to determine colistin susceptibility with broth microdilution, as recommended by EUCAST.

The proportion of *K. pneumoniae* resistant to meropenem has remained low and stable over a ten-year period, below 1% resistance. This is related to one of the EU Council recommendation's targets for Sweden for 2030. The target set for Sweden include an unchanged incidence of carbapenem resistant *K. pneumoniae* compared to 2019.

Staphylococcus aureus including MRSA

Mandatory reporting of methicillin-resistant *Staphylococcus aureus*

- Number of reported cases: 3 937 (previous year 3 547), relative change +11%
- Number of bloodstream infections: 123 (previous year 103)

Trends

In 2024, the incidence of MRSA was 37 cases per 100 000 inhabitants, compared to 34 cases per 100 000 inhabitants in 2023 (Figure 3.16). The number of cases reported with clinical infections was 2 140 (54%), while 1 574 cases (40%) were listed as carriers.

There was almost equal distribution between women and men, with a median age of 35 for all cases. Among the domestic MRSA cases (n=2 434, 62%), children below one year of age (n=175, 177 cases/100 000 inhabitants) had the highest incidence, followed by the elderly, 85 years or older (n=201, 68 cases/100 000 inhabitants). The high incidence of MRSA among the young children is likely due to screening practices at neonatal- and maternal care units in combination with contact tracing around new cases.

Community-acquired infections continue to be the most prominent route of acquiring MRSA. Among MRSA cases acquired in Sweden, 25% (n=620) were reported as acquired from family/household contacts and 21% as community-acquired (n=519). The proportion of domestic cases with MRSA acquired in hospital as well as healthcare/care outside hospital was 5% and 9% respectively (n=122 and n=228), which is nearly the same as in 2020 to 2023. Little more than a third (n=882) of the domestic cases lacked information on acquisition.

Microbiological surveillance programme, MRSA

Epidemiological typing of MRSA has included *spa*-typing and analysis of PVL-status since 2006. Since January 2018, the national microbiological surveillance of MRSA only includes isolates from clinical cases. In addition to the surveillance program, typing data are obtained from regional microbiological laboratories. *Spa*-typing data were available for isolates from 1 544 (72%) of the clinical cases and from 709 (45%) sampled from asymptomatic carriers. Among clinical cases, the ten most prevalent *spa*-types were identified in 53% of the isolates. The six most prevalent *spa*-types in clinical isolates 2024 were t304, t008, t355, t127, t223 and t005 which all except t355 have remained the same since 2018, although the order of magnitude has varied.

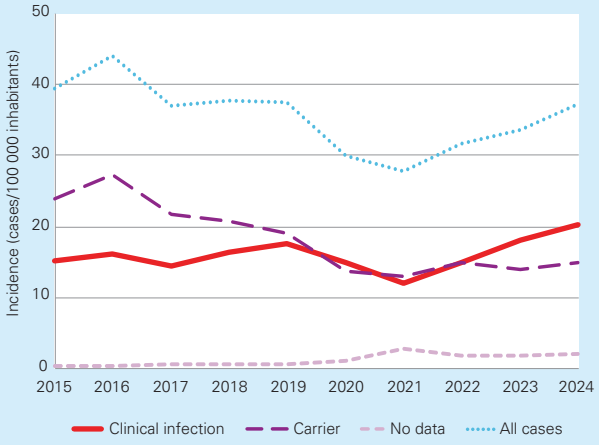
Clusters and outbreaks

In 2024, the Public Health Agency of Sweden performed whole-genome sequencing on almost 60 MRSA isolates in sixteen different investigations where spa-typing did not give enough discrimination. From the comparisons, clusters or pairwise-linkages were found for 48 of the isolates sequenced, of which three were added to a health care associated spread initially identified in 2019, with additional cases also in 2022 respectively 2023. Children in neonatal care are at increased risk for infection and 18 of the sequenced isolates were sampled from this risk group. For 15 of the isolates sampled from infants, a probable common origin was demonstrated within six different investigations, one of which was cross-regional as children were transferred between hospitals in different regions. For 11 of the sequenced isolates, no genetic linkage to another sequenced isolate was established.

Comments

The incidence of MRSA in Sweden continued to increase in 2024 and is now at the same level as the incidence before the pandemic. The increase is mainly seen in cases infected in Sweden and with clinical infections. The number of notifications with MRSA in blood increased in 2024.

Figure 3.16. The incidence (cases/100 000 inhabitants) of cases with MRSA in relation to type of infection, year 2015-2024.



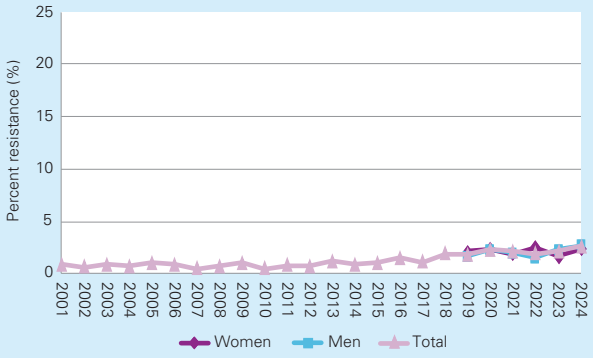
Source: The Public Health Agency of Sweden

Staphylococcus aureus from blood and skin and soft tissue cultures

The proportion of MRSA in bloodstream infections, one of two AMR indicators, has slowly increased and is now 2.6% of isolated *S. aureus* (indicated by cefoxitin resistance). The proportion of resistance was 2.7% among men and 2.4% among women (Figure 3.17 and Figure 3.18). The proportion of MRSA in skin and soft tissue infections is 2.7% (Table 3.6 and Figure 3.19). Susceptibility testing to vancomycin is not routinely performed on cefoxitin-susceptible *S. aureus* and in 2024, 59 of 7 470 (0.8%) isolates from blood were tested for vancomycin resistance with no resistance detected.

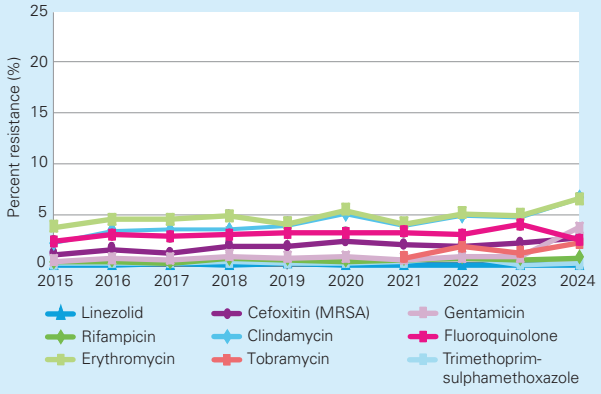
Since 2020, the proportion of methicillin-resistant *Staphylococcus aureus* (MRSA) in blood isolates have been used an indicator of antibiotic resistance in Sweden. The proportion of MRSA has gradually increased over the last decade, reaching 2.6%. This indicator is related to the EU Council recommendation's targets for Sweden for 2030. Sweden's targets include a 3% reduction of the prevalence of MRSA sepsis, compared to 2019. Considering the observed trend for the indicator used since 2020, this is an ambitious target.

Figure 3.17. One of the indicators for antibiotic resistance that shows the proportion of MRSA among *S. aureus* isolated from blood from women, men and in total.



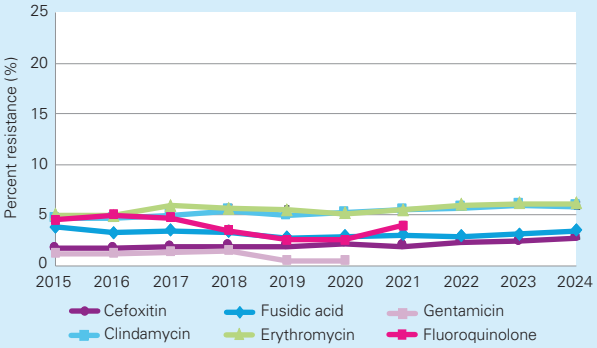
Source: The Public Health Agency of Sweden

Figure 3.18. Antibiotic resistance in *S. aureus* from blood during the years 2015-2024. The numbers of AST isolates for all years and antibiotics ranges from 3 028 to 7 925. The exact numbers are given in the attached file.



Source: The Public Health Agency of Sweden

Figure 3.19. Antibiotic resistance for *S. aureus* from skin and soft tissue samples 2014-2024. The resistance for norfloxacin is based on results from less than five laboratories in 2018-2020 and for gentamicin in 2020-2023. Data for aminoglycosides may be found in the attached file (not shown in graph) since the resistance rates are based on less than five laboratories. The numbers of AST isolates for all years and antibiotics ranges from 40 289 to 89 192. The exact numbers are given in the attached file.



Source: The Public Health Agency of Sweden

Table 3.6. Proportion (%) of antibiotic resistant isolates in *S. aureus* from blood and skin and soft tissue infections 2024.
NA: not applicable

Antibiotic	Blood isolates, % R (n=7 919)	Skin and soft tissue isolates % R (n=87 484)
Cefoxitin	2.6	2.7
Clindamycin	6.6	5.8
Erythromycin	6.5	6.1
Gentamicin	3.6	NA
Tobramycin	2.1	NA
Fluoroquinolone[a]	2.5	NA
Fusidic acid	1.9	3.4
Linezolid	0.0	NA
Rifampicin	0.7	NA
Trimetoprim-sulphamethoxazole	0.3	0.1

[a]Based on norfloxacin or ciprofloxacin

Enterococcus faecalis and *Enterococcus faecium* including VRE

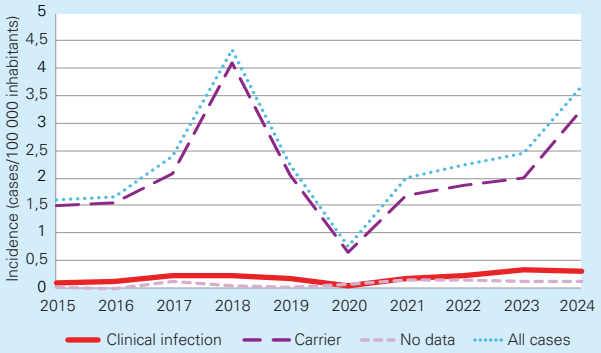
Mandatory reporting of vancomycin-resistant enterococci

- Number of reported cases: 390 (previous year: 260), relative change +50%.
- Number of reported cases of *E. faecium* with vancomycin resistance: 372 (previous year: 250), relative change +49%
- Number of reported cases of *E. faecalis* with vancomycin resistance: 18 (previous year: 10)
- There were seven cases infected with both *E. faecium* and *E. faecalis*.
- Number of bloodstream infections: 6 (previous year: 5)

Trends

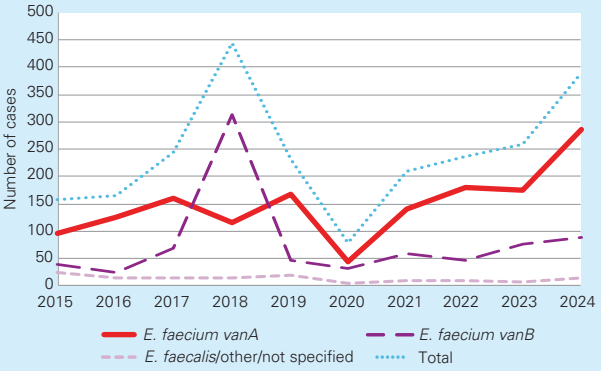
The national incidence of VRE increased from 2.5 to 3.7 cases per 100 000 inhabitants between 2023 and 2024. Sixteen of 21 regions reported cases of VRE during 2024. Of these cases, 277 (71%) were healthcare-related. A majority of the isolates (n=343, 88%) were from faeces, rectum and perineum and only 6% were from urine or wound (Figure 3.20). Six invasive VRE infections were reported in 2024. More than half of the cases were reported as acquired in Sweden (63%) and among the domestic cases, 35% were found through contact tracing and 50% through screening. Cases acquired abroad were mostly detected through screening (78%). The median age for VRE was 75 (range 13-99 years) and it is still most common among men (58%). In 2024, 372 *E. faecium* cases and 18 *E. faecalis* cases were reported. The *vanA* genotype was most commonly found among *E. faecium* (n=287) (Figure 3.21). In some cases, different genotypes of VRE were detected in the same patient. Therefore, a few more isolates than cases were epidemiologically typed.

Figure 3.20. The incidence (cases/100 000 inhabitants) of VRE in relation to type of infection, year 2015-2024.



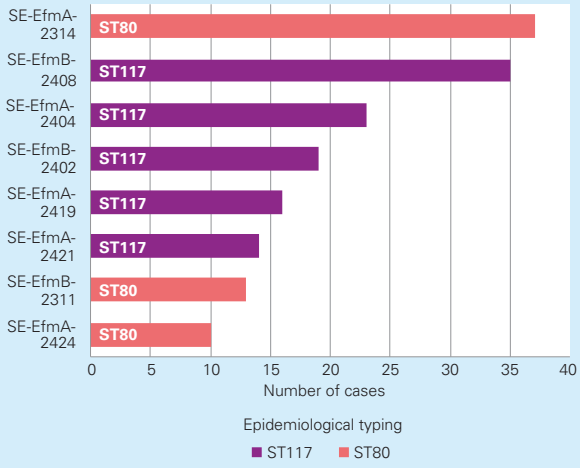
Source: The Public Health Agency of Sweden

Figure 3.21. Number of VRE cases and their corresponding *van*-type, year 2015-2024.



Source: The Public Health Agency of Sweden

Figure 3.22. Number of VRE cases within the five largest hospital-related outbreaks in 2024 and their respective sequence type.



Source: The Public Health Agency of Sweden

Microbiological surveillance programme, VRE

Whole genome sequencing (WGS) with "single nucleotide polymorphism" (SNP) based analysis and multilocus sequence typing (MLST) is used for epidemiological typing of VRE. The national VRE cluster nomenclature is as follows: species (Efm = *E. faecium*, Efs = *E. faecalis*) followed by *van*-gene (A or B), year of detection and a consecutive number for respective type found each year, e.g. SE-EfmB-2403. Isolates with no relation to other VRE isolates in the national database are denoted as unique (EfmA unique).

In 2024, eight large hospital-related outbreaks with 10-37 cases each and twenty-two smaller clusters with 2-8 cases each were reported, all *E. faecium* (Figure 3.22). Two of the large outbreaks denoted SE-EfmB-2311 and SE-EfmA-2314 were identified in September respectively November 2023 and still ongoing during 2024.

Among the six invasive cases, four cases were caused by outbreak strains (SE-EfmA-2405, SE-EfmB-2415, SE-EfmA-2419 and SE-EfmA-2424). The remaining cases were *E. faecium* with *vanB* and *E. faecalis* with *vanB*, respectively. Genes and/or mutations connected to linezolid-resistance were detected in seven isolates.

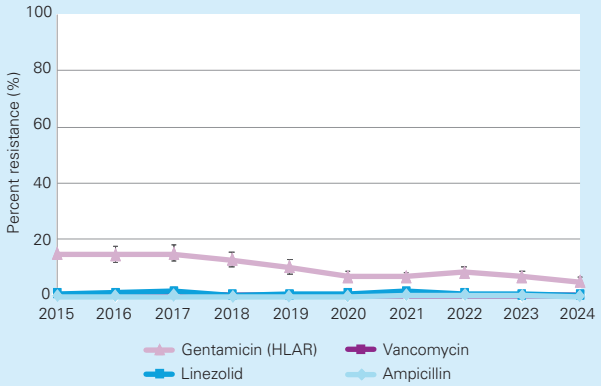
Comments

The number of VRE cases increased with 50% during 2024. This increase was mainly due to several hospital-related outbreaks. This stresses the importance of preventing spread of VRE in hospitals. Epidemiological typing of VRE is an important tool to monitor and investigate the spread of VRE. Culture and typing results are often necessary to initiate and motivate the extensive work needed to stop outbreaks of VRE.

Enterococcus faecalis and *Enterococcus faecium*, from blood cultures

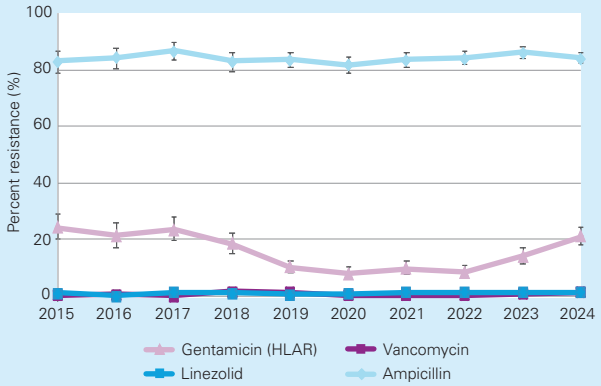
The vancomycin resistance among invasive isolates remains low and was 1.1% for *E. faecium* and 0.1% for *E. faecalis*. High-level aminoglycoside resistance (HLAR) has decreased compared to 2015 but an increase was seen in 2024 for *E. faecium* (Table 3.7 and Figures 3.23 and 3.24).

Figure 3.23. Antibiotic resistance in *E. faecalis* isolated from blood during the years 2015-2024. The numbers of AST isolates for all years and antibiotics ranges from 704 to 1 605. The exact numbers are given in the attached file.



Source: The Public Health Agency of Sweden

Figure 3.24. Antibiotic resistance in *E. faecium* isolated from blood during the years 2015-2024. The numbers of AST isolates for all years and antibiotics ranges from 368 to 1 523. The exact numbers are given in the attached file.



Source: The Public Health Agency of Sweden

Table 3.7. Proportion (%) of antibiotic resistant *E. faecalis* and *E. faecium* from blood 2024.

Antibiotic	Blood isolates *E. faecalis*, % R (n=1 523)	Blood isolates *E. faecium*, % R (n=960)
Ampicillin	0.0	84.2
Gentamicin (HLAR)	4.8	20.9
Linezolid	0.2	1.3
Vancomycin	0.1	1.1

Streptococcus pneumoniae including PNSP

Mandatory reporting of *Streptococcus pneumoniae* with reduced susceptibility to penicillin (PNSP)

- Number of reported cases: 148 (previous year 152), relative change -3%
- Number of bloodstream infections: 12 (previous year 7)

Trends

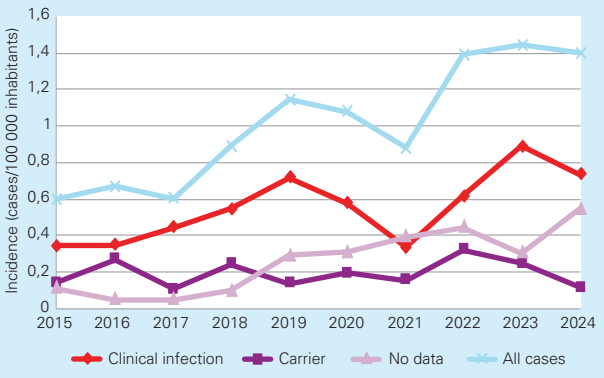
The national incidence of PNSP (MIC PcG > 1 mg/L) remained at 1.4 cases per 100 000 inhabitants during 2024. The incidence for PNSP acquisition was highest among children under one year of age (6 cases per 100 000 inhabitants) and children aged 0-9 years old represented 22% (n=32) of all cases. Of all cases, 55% were men. PNSP was most often found in cultures from the nasopharynx (45%, n=67) and 47 isolates were found in sputum/bronchoalveolar lavage (32%). Seventy-eight cases were reported with clinical infections (53%, incidence 0.7) and 8% (n=12, incidence 0.1) as carriers (Figure 3.25). A majority of the cases had been acquired in Sweden (45%, n=67) and 11% of the cases were acquired abroad. For the remaining cases, no country of acquisition was given (44%).

Microbiological surveillance programme, *S. pneumoniae*

A total of 132 isolates with PcG MIC > 1 mg/L were sent to PHAS for serotyping during 2024 (89% of notified cases). Of these isolates, 35% (n=46) belonged to serotypes included in the conjugate vaccines (PCV15), Figure 3.26. The corresponding figures for 2023 and 2022 were 42% and 52%, respectively. Five of the twelve isolates from invasive cases typed in 2024 were of vaccine type: 3 (n=1), 14 (n=1), 19F (n=1), and 23F (n=1). The remaining seven cases were of type 9A, 9N, 11A and NT, i.e. not included in the vaccines. To follow and evaluate the effect of vaccination against pneumococcal disease and to identify spread of antibiotic resistant clones, PHAS collects isolates of *S. pneumoniae* with PcG MIC ≥ 0.5 mg/L for serotyping.

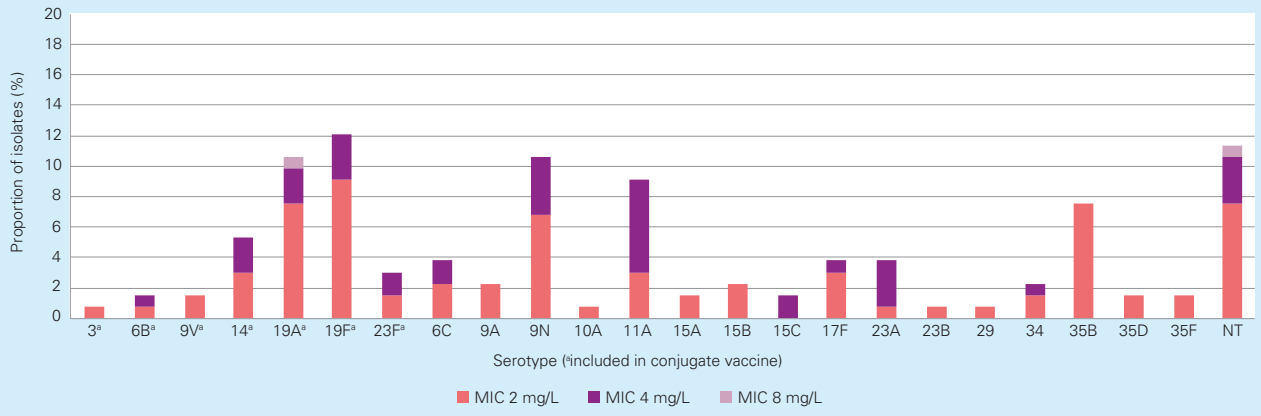
In 2024, 296 isolates were collected (including the 132 isolates from cases of PNSP). The serotype distribution was, in descending order: NT (13%), 19A (10%), 19F (10%), 23B

Figure 3.25. The incidence (cases/100 000 inhabitants) of cases with PNSP in relation to type of infection, year 2015-2024.



Source: The Public Health Agency of Sweden

Figure 3.26. Distribution of serotype MICs among PNSP with PcG MIC (n=132).



Source: The Public Health Agency of Sweden

(10%), 11A (9%), 9N (6%), 23A (5%), 35B (5%), and 6C (4%). Of the 296 isolates, 30% constituted of types included in the conjugate vaccines (PCV15).

Clusters and outbreaks

No clusters of PNSP were identified in 2024.

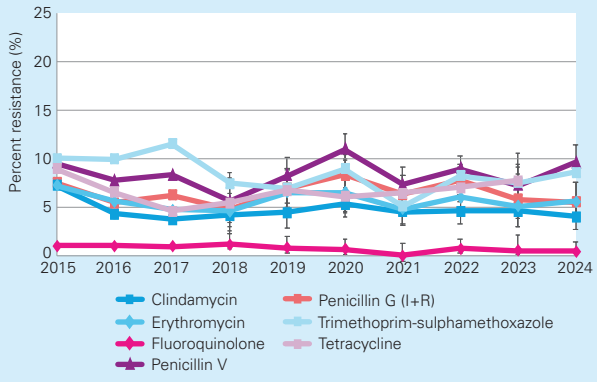
Comments

The number of PNSP cases remained stable during 2024 compared to 2023. The number of invasive cases increased to twelve compared to seven cases last year. The increase from 2017 could partly be due to changes in diagnostics in incidence from 2017, as more laboratories have switched to reporting data based on broth microdilution.

Streptococcus pneumoniae, from blood

The methodological problem of underestimating benzylpenicillin (PcG) MIC when using gradient tests does not influence the resistance proportions, since I and R are reported together. Among invasive infections, the proportion of PcG non-susceptible isolates was 5.5% in 2024 (Figure 3.27).

Figure 3.27. Antibiotic resistance in *S. pneumoniae* isolated from blood during the years 2015-2024. Penicillin V resistance is based on susceptibility testing using oxacillin. The numbers of AST isolates for all years and antibiotics ranges from 550 to 1 296. The exact numbers are given in the attached file.



Source: The Public Health Agency of Sweden

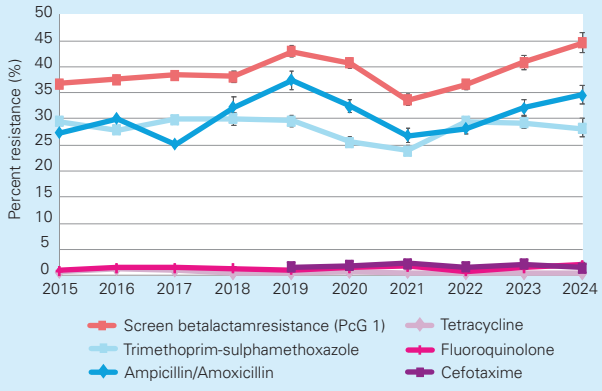
Haemophilus influenzae, from blood and nasopharynx cultures

- Number of mandatory reported cases of invasive *H. influenzae*: 248

Microbiological surveillance programme, *H. influenzae*

During 2024, 211 isolates were received within the microbiological characterisation program for cephalosporin resistance in *H. influenzae* at PHAS. The majority of these (n=190) showed high-level resistance to extended-spectrum cephalosporins, caused by alterations in penicillin-binding protein 3 (PBP3). Ninety-seven of these isolates also carried the betalactamase $bla_{\text{TEM-1}}$ gene which is the most prevalent gene of the acquired betalactamases. The remaining 21 isolates showed low level resistance to cephalosporins.

Figure 3.28. Antibiotic resistance in *H. influenzae* isolated from nasopharynx during the years 2015-2024. The numbers of AST isolates for all years and antibiotics ranges from 2 460 to 13 332. The exact numbers are given in the attached file.



Source: The Public Health Agency of Sweden

Comments

Invasive isolates of *H. influenzae* are notifiable according to the Communicable Disease Act regardless of antibiotic resistance. Cefotaxime resistance among invasive isolates remains low (Table 3.8 and Table 3.9). Among respiratory isolates, resistance levels to penicillin and ampicillin/amoxicillin is increasing (Figure 3.28).

Table 3.8. Proportion (%) of antibiotic resistant *H. influenzae* from blood or nasopharynx 2024.

Antibiotic	Blood isolates, % R (n=201)	Nasopharynx isolates, % R (n=12 110)
Ampicillin/Amoxicillin	35.7	34.6
Cefotaxime	2.7	1.6
Fluoroquinolone[a]	2.4	2.1
Screen betalactam-resistance (PcG 1)	36.4	44.5
Tetracycline	0.6	0.5
Trimethoprim-sulphamethoxazole	20.9	28.2

[a]Nalidixic acid was used for detection of fluoroquinolone resistance.

Table 3.9. Antibiotic resistance in *H. influenzae* isolated from blood during the years 2017-2024. The numbers of AST isolates for all years and antibiotics ranges from 73 to 213. The exact numbers are given in the attached file.

Species *Haemophilus influenzae*	2017			2018			2019			2020			2021			2022			2023			2024		
Sample: Blood	n	% R[a]	95% CI	n	% R[a]	95% CI	n	% R[a]	95% CI	n	% R[a]	95% CI	n	% R[a]	95% CI	n	% R[a]	95% CI	n	% R[a]	95% CI	n	% R[a]	95% CI
Number of AST isolates	**122**			**111**			**209**			**74**			**73**			**183**			**213**			**201**		
Screen betalactam-resistance (PcG 1)	120	26.7	(19.6-35.2)	111	36	(27.7-45.3)	208	34.1	(28.0-40.8)	60	50.0	(37.7-62.3)	67	26.9	(17.7-38.5)	164	32.3	(25.6-39.8)	178	37.6	(30.9-44.9)	184	36.4	(29.8-43.6)
Trimetoprim-sulphamethoxazole	121	14	(9.0-21.4)	111	12.6	(7.7-20.1)	209	23.9	(18.6-30.1)	74	12.2	(6.5-21.5)	72	13.9	(7.7-23.7)	183	21.3	(16.0-27.8)	213	25.4	(20.0-31.6)	201	20.9	(15.8-27.0)
Tetracycline	122	0.8	(0.1-4.5)	109	0.0	(0.0-3.4)	181	0.6	(0.1-3.1)	58	3.4	(1.0-11.7)	59	0.0	(0.0-6.1)	144	1.4	(0.4-4.9)	160	1.9	(0.6-5.4)	173	0.6	(0.1-3.2)
Ampicillin	40	20	(10.5-34.8)	34	29.4	(16.8-46.2)	157	34.4	(27.4-42.1)	64	43.8	(32.3-55.9)	55	25.5	(15.8-38.3)	142	28.2	(21.4-36.1)	158	28.5	(22.0-36.0)	157	35.7	(28.6-43.4)
Cefotaxime	103	1.0	(0.2-5.3)	90	2.2	(0.6-7.7)	178	2.8	(1.2-6.4)	67	3.0	(0.8-10.2)	53	1.9	(0.3-9.9)	159	3.1	(1.3-7.1)	187	4.3	(2.2-8.2)	187	2.7	(1.1-6.1)
Fluoroquinolone	89	1.1	(0.2-6.1)	75	0.0	(0.0-4.9)	160	0.0	(0.0-2.3)	44	2.3	(0.4-11.8)	73	5.5	(2.2-13.3)	134	0.7	(0.1-4.1)	148	1.4	(0.4-4.8)	168	2.4	(0.9-6.0)

[a]From 2014 the resistance is expressed as % of isolates tested

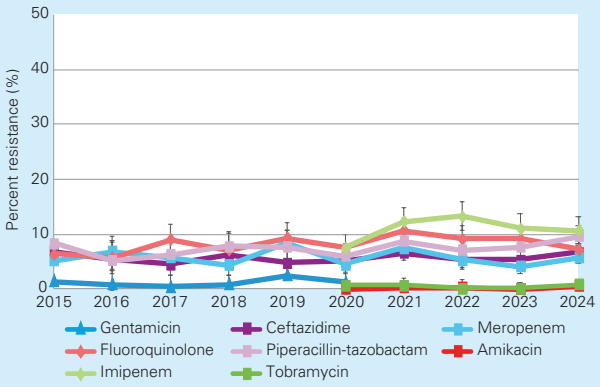
Pseudomonas aeruginosa, from blood and non-respiratory cultures

Resistance to ceftazidime is most often due to efflux pumps and porin loss, not ESBL production. Resistance levels are stable for most antibiotics in both blood isolates and non-respiratory isolates (Table 3.10, Figure 3.29 and Figure 3.30). Tobramycin has replaced gentamicin as the recommended aminoglycoside. Colistin resistance is occasionally seen in *P. aeruginosa* and is mainly tested in multiresistant isolates, most of which have a connection with healthcare abroad. It is important to determine colistin susceptibility with broth microdilution, as recommended by EUCAST.

Microbiological surveillance programme, *Pseudomonas* spp.

In total, 70 *Pseudomonas aeruginosa* isolates were received in 2024, of which eighteen belonged to the microbiological surveillance programmes for $ESBL_{CARBA}$-producing *Pseudomonas*

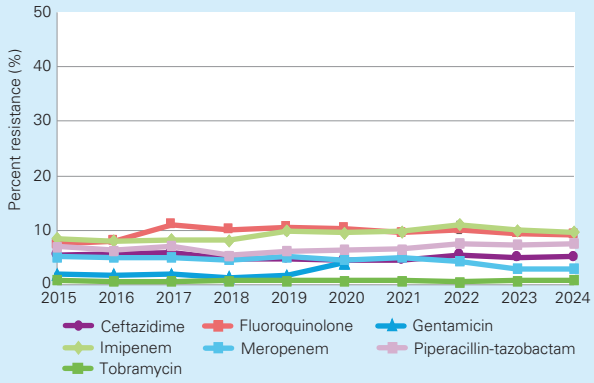
Figure 3.29. Antibiotic resistance in *P. aeruginosa* isolated from blood during the years 2015-2024. The numbers of AST isolates for all years and antibiotics ranges from 348 to 857. The exact numbers are given in the attached file.



Source: The Public Health Agency of Sweden

spp. Ten of these isolates carried a bla_{NDM}, five bla_{VIM}, two bla_{GES} and one bla_{IMP}. Five clusters were active during 2024, with 4 patients ($bla_{NDM)}$ in the largest cluster, and two patients in the remaning four clusters (bla_{NDM}, bla_{GES}, bla_{IMP}, bla_{VIM}).

Figure 3.30. Antibiotic resistance in *P. aeruginosa* from non-respiratory isolates 2015-2024. Results from gentamicin are only available until 2020. The numbers of AST isolates for all years and antibiotics ranges from 1 980 to 18 832. The exact numbers are given in the attached file.



Source: The Public Health Agency of Sweden

Table 3.10. Proportion (%) of antibiotic resistant *P. aeruginosa* isolated from blood and non-respiratory specimens 2024.

Antibiotic	Blood isolates, % R (n=848)	Non-respiratory isolates, % R (n=17 411)
Ceftazidime	6.7	5.2
Ciprofloxacin	7.3	9.2
Tobramycin	0.8	0.9
Meropenem	5.7	3.0
Piperacillin-tazobactam	9.6	7.6

Acinetobacter spp., from blood cultures

Comments

During 2024, 175 isolates of *Acinetobacter* spp. from blood were reported to Svebar. The carbapenem resistance was 1.3% (Table 3.11). Since it is not possible to deduplicate data from Svebar, multiple isolates from the same patients are included in the data. During 2023, isolates with a multiresistant *Acinetobacter baumannii* from one patient was reported multiple times, resulting in unusually high resistance rates. Bloodstream infections caused by *Acinetobacter* spp. are still rare in Sweden compared to other countries in Europe, where multiresistant *Acinetobacter* spp. is a problematic pathogen in hospitals. Colistin resistance is occasionally seen in *Acinetobacter* and is mainly tested in multiresistant isolates, most of which have a connection with healthcare abroad. It is important to determine colistin susceptibility with broth microdilution, as recommended by EUCAST.

Microbiological surveillance programme, *Acinetobacter* spp.

In total, 65 isolates were received in 2024 within the microbiological surveillance program for *Acinetobacter* spp. with reduced susceptibility to meropenem (I+R). This is an increase compared to what was seen in 2023 (n=46), however, similar to what was observed in 2022 (n=67). Of the 65 isolates, 38 carried species-specific bla_{OXA}-genes (23, 24 or 58-like), 19 harbdoured a combination of bla_{OXA} (23, 24 or 58-like) and bla_{NDM}, three carried only bla_{NDM}, and in five isolates no carbapenemase genes were detected. Eight clusters were active during 2024, with number of isolates ranging from 2-10.

Table 3.11. Antibiotic resistance in *Acinetobacter* species isolated from blood during year 2017-2024.

Species *Acinetobacter*	2017			2018			2019			2020			2021			2022			2023			2024		
Sample: Blood	n	% R	95% CI	n	% R	95% CI	n	% R	95% CI	n	% R	95% CI	n	% R	95% CI	n	% R	95% CI	n	% R	95% CI	n	% R	95% CI
Number of AST isolates	**54**			**55**			**113**			**126**			**138**			**151**			**160**			**175**		
Meropenem	53	0.0	(0.0-6.8)	54	3.7	(1.0-12.5)	113	3.5	(0.9-7.5)	125	7.2	(3.8-13.1)	133	0.8	(0.1-4.1)	151	1.3	(1.8-8.4)	160	4.4	(2.1-8.7)	172	1.3	(0.6-5.0)
Ciprofloxacin	54	0.0	(0.0-6.6)	55	7.3	(2.9-17.3)	113	8.0	(4.2-14.4)	126	7.1	(3.8-13.0)	137	1.5	(0.4-5.2)	149	2.0	(0.7-5.8)	160	5.0	(2.6-9.6)	175	2.3	(0.9-5.7)
Trimethoprim-sulfamethoxazole	54	0.0	(0.0-6.6)	55	3.6	(1.0-12.3)	112	4.5	(1.9-10.0)	126	9.5	(5.5-15.9)	138	7.3	(4.0-12.8)	149	4.0	(1.9-8.5)	160	5.6	(3.0-10.3)	175	5.1	(2.7-9.5)
Gentamicin	51	0.0	(0.0-7.0)	49	6.1	(2.1-16.5)	72	6.9	(3.9-17.0)	90	11.1	(6.1-19.3)	111	5.4	(2.5-11.3)	94	2.3	(0.6-8.0)	87	1.1	(0.2-6.2)	77	5.2	(2.0-12.6)
Tobramycin	NA	NA	NA	NA	NA	NA	67	0.0	(0.0-5.4)	65	12.3	(6.4-22.5)	75	2.7	(0.7-9.2)	79	1.3	(0.2-6.8)	95	5.3	(2.3-118.7)	91	2.2	(0.6-7.7)
Amikacin	NA	NA	NA	NA	NA	NA	65	7.7	(3.3-16.8)	61	11.5	(5.7-21.8)	66	1.5	(0.3-8.1)	78	3.8	(1.3-10.7)	62	6.5	(2.1-15.5)	81	4.9	(0.0-4.5)

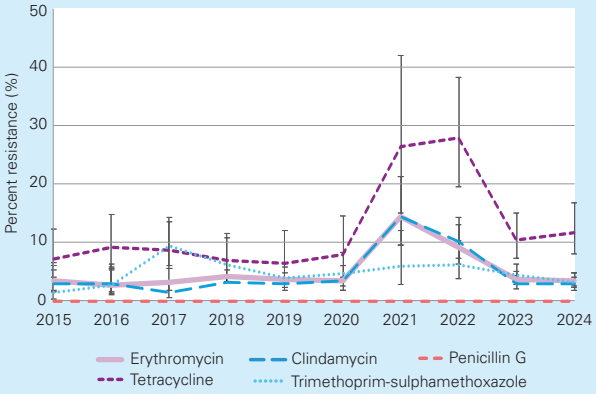
Streptococcus pyogenes, from blood cultures

- Number of mandatory reported cases of invasive *S. pyogenes*: 1 367

Comments

Invasive cases of *S. pyogenes* are notifiable according to the Communicable Disease Act and in 2024, the highest number of cases were reported since it became notifiable in July 2004 and slightly over the numbers for 2023 (n=1 323). AST results from 957 isolates were available from Svebar (Figure 3.31). Some laboratories did not test susceptibility to trimethoprim-sulphamethoxazole and tetracycline. The variation in resistance during 2021 to 2022 should be interpreted with caution since there was a small number of tested isolates. Clindamycin and erythromycin resistance rates has since 2023 returned to prepandemic levels and is now 2.8% and 3.5% respectively.

Figure 3.31. Antibiotic resistance in *S. pyogenes* (GAS) from bloodstream isolates during the years 2015-2024. The numbers of AST isolates for all years and antibiotics ranges from 139 to 1 006. The exact numbers are given in the attached file.



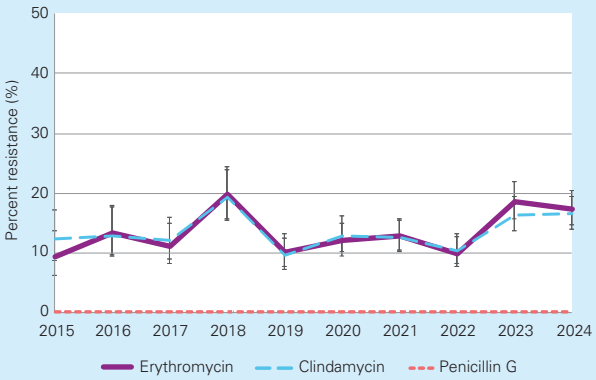
Source: The Public Health Agency of Sweden

Streptococcus agalactiae, from blood cultures

Comments

S. agalactiae is not included in the Communicable Disease Act. It is an important pathogen in the context of pregnancy and childbirth and can cause serious infections among others as well, mainly elderly with predisposing disease. AST results from 685 isolates were available from Svebar. Resistance to erythromycin and clindamycin is now 17% and 16%, respectively (Figure 3.32).

Figure 3.32. Antibiotic resistance in *S. agalactiae* (GBS) from bloodstream isolates during the years 2015-2024. The numbers of AST isolates for all years and antibiotics ranges from 184 to 685. The exact numbers are given in the attached file.



Source: The Public Health Agency of Sweden

Shigella species

Mandatory reporting of *Shigella*

- Total number of reported cases: 789 (previous year: 728)
- Number of bloodstream infections: 0 (previous year: 0)

The number of reported *Shigella* cases remained stable during 2024 compared to 2023. However, a significant increase was seen in the number of cases infected abroad. In 2024, 77% of the cases were reported as acquired abroad and 19% reported as acquired in Sweden. The number of reported cases increased before 2020, partly explained by a shift in the microbiological method of detection used, where nucleic acid amplification tests are utilised more now.

In 2024, 89 cases with *Shigella* were also notified as ESBL-producing Enterobacterales. Of the 81 cases with known ESBL-type, 80 had $ESBL_A$ and two $ESBL_M$. No cases with *Shigella* carrying $ESBL_{CARBA}$ were reported during 2024.

Shigella spp., from faecal samples

In 2024, 248 isolates of *Shigella* in feacal samples were reported in Svebar and AST results were available for 227 isolates. The majority of isolates with AST were *S. sonnei* and *S. flexneri*, with 39% and 34% of the isolates, respectively. None of the isolates was carbapenem resistant (Table 3.12). The number of isolates with an AST available for analysis was low. Hence, results should be interpreted with caution. The increase in cefotaxime resistance indicates a higher presence of ESBL among the tested isolates.

Microbiological surveillance programme, *Shigella sonnei and Shigella* spp.

In total, 34 isolates were received in 2024 within the microbiological surveillance program for *Shigella sonnei* and *Shigella* spp. with resistance to ciprofloxacin and cefotaxime and/or ceftazidime.

Whole genome sequencing and subsequent SNP-analysis confirmed that 29 of the 34 received isolates belonged to a cluster with a total of 31 isolates. The cluster is genetically related to a multidrug-resistant and internationally spread *S. sonnei* carrying a $bla_{\text{CTX-M-15}}$ gene, reported by the Netherlands on June 2023 and the United Kingdom on December 2023, mainly affecting men who have sex with men (ECDC, 2023b).

Table 3.12. Antibiotic resistance in *Shigella* spp. from faecal samples 2020-2024. The numbers of AST isolates for all years and antibiotics ranges from 40 to 227.

Species *Shigella* spp.	2020			2021			2022			2023			2024		
Sample: Faeces	**n**	**% R**	**95% CI**	**n**	**% R**	**95% CI**	**n**	**% R**	**95% CI**	**n**	**% R**	**95% CI**	**n**	**% R**	**95% CI**
Ciprofloxacin	63	22.2	(13.7-33.9)	65	21.5	(13.3-33.0)	151	23.2	(17.2-30.5)	195	33.8	(27.6-40.7)	227	32,6	(26.8-38.9)
Trimetoprim-sulphamethoxazole	63	73	(61.0-82.4)	65	69.2	(57.2-79.1)	152	73	(65.5-79.4)	195	74.4	(67.8-80.0)	226	69,9	(63.6-75.5)
Cefotaxime	62	11.3	(5.6-21.5)	64	32.8	(22.6-45.0)	151	33.8	(26.7-41.6)	194	36.1	(29.7-43.1)	226	34,1	(28.2-40.5)
Ceftazidime	61	3.3	(0.9-11.2)	64	6.2	(2.5-15.0)	151	7.9	(4.6-13.4)	192	7.8	(4.8-12.5)	225	5,8	(3.4-9.6)
Meropenem	55	0	(0.0-6.5)	51	0	(0.0-7.0)	140	0	(0.0-2.7)	188	0	(0.0-2.0)	223	0	(0.0-1.7)
Azithromycin	52	17.3	(9.4-29.7)	50	24.0	(14.3-37.4)	138	17.4	(12.0-24.6)	174	27.6	(21.5-34.7)	102	37,3	(28.5-46.9)
Piperacillin-tazobactam	40	2.5	(0.4-12.9)	44	0	(0.0-8.0)	123	1.6	(0.4-5.7)	145	0.7	(0.1-3.8)	172	3,5	(1.6-7.4)

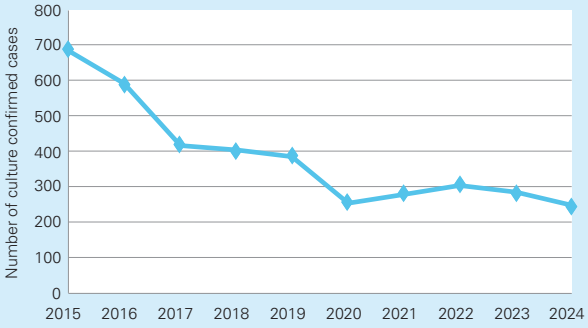
Mycobacterium tuberculosis, mandatory reporting

During 2024 a total of 315 cases of tuberculosis (TB) were reported compared to 362 cases during 2023 which is a decrease of 13%. Out of the 315 cases three were already on TB treatment when arriving in Sweden.

The number and proportion of culture confirmed cases were 254 (81%) compared to 285 (80%) in 2023. *Mycobacterium bovis* was identified in six cases and *Mycobacterium tuberculosis* in 248 cases (Figure 3.33). The proportions of *Mycobacterium tuberculosis* cases diagnosed with MDR-TB was 1.6% (4/248) compared to 2.5% (7/283) in 2023. Two of the MDR-cases was classified as pre-XDR-TB (additional resistance to fluoroquinolones).

Isolates of *M. tuberculosis* resistant to at least one of the four first line drugs (isoniazid, rifampicin, ethambutol or pyrazinamide) or fluoroquinolones were identified in 30 patients corresponding to 12.1% of the 248 with culture confirmed *M. tuberculosis*, (Figure 3.34). As always, the most common resistance found was against isoniazid.

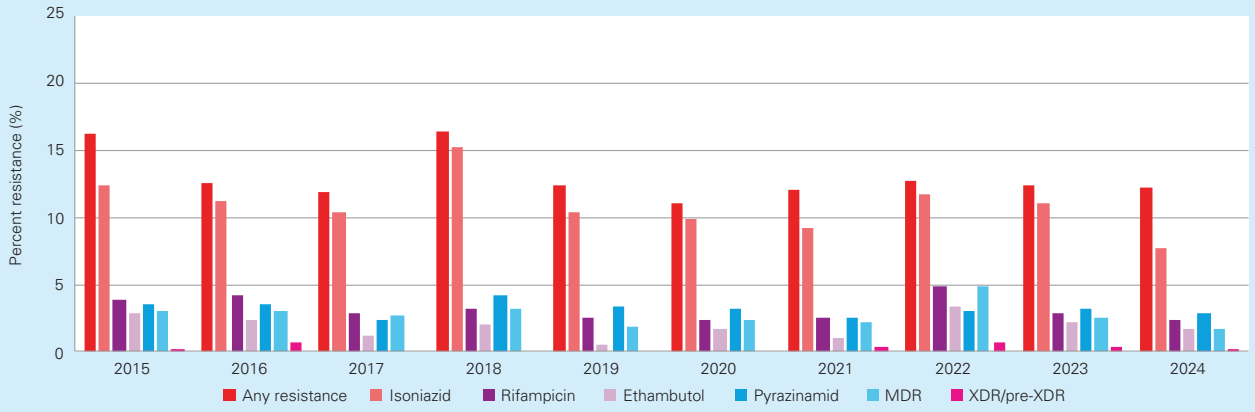
Figure 3.33. The number of culture confirmed *M. tuberculosis* in Sweden cases in Sweden 2015-2024.



Source: The Public Health Agency of Sweden

Of 49 persons with tuberculosis born in Sweden, 36 had a culture confirmed diagnosis with *M. tuberculosis*, four with isoniazid resistant strains and one with a pyrazinamide resistant strain. Of all the TB cases reported in Sweden 2024, 84%

Figure 3.34. Drug resistance in culture confirmed *M. tuberculosis* in Sweden 2015-2024.



Source: The Public Health Agency of Sweden

were born in another country. In total 212 in this group had a culture confirmed infection with *M. tuberculosis* and 25 (12%) had some kind of resistance out of which four had MDR-TB.

Genetic typing of TB isolates has been performed in Sweden since the late 1990's. This is done to identify clusters of cases as clustering indicates possible recent transmission and helps to identify missed opportunities of infection control. Of all the cases 19% (60/315) were reported as infected in Sweden and of 254 (including *M. bovis*) cases analysed with whole genome sequencing 80% were unique isolates not belonging to any cluster.

The number of reported TB cases in Sweden continued to decrease in 2024 and 315 cases of TB is the lowest number ever reported since surveillance started in 1940. The number and percentage of MDR-TB cases also continued to decrease during 2024 (Figure 3.34).

Neisseria gonorrhoeae, mandatory reporting

Gonorrhoea is a notifiable infection and in 2024, 4 365 cases (41.2 cases per 100 000 inhabitants) of gonococcal infections were reported to the Public Health Agency of Sweden. This represents an increase with 3.6% compared to 2023 (4 212 cases, 39.9 cases per 100 000 inhabitants). As in earlier years, most of the gonorrhoea cases in 2024 were identified in the three largest counties of Sweden, which comprise the cities Stockholm, Göteborg, and Malmö, respectively. Clinical isolates are in the present report described from the National Reference Laboratory for Sexually Transmitted Infections (an external body of the Public Health Agency of Sweden), Department of Laboratory Medicine, Clinical Microbiology, Örebro University Hospital, Örebro; Department of Clinical Microbiology, Karolinska University Hospital, Huddinge; and Clinical Microbiology, Infection Prevention and Control, Office for Medical Services, Lund, Sweden. In 2024, the antimicrobial susceptibility of 2 567 clinical *N. gonorrhoeae* isolates (one different per infection episode) is presented.

Antimicrobial susceptibility testing was performed according to standardised and quality assured methodology using Etest for MIC determination of ceftriaxone, cefixime, azithromycin, spectinomycin, ciprofloxacin, and tetracycline. The current clinical resistance breakpoints from the European Committee on Antimicrobial Susceptibility Testing (EUCAST; https://www.eucast.org/clinical_breakpoints, v15.0) were used for ceftriaxone, cefixime, ciprofloxacin, spectinomycin, and tetracycline. EUCAST does not state any clinical resistance breakpoint for azithromycin and in this report the EUCAST Epidemiological Cut-Off (ECOFF), distinguishing isolates with azithromycin resistance mechanisms, is instead used for azithromycin.

Table 3.13. Proportion (%) of antibiotic clinical *Neisseria gonorrhoeae* isolates 2015-2024.

Antibiotic	2015 (n=462)	2016 (n=601)	2017 (n=528)	2018 (n=580)	2019 (n=1 035)	2020 (n=1 713)	2021 (n=1 583)	2022 (n=894)	2023 (n=2 448)	2024 (n=2 567[a])
Ceftriaxone	0	0	0	0	0	0	0	<1 (0.1)	<1 (0.1)	<1 (0.1)
Cefixime	2	1	<1 (0.6)	1 (1.2)	<1 (0.8)	2	<1 (0.5)	1	<1 (0.4)	<1 (0.4)
Azithromycin	10	3	5	5	12	19	25	30	33	22
Ciprofloxacin	53	53	47	57	60	58	69	64	65	67
Spectinomycin	0	0	0	0	0	0	0	0	0	0
Tetracycline	NT	NT	NT	NT	NT	NT	NT	NT	NT	57

[a]For cefixime, spectinomycin and tetracycline, 2 320, 2 194 and 737 *N. gonorrhoeae* isolates were tested. NT, not tested.

Briefly, the level of resistance to ciprofloxacin remains very high (67% in 2024). The proportion of isolates above the azithromycin ECOFF (MIC>1 mg/L) was 22%, which represents a substantial decrease since 2023 (33%). The resistance to cefixime remained low and at the same level as in 2023, i.e., at 0.4%. For the third consecutive year since 2014, ceftriaxone-resistant isolates (n=2, 0.1%) were identified in Sweden. Ceftriaxone is the last remaining option for empirical antimicrobial monotherapy of gonorrhoea and it is a major concern if ceftriaxone-resistant strains will start to spread widely, which has been observed in especially some Asian countries such as Cambodia, China, Japan, and Vietnam. No gonococcal isolates resistant to spectinomycin have yet been detected in Sweden. However, the availability of spectinomycin can be limited (in Sweden as in most countries globally), and it is not suitable as monotherapy for pharyngeal gonorrhoea. Finally, the National Reference Laboratory for Sexually Transmitted Infections in Örebro also examined the susceptibility to tetracycline in 2024. This testing was initiated due to the interest of using doxycycline post-exposure prophylaxis (Doxy-PEP) against bacterial sexually transmitted infections (syphilis, chlamydia and gonorrhoea). The level of resistance to tetracycline was 57%, which indicates that Doxy-PEP is very unlikely to significantly reduce the number of incident gonorrhoea cases in Sweden.

Neisseria meningitidis, mandatory reporting

Invasive meningococcal disease is a notifiable disease. In 2024, 46 cases were reported in Sweden, corresponding to an incidence of 0.4 cases per 100 000 inhabitants that approaches the incidences observed in the years preceding the COVID-19 pandemic. From these 46 invasive cases, clinical samples obtained from blood, cerebrospinal fluid, or joint fluid were available and 44 of these samples (one sample per patient) were typed at the National Reference Laboratory for Neisseria meningitidis (an external unit of the Public Health Agency of Sweden), located within the Department of Laboratory Medicine, Clinical Microbiology, Örebro University Hospital. In total, 37 of the invasive cases were confirmed by *N. meningitidis* culture and the remaining nine with PCR only.

Antimicrobial susceptibility testing was performed on all culture-confirmed i solates (n=37) u sing s tandardised a nd quality-assured methodology. Minimum inhibitory concentrations (MICs) of penicillin G, cefotaxime, meropenem, chloramphenicol, ciprofloxacin, and rifampicin were determined using Etest. The current clinical resistance breakpoints determined by The European Committee on Antimicrobial Susceptibility Testing (EUCAST; https://www.eucast.org/clinical_breakpoints, v15.0) were used. β-lactamase production was assessed using nitrocefin solution.

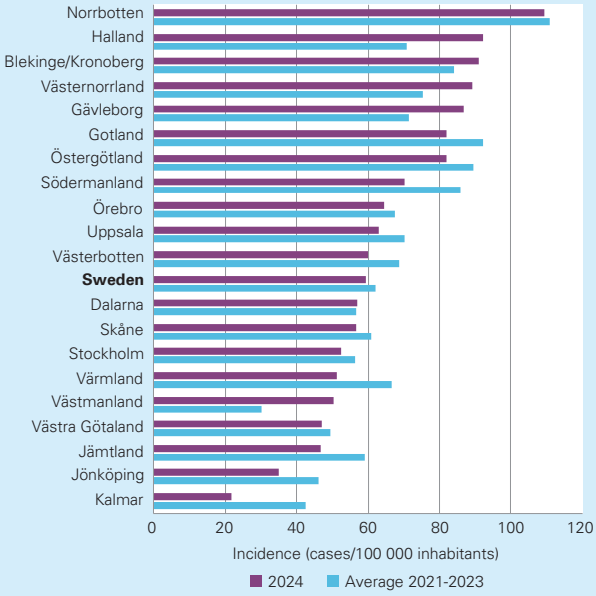
All isolates (100%) were susceptible to penicillin G (MIC range: 0.032–0.25 mg/L), cefotaxime (0.002–0.032 mg/L), meropenem (0.002–0.064 mg/L), chloramphenicol (0.25–2 mg/L), ciprofloxacin (<0.002–0.008 mg/L), and rifampicin (<0.002–0.25 mg/L). No β-lactamase production was detected in any of the 2024 isolates. To date, no β-lactamase-producing *N. meningitidis* isolate has ever been identified in Sweden.

Clostridioides difficile

Incidence of CDI

In 2024, 6 292 new CDI cases were reported corresponding to an incidence of 59 cases per 100 000 inhabitants (data corrected for reccurent CDI for two laboratories reporting all cases and missing data for one laboratory). The incidence, is slightly lower than the average incidence observed in the last three years (incidence 62). As in previous years, there are major differences between regions (spread 22-109 cases per 100 000 inhabitants; Figure 3.35).

Figure 3.35. The incidence of new cases with *C. difficile* (cases/ 100 000 inhabitants) by region in 2024 and average for the years 2021-2023. The regions are ranked from highest to lowest incidence in 2024. A case is considered new if at least eight weeks have elapsed since the previous positive test, otherwise it is counted as an ongoing illness episode or recurrence.



Source: The Public Health Agency of Sweden

Zoonotic pathogens: *Campylobacter*

Mandatory reporting of *Campylobacter*

- Total number of reported cases: 5 440 (previous year: 5 676)

The majority of notified cases, 55%, were reported as acquired in Sweden. The proportion of domestic infections were similar to the previous year. The proportion of cases infected abroad was 43%, also similar to the previous year, reaching pre-pandemic levels.

Campylobacter jejuni, from faecal samples

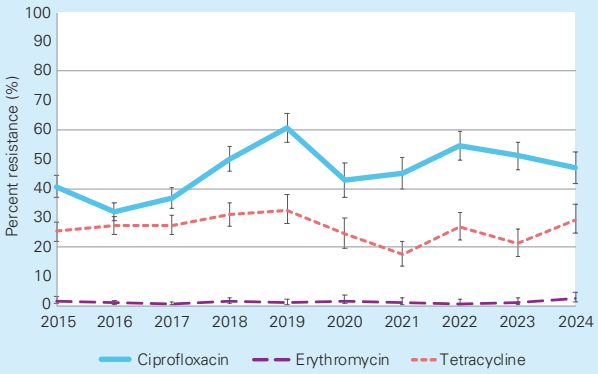
A total of 1 378 *Campylobacter* species were found in faecal sampling. Four-fifths of the isolates were reported as *C. jejuni*, 15% as *C. jejuni/C. coli* and the rest were other species. The presence of AST data, and in a sufficient number of isolates, was highest for *C. jejuni* (30% of all reported isolates). For

C. jejuni, resistance to ciprofloxacin was 47% and 29% for tetracycline in 2024. Resistance to erythromycin was 2.2% (Figure 3.36). The proportion of isolates fully susceptible to erythromycin, ciprofloxacin and tetracycline was 50% and fully resistant was 1.3% (Table 3.14). It should be noted that the number of isolates with combined AST is low. Only four fully resistant isolates were reported.

Comments

During 2018-2019, the majority of notifiable campylobacter infections were acquired abroad. During the pandemic years, 2020-2021, the total number of notified cases decreased and the proportion of cases infected in Sweden increased. Resistance to ciprofloxacin and tetracycline was slightly lower in 2020 and 2021, compared to 2019. In 2016 and 2017, there was a large outbreak of campylobacter in humans linked to domestic poultry production. During these two years, the proportion of isolates of Swedish origin was higher. It can be noted that the resistance to ciprofloxacin was lower 2016-2017 (Figure 3.36) and a higher percentage of isolates were fully susceptible (Table 3.14).

Figure 3.36. Antibiotic resistance in *Campylobacter jejuni* from faecal samples 2015-2024. The numbers of AST isolates for all years and antibiotics ranges from 254 to 816. The exact numbers are given in the attached file.



Source: The Public Health Agency of Sweden

Table 3.14. Combined susceptibility and resistance to erythromycin, ciprofloxacin and tetracycline in *Campylobacter jejuni* from faecal samples 2015-2024.

Sample: Faeces	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Number of AST isolates	**659**	**793**	**697**	**544**	**352**	**253**	**304**	**360**	**331**	**313**
Proportion suseptitible to erythromycin, ciprofloxacin and tetracycline, %	54	61	60	47	38	56	53	43	45	50
Proportion resistant to erythromycin, ciprofloxacin and tetracycline, %	1.4	0.8	0.4	0.9	0.6	1.2	0.3	0.3	1.2	1.3

Salmonella

Mandatory reporting of *Salmonella*

Infection with *Salmonella* species are divided into three notifiable diseases in Sweden: infection with *Salmonella enterica* (*S.* Typhi and *S.* Paratyphi excluded), typhoid fever and paratyphoid fever. In addition, cases with *Salmonella* carrying ESBL or $ESBL_{CARBA}$ are also notifiable in the mandatory reporting of ESBL-producing Enterobacterales.

- Total number of reported cases with *Salmonella enterica*: 1 612 (previous year: 1 316)
- Total number of reported cases with typhoid fever: 26 (previous year: 27)
- Total number of reported cases with paratyphoid fever: 9 (previous year: 12)
- Total number of *Salmonella* carrying ESBL: 15 (previous year: 12)
- Total number of *Salmonella* carrying $ESBL_{CARBA}$: 1 (previous year: 0)

Table 3.15. Proportion (%) of antibiotic resistance in *Salmonella enterica* (*S.* Typhi and *S.* Paratyphi excluded) isolated from blood or from faeces and urine samples in 2024.

Antibiotic	Blood, % R (n = 70-138)	Faeces/urine, % R (n= 317-559)
Azithromycin	1.8	1.6
Cefotaxime	3.6	2.9
Ceftazidime	3.6	2.3
Fluoroquinolone	24.1	20.8
Meropenem	0.0	0.0
Piperacillin-tazobactam	3.0	2.8
Trimethoprim-sulfamethoxazole	6.8	4.6

Table 3.16. Antibiotic resistance in *Salmonella enterica* from blood samples 2020-2024. Results from *S.*typhi and *S.*paratyphi are excluded. The numbers of AST isolates for all years and antibiotics ranges from 32 to 138.

***Salmonella* spp., *S.*typhi and *S.*paratyphi excluded**	**2020**			**2021**			**2022**			**2023**			**2024**		
Sample: Blood	**n**	**% R**	**95% CI**	**n**	**% R**	**95% CI**	**n**	**% R**	**95% CI**	**n**	**% R**	**95% CI**	**n**	**% R**	**95% CI**
Azithromycin	32	3.1	(0.6-15.7)	52	3.8	(1.1-13.0)	73	0	(0.0-5.0)	93	2.2	(0.6-7.5)	56	1.8	(0.3-9.4)
Cefotaxime	59	10.2	(4.7-20.5)	76	7.9	(3.7-16.2)	95	5.3	(2.3-11.7)	136	2.9	(1.1-7.3)	138	3.6	(1.6-8.2)
Ceftazidime	57	10.5	(4.9-21.1)	76	7.9	(3.7-16.2)	94	4.3	(1.7-10.4)	135	3	(1.2-7.4)	138	3.6	(1.6-8.2)
Fluoroquinolone	59	32.2	(21.7-44.9)	74	25.7	(17.1-36.7)	95	32.6	(24.0-42.6)	135	26.7	(19.9-34.7)	137	24.1	(17.7-31.9)
Meropenem	59	0	(0.0-6.1)	76	0.0	(0.0-4.8)	95	0	(0.0-3.9)	136	0	(0.0-2.7)	138	0	(0.0-2.7)
Piperacillin-tazobactam	56	3.6	(1.0-12.1)	73	0.0	(0.0-5.0)	90	1.1	(0.2-6.0)	133	2.3	(0.8-6.4)	132	3	(1.2-7.5)
Trimethoprim-sulfamethoxazole	59	15.3	(8.2-26.5)	76	1.3	(0.2-7.1)	95	7.4	(3.6-14.4)	135	4.4	(2.1-9.4)	132	6.8	(3.6-12.5)

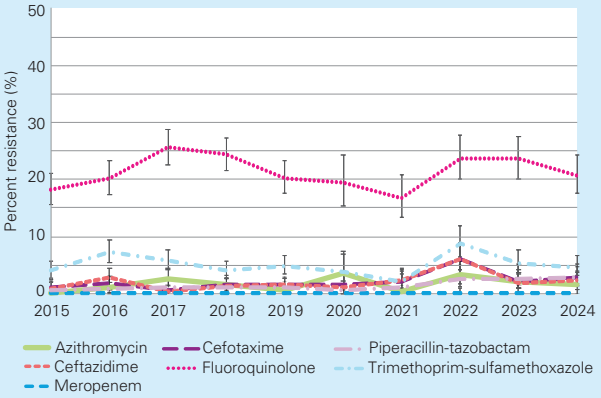
In 2024, the majority of the notifiable *Salmonella* cases, 55%, were acquired in Sweden and the highest incidence of domestic cases were noted since 2010. There have been six outbreaks with 10 or more cases during the year, where two of these have included more than 100 cases. These two outbreaks are international and linked to contaminated eggs and alfalfa sprouts. Cases with *Salmonella* acquired abroad constituted 43% of all cases and for two percent information was lacking. One case was reported with *Salmonella* species carrying $ESBL_{CARBA}$.

Salmonella spp., from blood or faecal and urine samples

A total of 1 796 *Salmonella enterica* isolates were reported in Svebar, with 75% from faecal samples, 14% from blood and 6.5% from urine. In 2024, there were 253 isolates of *Salmonella* reported in blood and 1 355 isolates from feaces. For both sampling materials, approximately half had an AST reported. A comparison for 2024 is presented in Table 3.15.

In previous years, the number of isolates found in blood with an AST has ranged between 32-138 per year and antibiotic (Table 3.16). The data may contain duplicates and there is a risk of overestimation of the resistance. Hence, results should be interpreted with caution. The general increase in resistance among faecal and urine isolates seen in 2022 (Figure 3.37), probably linked to the increase of *Salmonella* isolates carrying ESBL, decreased in 2023-2024 for several antibiotics. Almost four-fifths of the *Salmonella* from faecal and urine samples were fully susceptible to azithromycin, cefotaxime and ciprofloxacin (Table 3.17). During 2015-2023, no carbapenem-resistent *Salmonella* have been reported. The isolate reported in 2024 came from a laboratory not currently reporting data to Svebar.

Figure 3.37. Antibiotic resistance in *Salmonella enterica* from faecal and urine samples 2015-2024. Results from *S.* Typhi and *S.* Paratyphi have been excluded. The numbers of AST isolates for all years and antibiotics ranges from 187 to 875. The exact numbers are given in the attached file.



Source: The Public Health Agency of Sweden

Table 3.17. Combined susceptibility and resistance to azithromycin, cefotaxime and ciprofloxacin in *Salmonella enterica* from faecal and urine samples 2020-2024. Results from *S.* Typhi and *S.* Paratyphi have been excluded.

Sample: Faeces and urine	**2020**	**2021**	**2022**	**2023**	**2024**
Number of isolates with combined AST for azithromycin, cefotaxime and ciprofloxacin	183	267	327	342	311
Proportion fully suseptitible to azithromycin, cefotaxime and ciprofloxacin, %	77	79	73	76	78
Proportion fully resistant to azithromycin, cefotaxime and ciprofloxacin, %	0.0	0.0	1.5	0.0	0.0

Antibiotic resistance in animals

Notifiable diseases

In Sweden, findings of carbapenemase-producing Enterobacterales ($ESBL_{CARBA}$) and methicillin-resistant coagulase-positive staphylococci in animals are notifiable (SJVFS 2021:10 and previously SJVFS 2012:24 with amendments). In the monitoring, the attention regarding methicillin-resistant coagulase-positive staphylococci is mainly directed towards methicillin-resistant *Staphylococcus aureus* (MRSA) and *Staphylococcus pseudintermedius* (MRSP). Furthermore, as Enterobacterales producing classical ESBLs ($ESBL_A$) or plasmid-mediated AmpC ($ESBL_M$) as well as vancomycin resistant enterococci (VRE) are notifiable when detected in humans, specific attention is also paid to these bacteria in animals.

ESBL-producing Enterobacterales

Healthy farm animals

Escherichia coli

In Sweden, $ESBL_{CARBA}$ in animals are notifiable but not $ESBL_A$ or $ESBL_M$. During 2024, various samples from healthy farm animals were screened for *Escherichia coli* resistant to ESCs and carbapenems using selective media. Isolates with reduced susceptibility were further investigated by genome sequencing for presence of transferable genes coding for ESC resistance (for details see Material and methods, resistance in bacteria from animals).

Active screening for *E. coli* resistant to ESCs in healthy farm animals using faecal samples collected at slaughter has been performed since 2008. The proportions of samples positive for *E. coli* with $ESBL_A$ or $ESBL_M$ in screenings of healthy animals are available as supplementary material on the SVA web page (www.sva.se/svarm).

Broilers

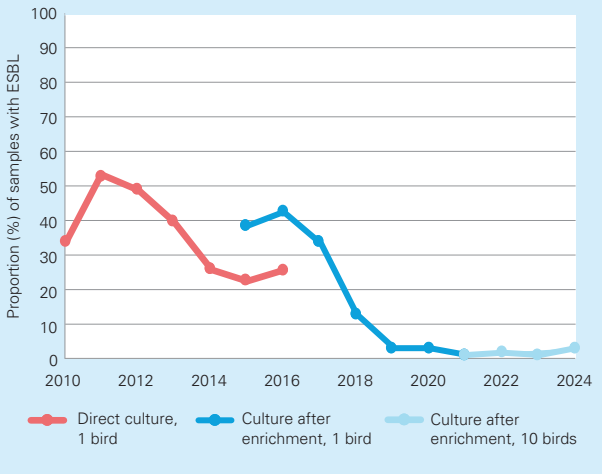
Samples from broilers were randomly selected among caeca collected at slaughter within the Swedish Campylobacter programme, in which whole caeca are collected from each batch of broilers slaughtered. Each sample was from a unique flock but not always from a unique production site. Samples cultured were collected from January to December at five abattoirs that in 2024 accounted for approximately 98% of the total volume of broilers slaughtered. The number of samples from each abattoir was roughly proportional to the annual slaughter volume of the abattoir and the sampling was distributed over the year.

Carbapenem resistant *Escherichia coli* was not isolated from any of 305 investigated samples.

Escherichia coli with ESC-resistance was isolated from 9 (3%) of 305 investigated samples, and a transferable gene coding for ESC resistance was detected in all of them (Table 4.1). All of the isolates had an $ESBL_A$ phenotype and carried bla_{TEM-52} (n=8) or $bla_{CTX-M-65}$ (n=1). Apart from resistance to beta-lactams, including ESCs, one of the isolates was also resistant to tetracycline, one to quinolones (ciprofloxacin and nalidixic acid), and one to chloramphenicol, ciprofloxacin, gentamicin, tetracycline, and trimethoprim.

Due to differences in methodology over the years, changes in the proportion of positive samples over the whole time period cannot be directly assessed. However, some comparison with earlier years is possible as the samples from 2015 and the first half of 2016 as well as the samples from 2021 were cultured in duplicate with both methods that were relevant for the respective years (for details on methodology see Material and methods, resistance in bacteria from animals in relevant Swedres-Svarm reports). The difference in the proportion of broiler caecal samples positive for *E. coli* with $ESBL_A$ or $ESBL_M$ since 2016 is statistically significant ($p<0.01$, X^2; Figure 4.1). This decrease is most likely explained by decreased occurrence of such bacteria in the breeding pyramid as described by Nilsson et al. (2020).

Figure 4.1. Proportion (%) of samples from broilers positive for *Escherichia coli* with $ESBL_A$ or $ESBL_M$ from 2010 to 2024. The number of samples each year varies (n=100-305, 2024 n=305).



Turkeys

Samples from turkeys consist of caecal content of healthy turkeys sampled at slaughter. Each sample is from a unique flock but not always from a unique production site. Samples cultured were collected from January to December at one abattoir that in 2024 accounted for approximately 80% of the total volume of turkeys slaughtered in Sweden.

Carbapenem resistant *Escherichia coli* or *E. coli* with ESC-resistance were not isolated from any of the 29 investigated samples (Table 4.1).

Cattle under one year

Samples from cattle under one year consist of faecal content of healthy cattle sampled at slaughter. Samples cultured were collected from September 2023 to September 2024 at thirteen abattoirs that in 2024 accounted for approximately 90% of the total volume of cattle under one year slaughtered in Sweden.

Carbapenem resistant *Escherichia coli* or *E. coli* with ESC-resistance were not isolated from any of the 34 investigated samples (Table 4.1).

Meat samples

Escherichia coli

In Sweden, neither carbapenemase-producing Enterobacterales ($ESBL_{CARBA}$), nor classical ESBLs ($ESBL_A$) or plasmid-mediated AmpC ($ESBL_M$) are notifiable in food. Active screening for *Escherichia coli* resistant to ESCs in meat samples collected at retail has been performed since 2008. During 2024, broiler and turkey meat samples were screened for *E. coli* resistant to ESCs and carbapenems using selective media (for details see Material and methods, resistance in bacteria from animals).

Samples from broiler and turkey meat were collected at retail by municipal environmental departments in nine different municipalities in Sweden. The samples were distributed throughout the year and among the municipalities in order to get a representative sampling. In 2024, there were no consignments of poultry meat from countries outside EU imported via border control posts in Sweden. Hence, no sampling of poultry meat was performed.

The proportions of samples positive for *E. coli* with $ESBL_A$ or $ESBL_M$ in screenings of meat sampled at retail are available as supplementary material on the SVA web page (www.sva.se/svarm).

Broiler meat

A total of 300 samples of fresh broiler meat were collected at retail. The samples comprised meat originating both from Sweden (n=275) and other EU countries (n=25).

Escherichia coli with carbapenem resistance was not isolated from any of the samples of broiler meat collected at retail.

Escherichia coli with ESC-resistance was isolated from 11 (4%) of 300 investigated samples, one of Swedish origin and ten originating from other EU countries. A transferable gene coding for ESC resistance was detected in all of the isolates. Seven had an $ESBL_A$ phenotype and carried bla_{SHV-12} (n=4), $bla_{CTX-M-14}$ (n=1), $bla_{CTX-M-65}$ (n=1), and bla_{TEM-52} (n=1) whereas four were $ESBL_M$ and all carried bla_{CMY-2}.

Turkey meat

A total of 75 samples of fresh turkey meat were collected at retail. The samples comprised meat only originating from Sweden.

Escherichia coli with carbapenem resistance or ESC-resistance were not isolated from any of the samples of turkey meat (Table 4.1).

Table 4.1. Proportion (%) of samples from broilers, turkeys, cattle under one year, broiler meat, and turkey meat positive for *Escherichia coli* with $ESBL_A$ or $ESBL_M$, 2024. Most recent data on occurrence of *E. coli* with $ESBL_A$ or $ESBL_M$ from other sample categories are given for comparison.

Origin and year	Broilers 2024	Cattle (2023-24)	Laying hens 2022	Pigs 2023	Turkey 2024	Broiler meat 2024	Cattle meat 2023	Pig meat 2023	Turkey meat 2024
Swedish	3	0	2	1	0	<1	0	0	0
Non-Swedish	–	–	–	–	–	40	0	0	–

Clinical isolates from companion animals and horses

In Svarm, there are no recurring active screenings for ESBL-producing Enterobacterales in healthy companion animals or horses. However, results of the screenings for ESC resistant *E. coli* that have been performed are available as supplementary material on the SVA web page (www.sva.se/svarm).

For a number of years, funding from the Swedish Board of Agriculture has enabled SVA to perform confirmation of suspected ESC-resistance in clinical isolates of Enterobacterales free of charge for referring laboratories. During 2024, 37 submitted isolates of Enterobacterales with phenotypic resistance to ESCs from companion animals and horses were confirmed to produce $ESBL_A$ and/or $ESBL_M$ by genome sequencing (Table 4.2). The isolates were from cats (n=3), dogs (n=12) and horses (n=22). The majority of the isolates from cats and dogs were *E. coli* and the most common

gene was *bla*$_{CTX-M-15}$. For horses, the majority of the isolates belonged to the *Enterobacter cloacae* group and the most common gene was *bla*$_{SHV-12}$. Data regarding clinical isolates from cats, dogs and horses confirmed to produce ESBL$_A$ and/or ESBL$_M$ is available as supplementary material on the SVA web page (www.sva.se/svarm).

About three quarters of the investigated isolates were resistant to at least two antibiotics besides beta-lactams, i.e. multiresistant. The most common resistances were against trimethoprim-sulphonamides (76%) and gentamicin (55%). Resistance to quinolones and tetracycline were also common traits. For the years 2021-2024 the occurrence of resistance to quinolones was higher among isolates from companion animals than among isolates from horses. On the contrary, the occurrence of resistance to gentamicin and trimethoprim-sulphonamides was higher among isolates from horses than among isolates from companion animals (Table 4.3).

Table 4.2. Clinical isolates of different bacterial species of Enterobacterales producing ESBL$_A$ or ESBL$_M$ from companion animals and horses, 2024.

Animal species	Beta-lactamase group	Beta-lactamase gene	Bacterial species	No. of isolates
Cats	**All**	**All**	**Enterobacterales**	**3**
	CTX-M-1	CTX-M-1	*Escherichia coli*	1
	CTX-M-1	CTX-M-15	*Escherichia coli*	1
	CTX-M-9	CTX-M-14	*Escherichia coli*	1
Dogs	**All**	**All**	**Enterobacterales**	**12**
	CIT	CMY-2	*Escherichia coli*	1
	CIT+DHA	CMY-4+DHA-1	*Escherichia coli*	1
	DHA	DHA-1	*Escherichia coli*	1
	CTX-M-1	CTX-M-15	*Escherichia coli*	1
	CTX-M-9	CTX-M-14	*Escherichia coli*	2
	CTX-M-9	CTX-M-27	*Escherichia coli*	1
	CTX-M-1	CTX-M-15	*Proteus mirabilis*	2
	CIT	CMY-2	*Proteus mirabilis*	1
	DHA	DHA-1	*Proteus mirabilis*	2
Horses	**All**	**All**	**Enterobacterales**	**22**
	SHV	SHV-12	*Enterobacter cloacae* group	10
	SHV	SHV-12	*Escherichia coli*	1
	SHV	SHV-12	*Klebsiella oxytoca*	1
	SHV+ACT	SHV-12+ACT-17	*Enterobacter cloacae* group	3
	CTX-M-1	CTX-M-1	*Escherichia coli*	1
	CTX-M-1	CTX-M-32	*Escherichia coli*	2
	CTX-M-1	CTX-M-15	*Klebsiella pneumoniae*	3
	CTX-M-1	CTX-M-3	*Klebsiella pneumoniae*	1

Table 4.3. Resistance (%) in clinical isolates of different bacterial species of Enterobacterales producing ESBL$_A$ or ESBL$_M$ from companion animals and horses, using *Escherichia coli* ECOFF:s, 2021-2024.

Antibiotic	ECOFF (mg/L)	Resistance (%)	
		Dogs and cats (n=65)	**Horses** (n=97)
Enrofloxacin	0.12	51	28
Gentamicin	2	26	87
Neomycin	8	8	31
Tetracycline	8	29	21
Trim-Sulph.[a]	0.5	51	84

[a]Concentration of trimethoprim given, tested in concentration ratio 1/20 (trimethoprim-sulphamethoxazole).

ESBL- and pAmpC-producing Enterobacterales in dogs and cats 2017–2021

One of the most important variants of resistance recognised in human medicine is resistance to extended spectrum cephalosporins among Enterobacterales, such as *Escherichia coli* and *Klebsiella* spp. These bacteria might spread between animals and humans, and moreover, the genes responsible for the resistance mechanism can also be transferred to other bacteria. The first ESBL-/pAmpC-producing Enterobacterales in samples from Swedish dogs and cats were confirmed in 2008 and 2009, respectively. Since then, the Swedish Veterinary Agency (SVA) has reported cases annually from these species within the Swedish veterinary antibiotic resistance monitoring programme (Svarm). To describe the isolates that have been confirmed, their antibiotic susceptibility and genetic relationship, a study was conducted by SVA covering isolates from 2017 to 2021.

Isolates of ESBL/pAmpC-producing bacteria from 82 dogs were included in the study. The majority of the isolates were *E. coli* (n=72), followed by *Klebsiella pneumoniae* (n=4), *Enterobacter hormaechei* (n=3), *Proteus mirabilis* (n=2), and *Klebsiella oxytoca* (n=1). The two most common ESBL/pAmpC genes among the isolates were $bla_{\text{CMY-2}}$ and $bla_{\text{CTX-M-15}}$, which were detected in more than half of the isolates. Among the remaining isolates, $bla_{\text{CTX-M-27}}$ and $bla_{\text{CTX-M-1}}$ were the most common genes. Resistance against trimethoprim-sulphonamides (52%), enrofloxacin (50%) and tetracycline (43%) were the most common finding among the dog isolates. Resistance to gentamicin was also a common trait (24%), whereas resistance to neomycin (9%), nitrofurantoin (7%) and colistin (2%) was more uncommon. Resistance to meropenem was not detected in any of the isolates. Half of the isolates (50%) were resistant to at least two substances in addition to beta-lactams, i.e., multi-resistant. The distributions of MICs and occurrence of resistance among only the *E. coli* isolates (n=72) are shown in Table. The most common sampling site was the urogenital tract (n=50), followed by wounds (n=16) and other anatomical samples sites (n=16), such as mammary glands, respiratory tract and abdominal cavity. The two most common multi-locus sequence types (MLST) among the *E. coli* isolates from dogs were ST372 (18%) and ST131 (13%).

Isolates with ESBL/pAmpC-producing bacteria from 23 cats were included in the study. The majority of the isolates were *E. coli* (n=20), followed by *Enterobacter kobei* (n=1), *Enterobacter roggenkampii* (n=1) and *K. pneumoniae* (n=1). The most common ESBL/pAmpC gene was $bla_{\text{CTX-M-15}}$. This gene was detected in almost half of the isolates. The most common resistances among the isolates from cats were against enrofoxacin (26%) and tetracycline (26%). Resistance to gentamicin (17%) and trimethoprim-sulphonamides (13%) were also common traits, whereas resistance to colistin (4%), neomycin (4%), and nitrofurantoin (4%) was detected only in one isolate, respectively. Resistance to meropenem was not detected in any of the isolates. Approximately one-fifth of the isolates (22%) were resistant to at least two substances apart from beta-lactams, i.e. multi-resistant. The distributions of MICs and occurrence of resistance among only the *E. coli* isolates (n=20) are shown in Table. The most common sampling site was the urogenital tract (n=20), the remaining isolates were from mammary gland (n=2) and postoperatively infected wound (n=1). The *E. coli* isolates from cats were dominated by ST73 (55%).

The percentage of multi-resistant bacteria among the dog isolates (50%) was more than twice the percentage among the cat isolates (22%). The difference in resistance among ESBL/pAmpC-producing bacteria between the two animal species is probably not due to selection by the use of antibiotics in dogs and cats per se. Instead, more frequent use of antibiotics could increase the probability of ESBL/pAmpC-producing bacteria transiently colonizing the host, when non-resistant bacteria are decreased during treatment. Furthermore, the use of substances other than beta-lactams could increase the likelihood that multi-resistant variants of ESBL/pAmpC-producing bacteria colonize the animals.

Monitoring the resistance patterns and genetic relationships of bacteria over time is important for following the results of measures taken to reduce resistance. Combining knowledge of regional resistance patterns with treatment guidelines is valuable for veterinary clinicians to ensure appropriate antibiotic usage.

Table. Distribution of MICs and resistance (%) in ESBL/pAmpC-producing *Escherichia coli* from cats (n=20) and dogs (n=72).

Antibiotic	Animal species	Resistance %	Distribution (%) of MICs (mg/L)											
			≤0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	>64
Amoxicillin-clavulanic acid	cats	35							30	35	15	10	10	
	dogs	61							12.5	26.4	23.6	13.9	23.6	
Colistin[a]	cats	0					100							
	dogs	1					90.3	8.3			1.4			
Enrofloxacin	cats	25		75	10					15				
	dogs	46		54.2	2.8	11.1	4.2	4.2	1.4	22.2				
Gentamicin	cats	20						80			5	15		
	dogs	17						83.3		2.8	4.2	9.7		
Neomycin	cats	5							80	15		5		
	dogs	8							88.9	2.8	4.2	1.4	2.8	
Nitrofurantoin	cats	5										85	10	5
	dogs	1										98.6		1.4
Tetracycline	cats	30						65	5		5	25		
	dogs	42						56.9	1.4		2.8	38.9		
Trimethoprim-sulphamethoxazole[b]	cats	15				85				15				
	dogs	47				52.8		1.4		45.8				

[a]The isolate with MIC 16 mg/L was investigated for mcr genes and found negative. [b]Concentration of trimethoprim given, tested in concentration ratio 1/20 (trimethoprim-sulphamethoxazole).

This In focus is a summary of Bonnevie et al. (2025). Further description of the study and a list of references can be found in the paper.

Reference

Bonnevie A, Myrenås M, et al. 2025, ESBL- and pAmpC-producing Enterobacterales from Swedish dogs and cats. *Acta Vet Scand*, 67(1):2.

Methicillin-resistant *Staphylococcus aureus* (MRSA)

In Sweden, methicillin-resistant Staphylococcus aureus (MRSA) in animals was first verified in 2006 and made notifiable in 2008 (SJVFS 2021:10 and previous legislation). Since then, most cases in domesticated animals have been detected in passive monitoring of clinical sampling in infected animals. Isolates of *S. aureus* with resistance to oxacillin or cefoxitin have been further analysed with confirmatory tests. Screening studies for active monitoring have been performed in pigs, cattle, horses, dogs, and hedgehogs during different years (see below). Cases from 2024 are presented in Table 4.4 and data regarding index cases of clinical isolates and isolates from screenings are shown as supplementary material on the SVA web page (www.sva.se/svarm).

Farm animals

Screening studies in pigs have been performed five times since 2006, with only two positive samples from pigs at slaughter in 2010. A screening was performed in all 39 nucleus and multiplying herds present in 2014 and all samples were negative. In 2025 an EU-wide baseline study on the prevalence of MRSA in pigs at slaughterhouses is performed. During the preparations for that study, a pilot study was performed in 2024 where MRSA was isolated from five pigs in a slaughterhouse in Sweden, probably originating from a single farm but this is not confirmed. Information about the occurrence of MRSA in Swedish pig herds is currently not complete.

In dairy cattle, active monitoring of selected isolates of beta-lactamase producing *S. aureus* from milk samples has been ongoing since 2010, and about 1 500 isolates have been tested up to and including 2024. The monitoring is performed

Table 4.4. Isolates of methicillin-resistant *Staphylococcus aureus* (MRSA) in Swedish animals 2024. All isolates were positive for the *nuc* gene and *mecA* or *mecC* genes. Shaded areas indicate MIC above EUCAST ECOFF.

		Antibiotic, MIC (mg/L)										
Animal species	**Beta-lactams**	**Cli**	**Ery**	**Tet**	**Fus**	**Gen**	**Cip**	**Tmp**	**Chl**	**Lzd**	***spa*-type**	***mec*-gene**
Cat	R	0.25	0.5	1	≤0.25	≤0.5	0.5	>16	16	4	t223	*A*
Cat	R	0.25	0.5	≤0.5	≤0.25	≤0.5	0.5	2	8	2	t15312	*C*
Cat	R	0.25	0.5	≤0.5	≤0.25	≤0.5	0.5	≤1	8	2	t3391	*C*
Cat	R	0.25	0.5	≤0.5	≤0.25	≤0.5	≤0.25	≤1	8	2	t728	*A*
Cat	R	0.25	≤0.25	≤0.5	≤0.25	≤0.5	0.5	2	8	2	t223	*A*
Cat	R	≤0.12	0.5	≤0.5	≤0.25	≤0.5	0.5	≤1	8	2	t002	*A*
Cat	R	≤0.12	0.5	≤0.5	≤0.25	≤0.5	≤0.25	≤1	8	2	t373	*C*
Cat	R	≤0.12	≤0.25	≤0.5	≤0.25	≤0.5	≤0.25	≤1	8	2	t3391	*C*
Dog	R	>4	>8	>16	≤0.25	>16	≤0.25	>16	16	2	t011	*A*
Dog	R	>4	>8	16	≤0.25	>16	>8	>16	16	≤1	t19605	*A*
Dog	R	>4	>8	≤0.5	≤0.25	>16	>8	>16	8	≤1	t002	*A*
Dog	R	>4	>8	≤0.5	≤0.25	>16	8	≤1	64	≤1	t430	*A*
Dog	R	0.25	0.5	≤0.5	≤0.25	≤0.5	≤0.25	≤1	8	2	t304	*A*
Dog	R	≤0.12	1	>16	4	≤0.5	≤0.25	>16	>64	2	t954	*A*
Horse	R	0.25	0.5	>16	≤0.25	>16	0.5	>16	8	2	t011	*A*
Horse	R	0.25	0.5	>16	≤0.25	>16	≤0.25	>16	8	2	t011	*A*
Horse	R	0.25	0.5	>16	≤0.25	>16	≤0.25	>16	8	2	t011	*A*
Horse	R	0.25	0.5	>16	≤0.25	16	0.5	>16	8	2	t011	*A*
Horse	R	0.25	0.5	>16	≤0.25	16	≤0.25	>16	16	2	t011	*A*
Horse	R	0.25	0.5	>16	≤0.25	16	≤0.25	>16	8	2	t011	*A*
Horse	R	0.25	0.5	>16	≤0.25	16	≤0.25	>16	8	2	t011	*A*
Horse	R	0.25	≤0.25	>16	≤0.25	>16	≤0.25	>16	8	2	t1451	*A*
Horse	R	0.25	≤0.25	>16	≤0.25	>16	≤0.25	>16	8	2	t034	*A*
Horse	R	≤0.12	>8	>16	≤0.25	>16	8	>16	8	≤1	t1257	*A*
Horse	R	≤0.12	0.5	>16	≤0.25	>16	0.5	>16	8	2	t011	*A*
Horse	R	≤0.12	0.5	>16	≤0.25	16	0.5	>16	8	2	t011	*A*
Horse	R	≤0.12	0.5	≤0.5	≤0.25	≤0.5	≤0.25	2	8	2	t127	*A*
Horse	R	≤0.12	≤0.25	>16	≤0.25	8	1	>16	8	≤1	t011	*A*
Pigs[a]	R	>4	0.5	>16	≤0.25	≤0.5	≤0.25- 1	>16	8- 16	2- 4	t034, t571	*A*
Rabbit	R	0.25	0.5	>16	≤0.25	1	≤0.25	>16	8	2	t223	*A*
Rabbit	R	0.25	0.5	≤0.5	≤0.25	≤0.5	0.5	>16	8	2	t223	*A*
Moose	R	≤0.12	>8	≤0.5	≤0.25	≤0.5	≤0.25	2	8	2	t127	*A*

[a]5 isolates

on isolates with anonymised origin. Since 2010 five PVL-negative isolates with *mecC*, two PVL-negative isolates with *mecA* and one PVL-positive isolate with *mecA* have been detected. In 2012, PVL-positive MRSA with *mecA* was isolated from several animals in a dairy herd (Unnerstad et al., 2018). In 2024 no MRSA was detected among the 60 isolates screened for occurrence of *mecA* and *mecC*.

In 2016 and early 2017 there was an outbreak of MRSA with *mecC* among goats and sheep connected to a zoo. In addition, MRSA with *mecC* was found in eight out of twenty-one sampled goats in a herd in 2017 and in one goat sold from the same herd. In 2019 an additional goat herd with MRSA was identified. The farm had an epidemiological link to the herd detected in 2017 and shared the same *spa*-type, t373. In total six goats were sampled, and samples were pooled two and two for cultivation with all pools being positive for *mecC*-MRSA. In 2019, twenty-two dairy goat herds were screened for occurrence of MRSA, using bulk-milk samples and pooled swabs, with no positive samples found (Persson et al., 2021).

Companion animals and horses

Up to and including 2024, a total of 285 cases of MRSA in companion animals and horses have been confirmed. These include 81 dogs, 60 cats, 4 rabbits, 1 parrot and 137 horses. In these animal species, there is currently no regular active monitoring of MRSA, but screenings in dogs were performed in 2006 and 2012 without detection of MRSA. Furthermore, a study on 325 healthy dogs in 2017-2018 detected no MRSA or other methicillin-resistant coagulase positive staphylococci (Börjesson et al., 2020). Screening studies in horses have been performed twice, in 2007 and 2010, with one positive sample in 2007.

In 2024, MRSA was detected in clinical samples, from wound infections and abscesses, from six dogs, two rabbits and eight cats (Table 4.4). During the years the identified *spa*-types have varied, and most have previously been detected in humans but in 2024 one dog carried the horse-related t011 (supplementary material, www.sva.se/svarm).

In 2024, MRSA was isolated from 14 horses, which is less cases compared to the figures in 2020-2021, but still more cases compared to previous years (2007-2019) when between one and nine cases were notified per year (supplementary material, www.sva.se/svarm). In 2020 and 2021 the increase was partly explained by gathered cases at outbreaks of MRSA in equine hospitals (*spa*-type t1971, t034 and t011). Historically, MRSA *spa*-type t011, has been dominating among horses in Sweden and in 2024 the *spa*-type was detected in ten of the fourteen cases. The remaining four MRSA were one each of spa-types t034, t127, t1257 and t1451 (Table 4.4). All the mentioned *spa*-types have also been detected more or less frequently in MRSA from humans.

Wild animals

In 2024, one case of MRSA in an elk was confirmed, typed to *spa*-type t127. High occurrence of *mecC*-MRSA has been described in hedgehogs in Sweden, 64%, Denmark, 61% (Bengtsson et al., 2017; Rasmussen et al., 2019) and other countries. Recent studies suggest that *mecC*-MRSA probably originate from hedgehogs as the result of selective pressure of beta-lactams produced by dermatophytes, and that this occurred long before introduction of clinically used antibiotics (Larsen et al., 2022).

Methicillin-resistant *Staphylococcus pseudintermedius* (MRSP)

In 2024, there were 57 MRSP cases from 49 dogs, 7 cats, and 1 horse reported to the Swedish Board of Agriculture. This number is roughly about the same level as in previous years (Figure 4.2).

All but two isolates were available for further susceptibility testing and genome sequencing. Information on the sampling site was available for 48 cases; wounds 24 cases, external ear canal 8 cases, skin 6 cases, urine 6 cases, and the remaining 4 were isolated from various other sites or from pooled samples. For resistance phenotypes, see Table 4.5.

The results of the genome sequencing of 55 isolates divided the isolates into 29 different multi-locus sequence types, of which ST551 was the most common type with 22 isolates. The ST551 was first detected in Sweden in 2016 and was also the most common ST in the last six years. The other sequence types occurring in 2024 were two isolates each of ST265, ST311, ST1054, ST1095, ST2692, and single isolates of ST181, ST277, ST315, ST621, ST642, ST730, ST1149, ST1216, ST1331, ST1602, and 13 new STs, named ST2815-ST2827. In earlier years, ST71 dominated among Swedish isolates but in 2024 no isolate of this type was found.

Figure 4.2. Number of cases of methicillin-resistant *Staphylococcus pseudintermedius* (MRSP) isolated from animals in Sweden 2006-2024. In 2006-2007 the numbers represent the isolates that were sent to SVA and confirmed as *mecA*-positive and from 2008 the number of cases notified to the Swedish Board of Agriculture.

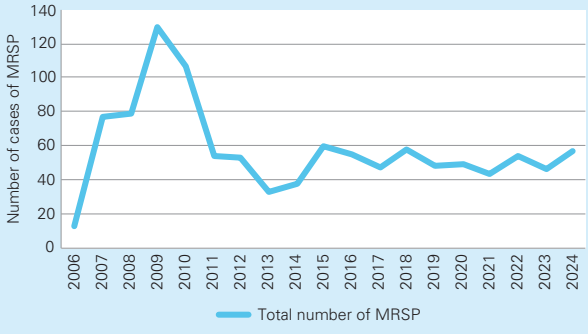


Table 4.5. Resistance phenotypes (beta-lactams excluded) of isolates of methicillin resistant *Staphylococcus pseudintermedius* (MRSP) isolated from animals in Sweden 2024. Two isolates were not available for further testing and are not included in the table. All isolates were positive for the *mecA* gene. Shaded areas indicate resistance.

Antibiotic, MIC (mg/L)									No. of isolates
Beta-lactams	Tet	Tsu	Ery	Cli	Gen	Enr	Fus	Nit	
R	>4	4->4	>2	>2	4->4	1->1	2->2	≤16	3
R	>4	1->4	>2	>2	2->4	>1	≤0.5	≤16	30
R	>4	>4	>2	>2	>4	≤0.25	≤0.5	≤16	2
R	>4	>4	>2	>2	≤1	1	≤0.5	≤16	1
R	4	>4	>2	R[a]	≤1	1	≤0.5	≤16	1
R	>4	4->4	≤0.25	≤0.25	4	>1	≤0.5	≤16	2
R	>4	4->4	≤0.25	≤0.25	>4	≤0.25	≤0.5	≤16	2
R	>4	0.5	>2	2	4->4	>1	≤0.5	≤16	2
R	>4	0.5	>2	>2	≤1	≤0.25	≤0.5	≤16	1
R	>4	0.5	>2	>2	≤1	>1	≤0.5	≤16	1
R	>4	0.5	≤0.25	≤0.25	>4	>1	≤0.5	≤16	1
R	>4	0.5	0.5	≤0.25	>4	≤0.25	≤0.25	≤16	1
R	>4	0.5	≤0.25	≤0.25	≤1	≤0.25	>2	≤16	1
R	≤0.25	>4	>2	>2	>4	>1	≤0.5	≤16	1
R	≤0.25	>4	>2	>2	>4	≤0.25	≤0.5	≤16	1
R	≤0.25	>4	>2	>2	≤1	≤0.25	≤0.5	≤16	1
R	≤0.25	>4	≤0.25	≤0.25	>4	≤0.25	≤0.25	≤16	1
R	≤0.25	>4	≤0.25	≤0.25	≤1	>1	>2	≤16	1
R	≤0.25	≤0.25	2	>2	≤1	≤0.25	>2	≤16	1
R	≤0.25	0.5	>2	>2	≤1	≤0.25	≤0.25	≤16	1

[a]One isolate had inducible clindamycin resistance.

Zoonotic pathogens

Zoonoses are diseases that can be naturally transmitted between animals and humans. Antibiotic resistance in zoonotic bacteria such as *Salmonella* and *Campylobacter* from animals is therefore of direct public health concern.

Salmonella

Findings of *Salmonella* in animals are notifiable in Sweden. In Svarm, antibiotic susceptibility is determined in one isolate from each notified incident in animals each year, except for wild birds and cats (see below). Isolates from incidents previously notified but still under restrictions are also included. In incidents involving more than one serovar, one isolate of each serovar is tested. In the case of poultry, one isolate from each infected flock is included.

Isolates from wild birds are usually from cases of salmonellosis among passerines during the winter season and most *Salmonella* from cats are cases when cats have eaten these birds lying dead or diseased on the ground (Söderlund et al., 2019). Such isolates are often *S.* Typhimurium and sus-

Table 4.6. Distribution of MICs and resistance (%) in *Salmonella enterica* ssp. *enterica* from domestic animals, 2024.

Antibiotic	Resistance %	Distribution (%) of MICs (mg/L)																
	n=69	≤0.016	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	512	>512
Amikacin	6									94.2	4.3	1.4						
Ampicillin	7							76.8	15.9				1.4	5.8				
Azithromycin	0								27.5	34.8	33.3	4.3						
Cefotaxime	0					100												
Ceftazidime	0					78.3	21.7											
Chloramphenicol	1										98.6				1.4			
Ciprofloxacin	3	52.2	44.9			1.4	1.4											
Colistin[a]	NA							82.6	7.2	8.7	1.4							
Gentamicin	3						81.2	13.0	2.9				2.9					
Meropenem	0		91.3	8.7														
Nalidixic acid	3									95.7	1.4				2.9			
Sulphamethoxazole	16										11.6	34.8	33.3	4.3			1.4	14.5
Tetracycline	7								92.8				1.4	5.8				
Tigecycline	1					92.8	5.8	1.4										
Trimethoprim	6					68.1	21.7	4.3					5.8					

[a]Two *S.* Enteritidis isolates with colistin MIC >2 were tested with PCR for the *mcr-1* to *mcr-9* genes and found negative and the remaining five isolates with colistin MIC >2 were *S.* Dublin. NA: Not applicable.

ceptible to all tested antibiotics. Therefore, only a selection of these isolates is tested. For details on methodology, see Materials and methods, resistance in bacteria from animals.

A total of 101 *Salmonella enterica* ssp. *enterica* isolates were tested in 2024. Of all tested isolates 69 were from domestic animals (Table 4.6). *Salmonella* Typhimurium was the most dominant serovar with 46 isolates, including a monophasic variant. Of these, 34 were from domestic animals (Table 4.7). The highest number of isolates was from cattle (n=22) belonging to 10 different serovars dominated by *S.* Dublin (n=7) and *S.* Typhimurium (n=6). In pigs (n=10) *S.* Typhimurium was the dominating serovar and in poultry (n=9) *S.* Enteritidis.

The majority of all isolates (84 of 101; 83%) were susceptible to all antibiotics tested and all isolates from wildlife were fully susceptible. Distributions of MICs and resistance for all isolates from domestic animals are presented in Table 4.6 and for the subset *S.* Typhimurium in Table 4.7. Seventeen isolates were resistant to one or more antibiotics (Table 4.8). No interpretation was done for colistin due to uncertainties in ECOFFs caused by differences in MIC distributions between serovars. EUCAST does no longer suggest a colistin ECOFF for *Salmonella*. Seven isolates had an MIC of >2 mg/L for colistin (Table 4.8). Five of these seven isolates belonged to serovar Dublin that often display a higher MIC to colistin than most other serovars. EUCAST has recently published a tentative ECOFF, (T)ECOFF, of 16 mg/L for colistin and *S.* Dublin. The other two isolates with an MIC of >2 mg/L for colistin were Enteritidis and these isolates were tested by PCR for the presence of *mcr-1 – mcr-9* genes, which may confer resistance to colistin, but were negative for these genes.

Table 4.7. Distribution of MICs and resistance (%) in *Salmonella* Typhimurium, including a monophasic variant, from domestic animals, 2023.

Antibiotic	Resistance % n=34	Distribution (%) of MICs (mg/L)																
		≤0.016	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	512	>512
Amikacin	6									94.1	5.9							
Ampicillin	6							73.5	20.6					5.9				
Azithromycin	0								35.3	38.2	26.5							
Cefotaxime	0					100												
Ceftazidime	0					82.4	17.6											
Chloramphenicol	3										97.1				2.9			
Ciprofloxacin	0	50.0	50.0															
Colistin	NA							91.2	8.8									
Gentamicin	0						79.4	14.7	5.9									
Meropenem	0		91.2	8.8														
Nalidixic acid	0									97.1	2.9							
Sulphamethoxazole	26										8.8	32.4	26.5	5.9			2.9	23.5
Tetracycline	15								85.3				2.9	11.8				
Tigecycline	3					88.2	8.8	2.9										
Trimethoprim	6					76.5	14.7	2.9					5.9					

NA: Not applicable

Table 4.8. MICs of 15 antibiotics (mg/L) for the 17 isolates of *Salmonella enterica* ssp. *enterica* from domestic animals resistant to one or more substances, 2024. Shaded fields indicate resistance.

Serovar	Source	Amp	Ctx	Caz	Mem	Gen	Amk	Sul	Tmp	Chl	Tet	Nal	Cip	Cst	Azm	Tgc
Anatum	Dog	≤1	≤0.25	0.5	≤0.03	≤0.5	8	≤8	≤0.25	≤8	≤2	≤4	0.03	≤1	8	≤0.25
Bovismorbificans	Horse	>32	≤0.25	≤0.25	≤0.03	>16	≤4	>512	>16	≤8	≤2	≤4	0.03	≤1	8	≤0.25
Bovismorbificans	Horse	>32	≤0.25	≤0.25	≤0.03	>16	≤4	>512	>16	≤8	≤2	≤4	0.03	≤1	8	≤0.25
Enteritidis	Poultry	≤1	≤0.25	≤0.25	≤0.03	1	≤4	16	≤0.25	≤8	≤2	>64	0.5	4	4	≤0.25
Enteritidis	Poultry	≤1	≤0.25	≤0.25	≤0.03	≤0.5	≤4	32	≤0.25	≤8	≤2	>64	0.25	4	8	≤0.25
Infantis	Pig	2	≤0.25	0.5	≤ 0.03	≤0.5	16	64	≤0.25	≤8	≤2	≤4	0.03	≤1	8	≤0.25
Newport	Cattle	>32	≤0.25	≤0.25	≤ 0.03	≤0.5	≤4	16	0.5	≤8	≤2	≤4	≤0.015	≤1	≤2	≤0.25
Typhimurium	Cattle	2	≤0.25	≤0.25	≤ 0.03	2	8	16	0.5	≤8	≤2	≤4	0.03	≤1	8	≤0.25
Typhimurium	Cattle	≤1	≤0.25	≤0.25	≤ 0.03	≤0.5	≤4	>512	≤0.25	≤8	>32	≤4	0.03	≤1	8	0.5
Typhimurium	Cattle	≤1	≤0.25	≤0.25	≤ 0.03	≤0.5	≤4	>512	≤0.25	≤8	>32	≤4	≤0.015	≤1	4	0.5
Typhimurium	Cattle	2	≤0.25	≤0.25	≤ 0.03	≤0.5	≤4	>512	≤0.25	≤8	>32	≤4	≤0.015	≤1	≤2	1
Typhimurium	Dog	≤1	≤0.25	≤0.25	≤ 0.03	≤0.5	≤4	512	≤0.25	≤8	≤2	≤4	≤0.015	≤1	≤2	≤0.25
Typhimurium	Horse	≤1	≤0.25	≤0.25	≤ 0.03	≤0.5	≤4	>512	≤0.25	≤8	>32	≤4	≤0.015	≤1	≤2	≤0.25
Typhimurium	Pig	≤1	≤0.25	≤0.25	≤ 0.03	≤0.5	≤4	>512	>16	≤8	≤2	≤4	0.03	≤1	4	≤0.25
Typhimurium	Pig	≤1	≤0.25	≤0.25	≤ 0.03	2	≤4	>512	>16	≤8	≤2	≤4	0.03	≤1	4	≤0.25
Typhimurium	Pig	>32	≤0.25	≤0.25	≤ 0.03	1	8	>512	≤0.25	>64	>32	≤4	0.03	≤1	8	≤0.25
Typhimurium[a]	Poultry	>32	≤0.25	0.5	≤ 0.03	≤0.5	≤4	>512	≤0.25	≤8	≤2	8	0.03	≤1	4	≤0.25

[a]Monophasic variant

Campylobacter

The isolates of *Campylobacter jejuni* and *Campylobacter coli* tested were isolated from caecal content of broilers collected at abattoirs within the framework of the Swedish Campylobacter control programme. In 2024 approximately 8% of 3 670 flocks were culture positive for *C. jejuni* or *C. coli*. For details on methodology see Materials and methods, resistance in bacteria from animals.

In total, 175 isolates of *C. jejuni* and 5 of *C. coli* were tested. Of the 5 *C. coli* isolates, 2 were resistant to fluoroquinolones (data not shown). Of the 175 *C. jejuni* isolates, 145 (83%) were susceptible to all six antibiotics tested. Resistance to fluoroquinolones only was the most common phenotype (14%), two isolates were resistant to both fluoroquinolones and tetracycline, and two isolates were resistant to ertapenem (Table 4.9).

In 2024, only two isolates were resistant to tetracycline. The highest figure noted over the years was in 2016 (16%), the variation is probably explained by an outbreak in 2016 with a high percentage of positive flocks and spread of certain resistant or susceptible clones (Figure 4.3). Clonal spread is also the probable explanation for the variation in fluoroquinolone resistance. Selection through use of antibiotics is unlikely since these substances are almost never used in broiler production in Sweden.

Figure 4.3. Ciprofloxacin, nalidixic acid and tetracycline resistance (%) in *Campylobacter jejuni* from broilers, 2001-2024. In the years 2001-2002 enrofloxacin was tested instead of ciprofloxacin. The number of isolates per year varies (n=38-180, 2024 n=175).

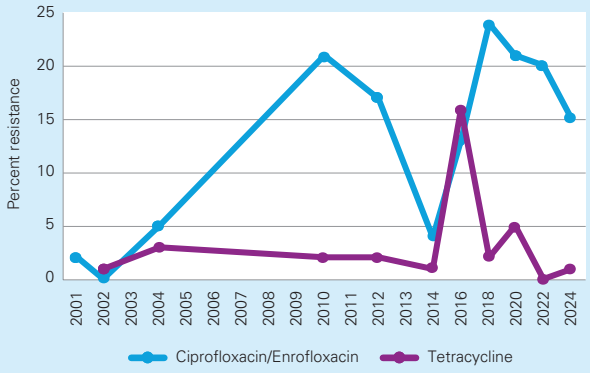


Table 4.9. Distribution of MICs and resistance (%) for *Campylobacter jejuni* from healthy broilers, 2024. Isolates from caecal content.

Antibiotic	Resistance (%) n=175	Distribution (%) of MICs (mg/L) ≤0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	512	>512
Chloramphenicol	0					94.3	1.1	4.6							
Ciprofloxacin	15	80.0	4.0	0.6				13.7	1.7						
Ertapenem	1	92.0	4.0	2.9	1.1										
Erythromycin	0				98.9	1.1									
Gentamicin	0		25.7	72.0	2.3										
Tetracycline	1			97.1	1.7						1.1				

Clinical isolates from animals

Isolates tested are from clinical submissions of samples to SVA, if not otherwise stated. For many samples information on the indication for sampling was not available but the vast majority of submissions were likely from animals with infections. Therefore, data may be biased towards samples from treated animals or from herds where antibiotic treatment is common. Any assessments of trends are based on the assumption that this bias is inherent throughout the observation period. Furthermore, in some cases there are more than one animal sampled from the same herd. Likewise, regarding horses, dogs and cats, duplicates based on animal identity have not been excluded.

In Svarm, isolates are, when possible, classified as susceptible or resistant by ECOFFs issued by EUCAST (see Guidance for readers for details). This classifies isolates with acquired reduced susceptibility as resistant, which is relevant for monitoring purposes, but it should be understood that this does not always imply clinical resistance.

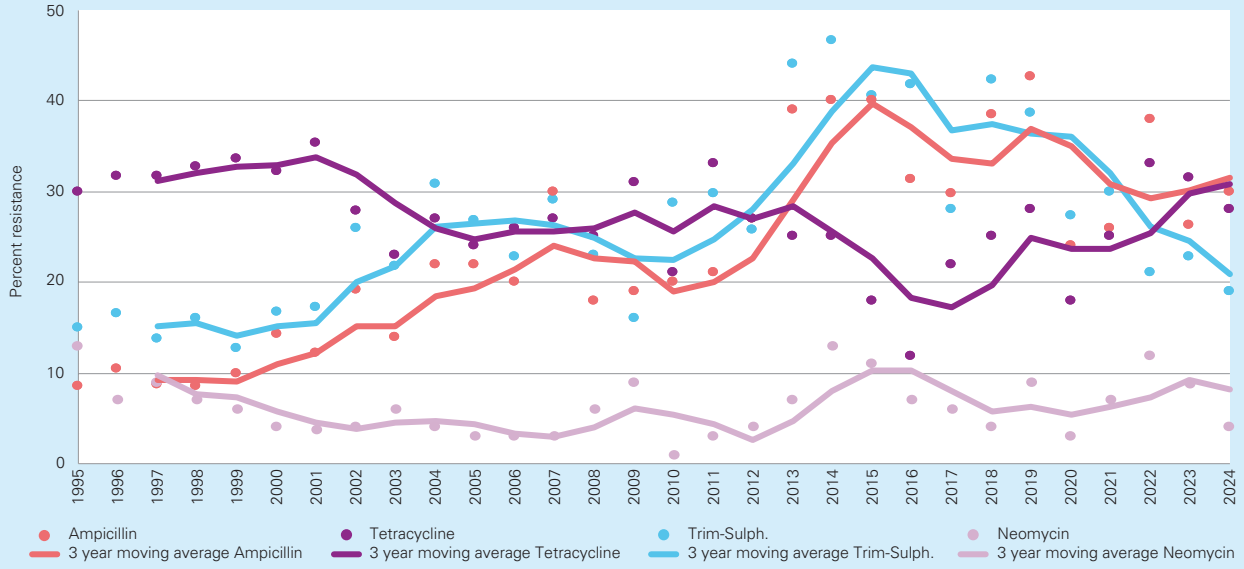
Pigs

Escherichia coli

Isolates of *E. coli* are from clinical submissions of faecal samples or samples taken post-mortem from the gastro-intestinal tract. The isolates are tested by PCR for genes coding for the virulence factors heat-labile enterotoxin (LT), heat-stable enterotoxin a and b (STa and STb), verocytotoxin (VT2e) and adhesion factors F4, F5, F6, F18 and F41. Only isolates with any of the mentioned virulence factors are included in Table 4.10.

As in previous years, resistance to ampicillin, tetracycline and trimethoprim-sulphamethoxazole were the most common resistance traits. Resistance to ampicillin and to trimethoprim-sulphamethoxazole has increased considerably from 1995 with a peak in 2015-2016 but from 2019 there is a downward trend (Figure 4.4). Resistance to neomycin was comparatively low throughout this period (1995-2024) despite increased sales of veterinary medicinal products aimed at treating post-weaning diarrhoea (see Sales of antibiotics for animals, comments on

Figure 4.4. Resistance (%) in *Escherichia coli* from pigs 1995-2024 with a three-year moving average. Clinical isolates from faecal samples taken post-mortem from the gastrointestinal tract. The number of isolates each year varies (n=52-482, 2024=69). From 2020 and onwards, only results from isolates with virulence factors are shown.



data by animal species). This differs from data displayed in figure 4.5, taken from SVA's interactive resistance monitoring tool SvarmIT, which includes all susceptibility-tested *E. coli* from pigs (i.e. not limited to ETEC) (SVA, 2025). The occurence of resistance to trimethoprim-sulphamethoxazole is also higher in the material in SvarmIT. The reason for the observed differences is unclear; however, it should be noted that the number of isolates is relatively small for both materials.

Multidrug resistance occurred in 13% (9/69) of the isolates in 2024 and has varied over the years (14% in 2023, 20% in 2022, 16% in 2021, 11% in 2020, 33% in 2019). Fifty-four percent of the isolates were susceptible to all tested antibiotics.

Figure 4.5. Resistance (%) in *Escherichia coli* from pigs 2010-May 2025 with a three-year moving average. Data derived from SvarmIT, SVA's interactive resistance monitoring tool. Clinical isolates from pigs. The number of isolates each year varies (2010-2024 n=98-210, 2025 until May 6 =50).

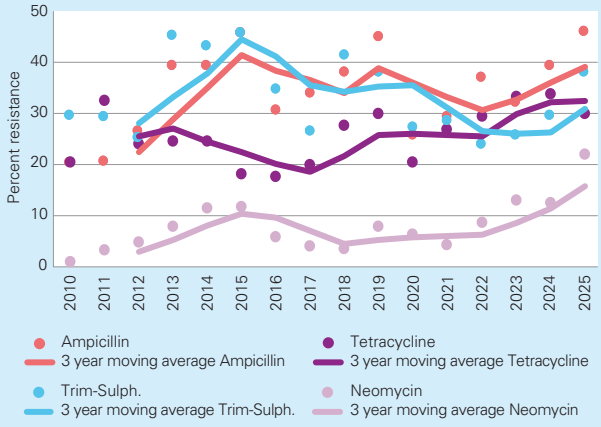


Table 4.10. Distribution of MICs and resistance (%) in enterotoxigenic *Escherichia coli* from pigs 2024.

Antibiotic	Resistance (%) 2024 n=69	Distribution (%) of MICs (mg/L) ≤0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	>64
Ampicillin	30							44.9	20.3	4.3		30.4		
Cefalexin	0								40.6	53.6	5.8			
Cefotaxime	0				100.0									
Colistin	0						98.6	1.4						
Enrofloxacin	7			92.8	7.2									
Gentamicin	0							100.0						
Meropenem	0		100.0											
Neomycin	4								95.7			2.9	1.4	
Nitrofurantoin	0											98.6	1.4	
Tetracycline	28							71.0	1.4			27.5		
Trim-sulph.[a]	19					81.2				18.8				

[a]Concentration of trimethoprim is given, tested in concentration ratio 1/20 (trimethoprim/sulphamethoxazole).

Brachyspira hyodysenteriae

Isolates of *Brachyspira hyodysenteriae* are from clinical submissions of faecal samples. The number of isolates each year varies (n=4-29, 2024 n=10). In routine diagnostics at SVA clinical breakpoints at >2 mg/L for tiamulin and >16 mg/L for tylosin are used. Analysis of antibiotic susceptibility data from isolates of *B. hyodysenteriae* from Sweden 1990-2010 resulted in a proposal for wild type cut-off values (Pringle et al., 2012). In Table 4.11 these cut-off values are used on all data. With the suggested wild type cut-off value >0.25 mg/L for tiamulin, resistance is detected throughout the period. During 2016 and 2017, therapeutic failure of tiamulin was observed in an outbreak of swine dysentery that involved several herds. The outbreak was shown to be caused by a *B. hyodysenteriae* clone with MIC of tiamulin above the clinical breakpoint. Fortunately, the clone was susceptible to macrolides and could be eradicated. Tylosin resistance has decreased over the years but increased slightly in 2018-2024.

Table 4.11. Resistance (%) in *Brachyspira hyodysenteriae* from pigs 2005-2024 and distribution of MICs for isolates from 2018-2024. Clinical isolates from faecal samples.

Antibiotic	Resistance (%)					Distribution (%) of MICs (mg/L)												
	2005-06 n=54	2007-08 n=38	2009-11 n=40	2012-17 n=55	2018-24 n=52[b]	≤0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	>128
Doxycycline	9	3	5	0	0			25.0	61.5	13.5									
Tiamulin	7	18	8	16[a]	10		44.2	11.5	34.6	5.8	3.8								
Tylosin	81	76	60	42	71							7.7	9.6	11.5		1.9	1.9		67.3
Tylvalosin		93	55	51	71				1.9	9.6	17.3	3.8	9.6	32.7	19.2		5.8		
Valnemulin	0	18	3	24	8	53.8	32.7	5.8		5.8		1.9							

[a]Five isolates with MICs above 2 mg/L from a defined outbreak in 2016-2017, [b]Number of isolates 2024 = 10.

Brachyspira pilosicoli

Isolates of *Brachyspira pilosicoli* are from clinical submissions of faecal samples. ECOFFs for *B. pilosicoli* are not defined for the antibiotics tested. The assessed percentage of resistance using the same wild type cut-off value as for *B. hyodysenteriae* is shown in Table 4.12.

If clinical breakpoints for *Brachyspira hyodysenteriae* are used as guide for the choice of antibiotic for treatment of spirochaetal diarrhoea, 10% are resistant to tiamulin (>2 mg/L).

Resistance to tylosin has decreased from a high level (60-70%) around 2010 to 2015, then there was an increase from 2016 that now seems to have stopped, whereas resistance to tiamulin has remained at a steady level during the same time period (figure 4.6). However, the number of isolates analysed per year is low. In 2024, one isolate was resistant to pleuromutilins, macrolides and doxycycline, i.e. multiresistant.

Figure 4.6. Resistance (%) to tylosin and tiamulin in *Brachyspira pilosicoli* from pigs 2005-2024 with a three-year moving average. The number of isolates per year has varied (n=7-67, 2024 n=44).

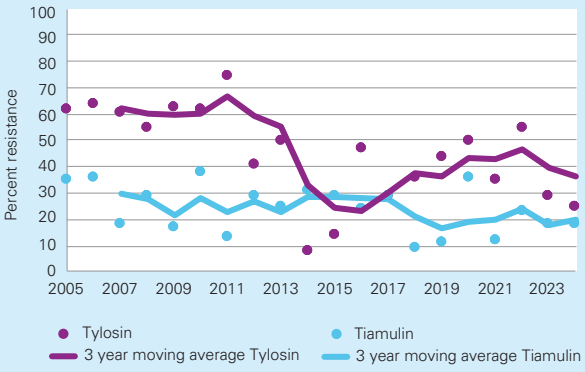


Table 4.12. Resistance (%) and distribution of MICs in *Brachyspira pilosicoli* from pigs 2023-2024. Clinical isolates from faecal samples.

Antibiotic	Resistance (%)[a]	Distribution (%) of MICs (mg/L)													
	2023-2024 n=82[b]	≤0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	>128
Doxycycline	5			78.0	13.4	3.7	4.9								
Tiamulin	18		63.4	13.4	4.9	1.2	2.4	4.9	2.4	3.7	3.7				
Tylosin	27							48.8	14.6	8.5	1.2	3.7	4.9	2.4	15.9
Tylvalosin	32				6.1	41.5	20.7	14.6	4.9	1.2	2.4	2.4	6.1		
Valnemulin	15	63.4	11.0	11.0	4.9	6.1	1.2			2.4					

[a]Assessed percentage of resistance using wild type cut-off values for *B. hyodysenteriae*, shown as vertical blue lines, [b]Number of isolates 2024=44.

Actinobacillus pleuropneumoniae

Isolates of *Actinobacillus pleuropneumoniae* are mostly from post-mortem investigations of lungs, but also from cases of arthritis. Seventeen isolates were collected in a SvarmPat project (see InFocus SvarmPat) where acute lesions in lungs and pericardium were sampled at slaughter. Data from 2024 and back to 2005 show that the resistance situation is favourable and almost no resistance has been detected to tested antibiotics including penicillin during this period (Table 4.13). Since pneumonia caused by *A. pleuropneumoniae* is an important disease in pig production, sampling and susceptibility testing is desirable if emerging resistance is to be detected early. For treatment of *Actinobacillus pleuropneumoniae* with MICs within the wild type distribution of penicillin (MIC 0.12 – 0.5 mg/L), increased exposure to penicillin is required (Medical Products Agency, 2022). Exposure includes e.g. administration route, dose, and dose interval.

Pasteurella multocida

Clinical isolates of *Pasteurella multocida* are from post-mortem examinations of lungs. Eight of the isolates were collected in a SvarmPat project (see InFocus SvarmPat) where acute lesions in lungs and pericardium were sampled at slaughter. All tested isolates were susceptible to relevant antibiotics including penicillin (Table 4.14).

Streptococcus suis

Isolates of *Streptococcus suis* are from post-mortem examination of different organs in diseased pigs from 2013-2018 (n=37), 2019-2021 (n=52) and 2022-2024 (n=33). Resistance to penicillin was rarely found before 2020 (Table 4.15). In 2024, three penicillin-resistant isolates were also resistant to tetracycline and clindamycin, and one of them was additionally resistant to erythromycin and trimetoprim-sulfamethoxazole.

Table 4.13. Resistance (%) in *Actinobacillus pleuropneumoniae* and distribution of MICs from pigs 2024.

Antibiotic	Resistance (%) 2024 n=47	Distribution (%) of MICs (mg/L) ≤0.016	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	>32
Ampicillin	0				76.6	23.4								
Doxycycline	0					4.8	95.2							
Enrofloxacin	0		80.9	19.1										
Florfenicol	0							100.0						
Gamithromycin	2							2.1	27.7	68.1	2.1			
Penicillin	0				2.1	89.4	8.5							
Tetracycline	0				2.1	68.1	29.8							

Table 4.14. Resistance (%) in *Pasteurella multocida* and distribution of MICs from pigs 2024. Clinical isolates from post-mortem investigations of lungs and from nasal swabs.

Antibiotic	Resistance (%) 2024 n=32	Distribution (%) of MICs (mg/L) ≤0.016	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	>32
Ampicillin	0			6.3	56.3	37.5								
Doxycycline	0				9.4	71.9	18.8							
Enrofloxacin	0	100												
Florfenicol	0							100						
Gamithromycin	0							15.6	59.4	25.0				
Penicillin	0			43.8	56.3									
Tetracycline	0				3.1	68.8	28.1							

Table 4.15. Resistance (%) in *Streptococcus suis* from pigs 2013-2018 and 2019-2021, and distribution of MICs from 2022-2024. Samples are from various organs.

Antibiotic	Resistance (%) 2013-2018 n=37	2019-2021 n=52	2022-2024 n=33	Distribution (%) of MICs (mg/L) ≤0.03	0.06	0.12	0.25	0.5	1	2	4	>4
Clindamycin	11	25	24				27.3	48.5		3	21.2	
Enrofloxacin	NR	NR	NR				30.3	69.7				
Erythromycin	8	8	6					93.9	3.0		3.0	
Gentamicin	NR	NR	NR						6.1	36.4	54.5	3.0
Penicillin	3	17	15	78.8	3.0	3.0	3.0	6.1	6.1			
Tetracycline	65	67	58				39.4	3.0	6.1	33.3	18.2	
Trim-Sulph.[a]	11	19	12				87.9		3.0	9.1		

NR, not relevant as the genus has inherently low susceptibility to the antibiotic. [a]Concentration of trimethoprim given, tested in concentration ratio 1/20 (trimethoprim/sulphamethoxazole).

Cattle

Escherichia coli from milk samples

Isolates of *E. coli* are from clinical submissions of milk samples from dairy cows. It is likely that most sampled cows had clinical mastitis.

Most of the isolates (78%, 28/36) were susceptible to all antibiotics tested. Resistance to ampicillin and trimethoprim-sulphamethoxazole were the most common traits, followed by tetracycline and enrofloxacin. (Table 4.16). Three isolates (8%) were multiresistant, i.e. resistant to three or more antibiotics (two isolates resistant to ampicillin, tetracycline and trimethoprim-sulphamethoxazole, and one isolate resistant to ampicillin, enrofloxacin and trimethoprim-sulphamethoxazole).

Klebsiella pneumoniae from milk samples

Isolates of *Klebsiella pneumoniae* are from clinical submissions of milk samples from dairy cows (Table 4.17). It is likely that most sampled cows had clinical mastitis. One isolate was multiresistant, i.e. resistant to three or more antibiotics (enrofloxacin, tetracycline and trimethoprim-sulphamethoxazole). *Klebsiella pneumoniae* has an inherent low susceptibility to ampicillin.

Staphylococcus aureus from milk samples

Isolates of *Staphylococcus aureus* are from clinical submissions of milk samples from dairy cows with clinical mastitis. In 2024, 726 isolates of *S. aureus* were analysed for penicillinase production of which 1.9% (n=14) were positive. Between 2019 and 2023 the numbers have varied between 1.2% and 3.1%.

Table 4.16. Resistance (%) in *Escherichia coli* from dairy cows 2020-2024 and distribution of MICs from 2024. Clinical isolates from milk.

Antibiotic	Resistance (%)					Distribution (%) of MICs (mg/L)										
	2020 n=60	2021 n=55	2022 n=46	2023 n=44	2024 n=36	≤0.06	0.12	0.25	0.5	1	2	4	8	16	32	>32
Ampicillin	15	18	11	9	17						44.4	38.9			16.7	
Cefalexin				0	0							38.9	58.3	2.8		
Cefotaxime	0	0	0	0	0			100								
Colistin	0	0	0	0	0					100						
Enrofloxacin	2	0	7	2	6		94.4		5.6							
Gentamicin	2	0	0	0	0						100					
Meropenem	0	0	0	0	0	100										
Neomycin	2	4	4	0	0							100				
Tetracycline	7	9	11	0	8						91.7				8.3	
Trim-sulph.[a]	5	20	7	7	17				83.3				16.7			

[a]Concentration of trimethoprim given, tested in concentration ratio 1/20 (trimethoprim/sulphamethoxazole).

Table 4.17. Resistance (%) in *Klebsiella pneumoniae* from dairy cows 2020-2024 and distributions of MICs from 2024. Clinical isolates from milk.

Antibiotic	Resistance (%)					Distribution (%) of MICs (mg/L)										
	2020 n=45	2021 n=39	2022 n=35	2023 n=52	2024 n=53	≤0.06	0.12	0.25	0.5	1	2	4	8	16	32	>32
Ampicillin	NR	NR	NR	NR	NR							1.9		47.2	50.9	
Cefotaxime	0	0	0	0	0			100								
Colistin	4[b]	0	0	0	0					100						
Enrofloxacin	4	0	0	2	2		98.1		1.9							
Gentamicin	2	0	0	0	0						100					
Meropenem	0	0	0	0	0	100										
Neomycin	0	0	0	0	0							100				
Tetracycline	11	0	9	2	4						90.6	1.9	3.8		3.8	
Trim-sulph[a]	13	0	0	2	2				98.1	1.9						

NR, not relevant as the genus has inherently low susceptibility to the antibiotic. [a]Concentration of trimethoprim given, tested in concentration ratio 1/20 (trimethoprim-sulphamethoxazole); [b]Two isolates with MIC 16 mg/L were negative for *mcr-1* to *mcr-9* genes with PCR. One isolate with MIC 4 mg/L was not available for PCR detection of *mcr* genes.

Pasteurella multocida

Most isolates of *Pasteurella multocida* are from nasal swabs from calves with respiratory disease or from post-mortem investigations of lungs. Because of a change of panel design, direct comparison with data from earlier years is not possible. For older data see earlier Swedres-Svarm reports.

Antibiotic resistance was generally rare among isolates of *P. multocida* (Table 4.18), but beta-lactamase producing *P. multocida* have been isolated every year since 2016. In 2024, one isolate was penicillin resistant and ampicillin resistant but was negative in the beta-lactamase test. Further, six other isolates from different farms were trimethoprim-sulphamethoxazole resistant. Penicillin is considered the first-choice antibiotic for treating pneumonia in cattle in Sweden. Sampling and susceptibility testing are important for early detection of resistance, especially in cases of therapeutic failure.

Mannheimia haemolytica and *Bibersteinia trehalosi*

Most isolates of *Mannheimia haemolytica* and half of the *Bibersteinia trehalosi* isolates were from the respiratory tract: from nasal swabs or from post-mortem investigations of lungs from calves with respiratory disease, and a few from other organs: joints, spleen, navel, and for *Bibersteinia trehalosi* also tonsil and udder. Between 2014 and 2024, forty-nine isolates of *Mannheimia haemolytica* and seventeen isolates of *Bibersteinia trehalosi* have been susceptibility tested. Since there are no ECOFFs for *B. trehalosi*, ECOFFs for *M. haemolytica* were used. Five isolates of *Mannheimia haemolytica* (years 2015, 2016 and 2019) from three different farms were penicillin resistant (MIC >0,5 mg/L). No penicillin resistant *Bibersteinia trehalosi* was detected in the same period (table 4.19).

Figure 4.7. Resistance (%) to penicillin in *Pasteurella multocida* from calves 2014-2024 with a three-year moving average. Clinical isolates originating from the respiratory tract, isolated from nasal swabs or from post-mortem investigations of lungs. The number of isolates each year varies (n=24-104, 2024=41)

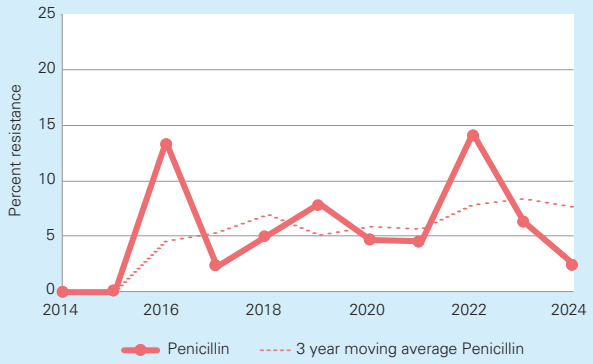


Table 4.19. Resistance (%) in *Mannheimia haemolytica* and *Bibersteinia trehalosi* from cattle 2014-2024.

Antibiotic	Resistance % *M. haemolytica* (n=49)	Resistance % *B. trehalosi* (n=17))
Penicillin	10	0
Enrofloxacin	0	18
Florfenicol	0	0
Tetracycline[a]	0	12

[a]Doxycycline was tested 2022-2024, oxytetracycline 2020-2021 and tetracycline 2014-2019 and 2022-2024.

Table 4.18. Distribution of MICs and resistance (%) in *Pasteurella multocida* from calves 2024. Clinical isolates originating from the respiratory tract, isolated from nasal swabs or from post-mortem investigations of lungs.

Antibiotic	Resistance (%) 2024 n=41	Distribution (%) of MICs (mg/L) ≤0.016	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	>32
Ampicillin	2				51.2	43.3			2.4					
Ceftiofur	0				100									
Enrofloxacin	0	90.2	9.8											
Florfenicol	0							100						
Gamitromycin	0						7.3	14.6	58.5	19.5				
Penicillin	2			46.3	46.3	4.9			2.4					
Tetracycline	0				7.3	75.6	14.6	2.4						
Trim-sulph[a]	15		17.1	43.9	24.4	7.3	4.9		2.4					

[a]Concentration of trimethoprim given, tested in concentration ratio 1/20 (trimethoprim/sulphamethoxazole).

Sheep

Mannheimia haemolytica and *Bibersteinia trehalosi*

Isolates of *Mannheimia haemolytica* are from 2020 to 2024 (n=39) and derive primarily from postmortem investigation of lungs but also from nasal swabs, milk, abscesses, wound secretions and one eye sample. ECOFFs for *M. haemolytica* have been used when available. Resistance to penicillin (MIC >0.5) was detected in one isolate from nasal swab in 2020, in one milk sample in 2024 and in one isolate from lung in 2024 (Table 4.20).

Isolates of *Bibersteinia trehalosi* (n=33) are from the same period as *M. haemolytica* and derive mainly from lung samples. Since there are no ECOFFs for *B. trehalosi*, ECOFFs for *M. haemolytica* were used. Two isolates from 2021 and one from 2022, all from lungs, were penicillin resistant (Table 4.20).

Table 4.20. Resistance (%) in *Mannheimia haemolytica* and *Bibersteinia trehalosi* from sheep 2020-2024.

Antibiotic	Resistance % *M. haemolytica* (n=39)	Resistance % *B. trehalosi* (n=33)
Penicillin	8	9
Enrofloxacin	3	6
Florfenicol	0	3
Tetracycline[a]	0	0

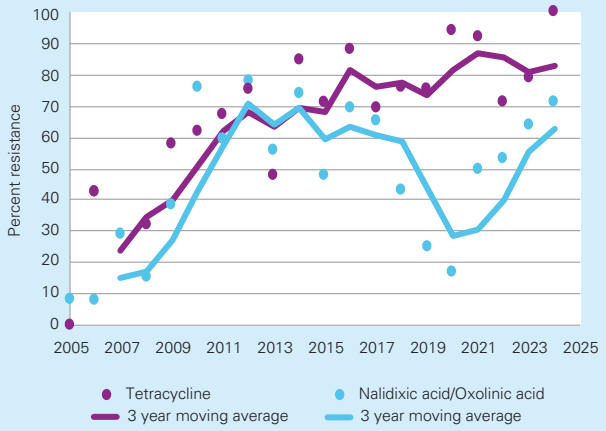
[a]Doxycycline was tested 2022-2024, oxytetracycline 2020-2021 and tetracycline 2014-2019 and 2022-2024.

Farmed fish

Flavobacterium psychrophilum

Isolates of *Flavobacterium psychrophilum* are from clinical submissions of farmed fish, most of them from outbreaks of disease. More than one isolate can be analysed from the same outbreak. More than one phenotype is detected in more than half of such cases (data not shown). Data from 2020-2024 are compiled and presented as distributions of MICs in Table 4.21.

Figure 4.8. Resistance (%) in *Flavobacterium psychrophilum* to tetracycline and nalidixic acid/oxolinic acid from farmed fish 2005-2024 with a three-year moving average. No resistance to florfenicol was detected in this period. The number of isolates each year varies (n=8-31, 2024=24).



Most isolates are from rainbow trout. Epidemiological cut-offs issued by CLSI are being used (CLSI, 2020b). Resistance to oxolinic acid and oxytetracycline was high in this material whereas no resistance to florfenicol was detected.

In Figure 4.8 resistance to tetracycline and quinolones (nalidixic acid or oxolinic acid) in *F. psychrophilum* 2005-2024 is shown. A three-year moving average is used. There is a marked increase in resistance to these antibiotics over the years despite a limited use up until recently (See Sales of antibiotics for animals, comments on data by animal species). For nalidixic acid/oxolinic acid a downward trend was seen after a peak in 2012, however this downward trend has turned in the latest years. Genome sequencing was used for analysis of a temporally and geographically representative set of *F. psychrophilum* isolates from outbreaks among Swedish farmed salmonid fish. The results indicate repeated nationwide introductions of new clones, presumably by trade of fish and eggs. It is probable that such introductions have contributed to the observed increase in resistance (Söderlund et al., 2018).

Table 4.21. Distributions of MICs and resistance (%) in *Flavobacterium psychrophilum* from farmed fish 2020-2024. The number of isolates each year varies (n=12-23, 2024=23).

Antibiotic	Resistance (%) 2020-2024 n=85	≤0.008	0.016	0.03	0.06	0.12	0.25	0.5	1	2	4	8	>8
Florfenicol	0					3.5	37.6	44.7	14.1				
Oxolinic acid	52				1.2	15.3	31.8	1.2	12.9	37.6			
Oxytetracycline	88				10.6	1.2	1.2	2.4	3.5	16.5	47.1	17.6	

Flavobacterium columnare

Isolates of *Flavobacterium columnare* are from clinical submissions of farmed fish. Data from 2020-2024 are compiled and presented as distributions of MICs in Table 4.22. Most isolates of *F. columnare* are from rainbow trout and brown trout. Epidemiological cut-offs issued by CLSI are being used (CLSI, 2020b).

Aeromonas salmonicida var. *salmonicida*

Isolates of *Aeromonas salmonicida* var. *salmonicida* are from clinical submissions of farmed fish. Data from 2020-2024 are compiled and presented as distributions of MICs in Table 4.23. Most isolates are from trout.

Laying hens

Escherichia coli

Isolates of *Escherichia coli* are from samples taken at post-mortem examination of laying hens from commercial farms.

Usually more than one hen from the same farm are submitted for examination in disease outbreaks. Compared to 2017-2018 resistance was lower in 2022-2024 for enrofloxacin (Table 4.24).

Table 4.22. Distributions of MICs and resistance (%) in *Flavobacterium columnare* (n=31) from farmed fish 2020-2024. The number of isolates each year varies (n=2-11, 2024 n=2).

Antibiotic	Resistance (%) 2020-2024 n=31	Distribution (%) of MICs (mg/L) ≤0.008	0.016	0.03	0.06	0.12	0.25	0.5	1	2	4	8	>8
Florfenicol	3						6.5	38.7	45.2	3.2	3.2		3.2
Oxolinic acid	3		3.2	6.5	25.8	58.1	3.2			3.2			
Oxytetracycline	13			32.3	48.4	3.2	3.2	6.5				6.5	

Table 4.23. Distributions of MICs and resistance (%) in *Aeromonas salmonicida* var. *salmonicida* from farmed fish 2020-2024. The number of isolates each year varies (n=1-15, 2024 n=8).

Antibiotic	Resistance (%) 2020-2024 n=34	Distribution (%) of MICs (mg/L) ≤0.008	0.016	0.03	0.06	0.12	0.25	0.5	1	2	4	8	>8
Florfenicol	0						38.2	61.8					
Oxolinic acid	3	14.7	70.6	8.8		2.9		2.9					
Oxytetracycline	0			2.9	2.9	35.3	58.8						

Table 4.24. Distributions of MICs 2022-2024 and resistance (%) in *Escherichia coli* from laying hens 2017-2018 and 2022-2024.

Antibiotic	Resistance (%) 2017-2018 n=100	2022-2024 n=114	Distribution (%) of MICs (mg/L) ≤0.06	0.12	0.25	0.5	1	2	4	8	16	32	>64
Ampicillin	11	8						47.4	43.9	0.9		7.9	
Cefotaxim	1[b]	0			100								
Colistin	1[c]	0					98.2	1.8					
Enrofloxacin	39	12		87.7	9.6	1.8		0.9					
Gentamicin	1	3						97.4	1.8			0.9	
Meropenem		0	100										
Neomycin	0	0							98.2	1.8			
Tetracycline	13	16						83.3	0.9			15.8	
Trim-sulph[a]	3	0				100							

[a]Concentration of trimethoprim given, tested in concentration ratio 1/20 (trimethoprim-sulphamethoxazole); [b]One isolate with MIC >2 mg/L carried bla_{CMY-2}; [c]one isolate with MIC >8 mg/L was negative for *mcr-1* to *mcr-5* genes with PCR.

SvarmPat – monitoring of resistance in pathogens from farm animals

The SvarmPat programme (Swedish Veterinary Antibiotic Resistance Monitoring – farm animal pathogens) is a project in co-operation between Farm & Animal Health and SVA that started in 2005. It is financed by the Swedish Board of Agriculture.

The purpose of SvarmPat is to reduce emergence and spread of antibiotic resistance in pathogenic bacteria from farm animals, including farmed fish. This is achieved by monitoring and documenting antibiotic resistance in farm animal pathogens, by activities that increase knowledge of antibiotic resistance and prudent use of antibiotics, and by communication of knowledge to practitioners and farmers. Respiratory pathogens from farm animals are generally susceptible to benzylpenicillin, but penicillin resistance occurs in *Pasteurella multocida* and *Mannheimia haemolytica* from calves and in *Mannheimia haemolytica* and *Bibersteinia trehalosi* from sheep. Resistance is particularly common in *Escherichia (E). coli* isolates from pigs with diarrhoea. Even if most isolates of farm animal pathogens are susceptible to first line antibiotics, susceptibility testing is warranted for guidance in antibiotic therapy as well as monitoring of resistance trends.

SELECTED STUDIES WITHIN SVARMPAT

Some of the results regarding resistance in various pathogens are available under the heading Clinical isolates from animals.

Milk samples from dairy cows

Continuous monitoring of resistance in bacteria from clinical mastitis in dairy cows started in 2013. Randomly collected milk samples from dairy cows with clinical mastitis are cultured, isolated bacteria are susceptibility tested, and information about the cow and the herd is registered.

Between 2013 and 2018, the five most common pathogens isolated were *Staphylococcus aureus* (28%), *Streptococcus dysgalactiae* (16%), *Escherichia coli* (15%), *Streptococcus uberis* (11%), and *Trueperella pyogenes* (8%) (Duse et al., 2021). Most pathogens were susceptible to antibiotics used in Sweden and resistance to penicillin in *S. aureus* was low (3%).

Screening for MRSA in milk samples from dairy cows has been going on since 2010 within the SvarmPat programme. Isolates of beta-lactamase producing *Staphylococcus aureus* from routine submissions to SVA are investigated for methicillin resistance. Between 2013 and 2024, 1499 isolates of anonymous origin have been tested within the screening program. Ten isolates have been confirmed as MRSA, most recently in 2017.

Respiratory tract samples from calves

One of the most common infections in calves is pneumonia caused by *Pasteurella multocida*, for which penicillin is considered the first-choice antibiotic in Sweden. However, since beta-lactamase producing *P. multocida* have been isolated every year since 2016, sampling and susceptibility testing is important, especially if therapeutic failure is seen in a herd. Within SvarmPat, respiratory samples from calves that are PCR-positive for *P. multocida*, *Mannheimia haemolytica* or *Histophilus somni*, are cultured to obtain isolates for susceptibility testing. Also, samples from calves PCR-positive for *Mycoplasma bovis* are cultured and susceptibility tested. MICs for *M. bovis* were high for most antibiotics available for treatments, except for enrofloxacin, and the results indicate that the treatment options for infections with *M. bovis* are few (Backhans et al, 2023).

Survey on antibiotic use for pneumonia caused by *Mycoplasma bovis*

Mycoplasma bovis infections in cattle have increased in Sweden, primarily affecting calves. A 2024 survey of 62 Swedish cattle veterinarians explored antibiotic use in treating respiratory infections, especially those caused by *M. bovis* (Kuusela J, 2025). Benzylpenicillin was the first-line treatment for general bovine respiratory disease (97%), often combined with NSAIDs (98%). For suspected *M. bovis*, tetracycline was the most chosen antibiotic (67%), followed by penicillin and florfenicol. Antibiotic choice was mainly guided by national or institutional guidelines. While 35% had treated confirmed or suspected *M. bovis* cases, many (18%) were unsure if they had. Although only 39% routinely used diagnostic sampling, two-thirds reported using it at treatment failure, or herd investigations. The study highlights a need for clearer guidelines on when *M. bovis* should be suspected.

Respiratory tract samples from pigs

Respiratory samples from pigs that are PCR-positive for *Actinobacillus pleuropneumoniae* and *Pasteurella multocida*, are being cultured to obtain isolates for susceptibility testing. Resistance to penicillin in these bacteria is uncommon, supporting the recommendation to primarily use penicillin for treatment of pneumonia in pigs.

Respiratory pathogens from pigs at slaughter

In autumn 2024, a project investigated respiratory pathogens and their antibiotic susceptibility in pigs, focusing on whether slaughterhouse sampling could improve

surveillance of *Actinobacillus pleuropneumoniae* (APP) and *Pasteurella multocida* (Kyhlsgård, 2025). Samples from 69 lungs with pneumonia or pericarditis, from 19 herds, were collected at a slaughterhouse in southern Sweden. PCR detected one or more pathogens in 44 samples, most commonly APP (n=33), *Pasteurella multocida* (n=15), and *Mycoplasma hyopneumoniae* (n=12). APP and *P. multocida* were also cultured and tested for resistance. All isolates were susceptible to penicillin. The study shows that slaughterhouse sampling is a possible tool for identifying pathogens and monitoring antibiotic resistance in pig respiratory pathogens.

Enteric samples from pigs

Resistance to ampicillin, tetracycline and trimethoprim-sulphamethoxazole are the most common resistance traits in *Escherichia coli* isolated from piglets with diarrhoea, and multidrug resistance has varied between 11% and 16% in the last five years. This emphasizes the importance of susceptibility testing in herds with neonatal and post-weaning diarrhea.

Swine dysentery caused by *Brachyspira hyodysenteriae* is a severe disease in pigs, with a few cases each year in Sweden. The resistance situation in the causative agent *B. hyodysenteriae* is favorable compared to many other countries, but clinical resistance to tiamulin in *B. hyodysenteriae* was detected for the first time 2016 in an outbreak in several herds. Within SvarmPat, whole genome sequencing confirmed that the outbreak was caused by the same clone. After successful eradication in affected herds, no isolates with tiamulin-MICs >2 mg/L have been detected since 2018.

Spirochaetal diarrhoea caused by *Brachyspira pilosicoli* is a less severe but more common disease than swine dysentery. Cases with treatment failure have been reported and multiresistant isolates have been detected, but breakpoints for antibiotic resistance specific for *B. pilosicoli* are lacking.

Antimicrobial resistance in *Escherichia coli* and associations with potential risk factors

A study investigated antimicrobial resistance (AMR) in *Escherichia coli* from Swedish piglets with diarrhoea, comparing clinical submissions with study samples from 97 herds (Ågren et al, 2025). AMR levels in study and clinical samples were similar, supporting the use of clinical submissions for AMR monitoring. In 70% of the herds, over 10% of sows were treated with antibiotics after farrowing, most commonly trimethoprim-sulphonamide. Piglet *Escherichia coli* resistance to this antibiotic was directly associated with such treatments in sows. Ampicillin, tetracycline, and streptomycin resistance were indirectly linked, likely due to co-resistance. These findings suggest that even limited antibiotic use in sows contributes to AMR in *E. coli* in piglets, underscoring the need for reduced usage.

Bacteriological Investigations of suspected NNPD cases in Sweden

New neonatal porcine diarrhoea (NNPD) is a serious disease of newborn piglets, in Swedish pig herds often associated with *Enterococcus hirae*. In a study the presence of *Enterococcus hirae* and enterotoxigenic *Escherichia coli* (ETEC) was examined in diarrhoeic piglets less than one week old (Arosenius et al, 2025). Samples from 67 piglets across 14 herds detected *E. hirae* in all herds and in 53 piglets, while ETEC was found in 9 piglets from 8 herds. Both bacteria co-occurred in 7 cases. In 17 piglets, histological findings revealed enteritis and in four piglets enteroadherent coccoid bacteria. *Enterococcus hirae* was the most common pathogen, but its role is hard to confirm, and other contributing factors must be considered.

Enhanced sampling for antibiotic resistance monitoring in salmonid farming

Since 2022, bacterial samples have been collected from healthy fish at Swedish salmon farms (Hällbom, 2024). Of 108 fish sampled, pure bacterial cultures were obtained from 14 samples. The most common genera were *Aeromonas*, *Yersinia*, and *Pseudomonas*. Most of the investigated bacteria were susceptible to the antibiotics commonly used in Swedish fish farming, except *Pseudomonas*, which showed multiresistance. The presence of *Yersinia ruckeri* in healthy fish was unexpected, though the detected strain was low pathogenic.

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Horses

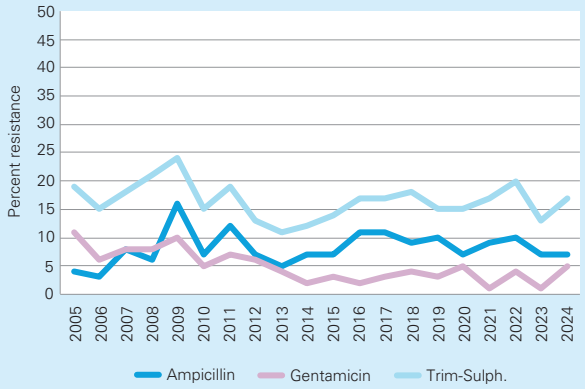
Escherichia coli

Isolates of *Escherichia coli* are from clinical submissions of samples from the genital tract of mares. As in previous years, resistance to trimethoprim-sulphamethoxazole was the most common trait in 2024 (Figure 4.9 and Table 4.25). Occurrence of resistance to gentamicin is continuously low, from 2013 and onwards ≤5% (Figure 4.9). However, this resistance has varied somewhat over the years and trends are difficult to estimate.

Eighty percent (175/218) of the isolates were susceptible to all the tested antibiotics. The proportion of multiresistance was 5% (11/218). Five of the 11 multiresistant isolates were resistant to three antibiotics and six isolates to four antibiotics. The most common phenotype was resistance to ampicillin, tetracycline and trimethoprim-sulphamethoxazole. The six isolates resistant to four antibiotics had a common phenotype with resistance to gentamicin, tetracycline and trimethoprim-sulphamethoxazole in addition to ampicillin or neomycin. For comparison of resistance in *E. coli* of different origin see "Comparative analysis".

One of the isolates was resistant to cefotaxime, but none were resistant to colistin or meropenem. The one isolate resistant to cefotaxime (MIC >0.25mg/L) was available for further testing but genes conferring transferable ESC resistance were not detected.

Figure 4.9. Resistance (%) in clinical isolates of *Escherichia coli* from horses 2004-2024. Isolates are from clinical sampling of the genital tract of mares. The number of isolates each year varies (n=124-324, 2024 n=218).



Streptococcus equi ssp. *zooepidemicus*

Isolates of *Streptococcus equi* ssp. *zooepidemicus* are from clinical submissions, and mainly from the respiratory tract (76%) of horses. Over the years, most of the isolates (92% in 2024) have been susceptible to all relevant tested antibiotics. In 2024, resistance to clindamycin, trimethoprim-sulphamethoxazole and erythromycin was detected. None of the isolates were resistant to penicillin and all isolates were screened for erythromycin induced clindamycin resistance. No isolates displayed

Table 4.25. Distribution of MICs and resistance (%) in *Escherichia coli* from horses, 2024. Clinical isolates from the genital tract of mares.

Antibiotic	Resistance (%) 2024 n=218	Distribution (%) of MICs (mg/L) ≤0.06	0.12	0.25	0.5	1	2	4	8	16	32	>32
Ampicillin	7						40.4	49.5	3.2		6.9	
Cefotaxime	<1			99.5	0.5							
Colistin	0					98.6	1.4					
Enrofloxacin	2		98.2	0.9	0.9							
Gentamicin	5						95.0		0.5	0.5	4.1	
Meropenem	0	100										
Neomycin	1							98.2	0.5		0.5	0.9
Tetracycline	6						92.2	1.8			6.0	
Trim-Sulph.[a]	17				83.5	0.5			16.1			

[a]Concentration of trimethoprim given, tested in concentration ratio 1/20 (trimethoprim/sulphamethoxazole).

Table 4.26. Distribution of MICs and resistance (%) in *Streptococcus equi* ssp. *zooepidemicus* isolated from horses, 2024. Clinical isolates mainly from the respiratory tract.

Antibiotic	Resistance (%) 2024 n=90	Distribution (%) of MICs (mg/L) ≤0.03	0.06	0.12	0.25	0.5	1	2	4	>4
Cefalexin	0						98.9	1.1		
Clindamycin	7[b]				56.7	36.7	6.7			
Erythromycin	1				96.6	3.3			1.1	
Gentamicin	NR								6.7	93.3
Penicillin	0	100								
Tetracycline	NR						2.2	23.3	53.3	21.1
Trim-Sulph.[a]	2				96.7	1.1	2.2			

NR, not relevant as the inherent susceptibility is above concentrations that can be obtained during therapy.
[a]Concentration of trimethoprim given, tested in concentration ratio 1/20 (trimethoprim/sulphamethoxazole); [b]Denotes resistance, including inducible resistance (0 isolates).

such resistance (Table 4.26). The number of isolates is low and varies each year (n=43-102, and in 2024 n=90) which could somewhat cause minor variations between years.

Streptococcus equi ssp. *zooepidemicus* has a low inherent susceptibility to aminoglycosides (e.g. gentamicin) and tetracyclines.

Staphylococcus aureus

Isolates of *Staphylococcus aureus* are from clinical submissions of samples from skin lesions, excluding wounds and abscesses, from horses.

Resistance to penicillin due to penicillinase production is still the most common trait (22%). The proportions of resistance to gentamicin, tetracycline and trimethoprim-sulphamethoxazole have differed slightly over the years and trends are difficult to estimate (Figure 4.10). Resistance to fusidic acid has varied and decreased to 2% in 2024 (Table 4.27 and previous Swedres-Svarm reports).

Forty-four percent (21/48) were susceptible to all the tested antibiotics. Two isolates (4%) were resistant to three or more of the tested antibiotics (i.e. multiresistant), which is comparable to the figures in 2015-2023 (0-5%) (see previous Swedres-Svarm reports).

No isolate was resistant to cefoxitin (MIC >4 mg/L). For more information on MRSA isolated from horses in Sweden, see Notifiable diseases, Methicillin-resistant *Staphylococcus aureus* (MRSA).

Due to the gradual introduction of an AMR panel with substances and cut-off values for topical treatment, the number of isolates tested for systemical treatment has declined during the past two years. A new routine has been implemented in the diagnostic lab in 2024 - *Staphylococcus aureus* isolates from horses are tested for penicillinase production as in previous years, but not all of the negative isolates are tested on the full AMR panel for staphylococci. Instead, they are followed by a comment to the clinician that the isolate does not produce beta-lactamase and can be treated with penicillin. Isolates tested on the full AMR panel are reported in Table 4.27. The isolates were screened for erythromycin-induced clindamycin resistance, no isolates displayed such resistance.

Figure 4.10. Resistance (%) in clinical isolates of *Staphylococcus aureus* 2008-2024 from skin of horses. Figure for trimethoprim-sulphamethoxazole 2015-2024.The number of isolates each year varies (n=75-145, 2024 n=49).

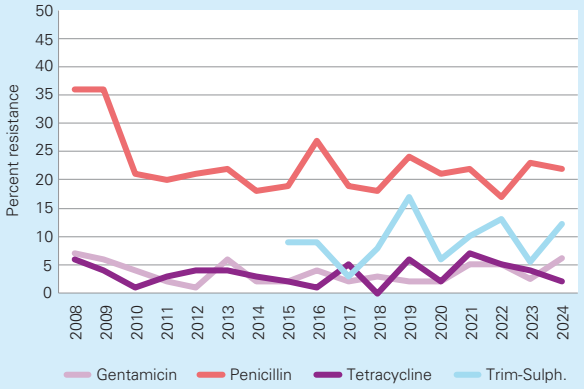


Table 4.27. Distribution of MICs and resistance (%) in *Staphylococcus aureus* isolated from horses, 2024. Clinical isolates from the skin.

Antibiotic	Resistance (%) 2024 n=49	Distribution (%) of MICs (mg/L) ≤0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	>64
Cefoxitin	0							14.6	85.4					
Cefalexin	2						6.3	54.2	37.5	2.1				
Clindamycin	0[b]				91.8	8.2								
Enrofloxacin	0				91.8	8.2								
Erythromycin	0				67.3	32.7								
Fusidic acid	2				40.8	57.1	2.0							
Gentamicin	6						93.9			6.1				
Nitrofurantoin	2										75.5	22.4	2.0	
Penicillin	22[c]	51.0		4.1		10.2	2.0	32.7						
Tetracycline	2				73.5	22.4	2.0			2.0				
Trim-Sulph.[a]	12				87.8	8.2	4.1							

[a]Concentration of trimethoprim given, tested in concentration ratio 1/20 (trimethoprim/sulphamethoxazole); [b]Denotes resistance, including inducible resistance (0 isolates); [c]Denotes beta-lactamase production, all tested isolates included.

Actinobacillus

Isolates of *Actinobacillus* spp. are from clinical submissions of samples from various anatomical sites, of which the most common are wounds (33%) and the respiratory tract (25%). Seven percent of the samples are from abscesses.

For *Actinobacillus* spp. isolated from horses, ECOFFs for *A. pleuropneumoniae* have been used regarding penicillin, tetracycline and trimethoprim-sulphamethoxazole. For other antibiotics clinical breakpoints have been applied (Table 4.28). All isolates with MIC >0.25 mg/L for penicillin (n=35), were tested for penicillinase production. One with MIC >1 was positive but all tested isolates with MIC 0.5 mg/L were negative.

The *Actinobacillus* spp. wild type distribution of penicillin (MIC 0.03 - 1 mg/L) requires increased exposure for successful treatment (Medical Products Agency, 2015). Exposure includes e.g. administration route, dose, and dose interval.

Rhodococcus equi

Isolates of *Rhodococcus equi* are from clinical submissions from 2022-2024 and samples from various anatomical sites, of which the most common is the respiratory tract (76%) (Table 4.29).

The one isolate resistant to rifampicin (October 2024) was sequenced and a mutation was detected in *rpoB* causing an amino acid switch in RpoB (S531L). An amino acid switch in this position is a commonly described mechanism for rifampicin resistance.

Table 4.28. Distribution of MICs and resistance (%) in *Actinobacillus* spp. from horses, 2024. Clinical isolates from various locations.

Antibiotic	Resistance (%) 2024 n=107	Distribution (%) of MICs (mg/L) ≤0.016	0.03	0.06	0.12	0.25	0.5	1	2	4	>4
Enrofloxacin	3	75.7	18.7	1.9	0.9	1.9		0.9			
Gentamicin	NR							14.0	18.7	56.1	11.2
Penicillin	6		5.6	1.9	14.0	45.8	19.6	7.5	5.6		
Tetracycline	0				4.7	35.5	55.1	4.7			
Trim-Sulph.[a]	1		73.8	14.0	6.5	4.7		0.9			

NR, not relevant as the inherent susceptibility is above concentrations that can be obtained during therapy. [a]Concentration of trimethoprim given, tested in concentration ratio 1/20 (trimethoprim/sulphamethoxazole).

Table 4.29. Distribution of MICs and resistance (%) in *Rhodococcus equi* from horses 2022-2024. Clinical isolates from various locations.

Antibiotic	Resistance (%) 2022-2024 n=66	Distribution (%) of MICs (mg/L) ≤0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	>16
Clarithromycin	0		28.8	69.7	1.5							
Doxycycline	NA				4.5	19.7	56.1	16.7	3.0			
Erythromycin	2[a]					92.4	6.1		1.5			
Rifampicin	2		12.1	68.2	13.6	3.0	1.5		1.5			

NA, not applicable. [a]The one isolate with erythromycin MIC >2 mg/L was not available for futher testing but was susceptible to clarithromycin.

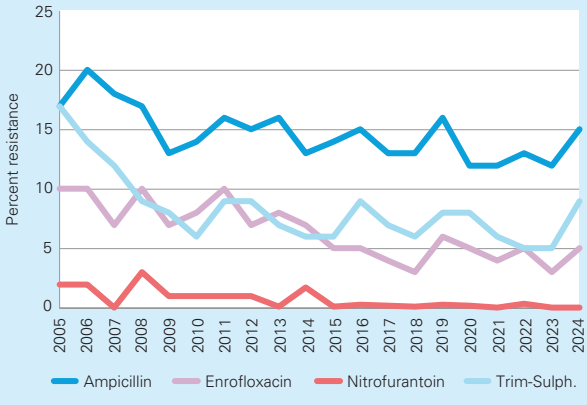
Dogs

Escherichia coli

Isolates of *Escherichia coli* are from clinical submissions of urine from dogs, submitted either as urine, swab dipped in urine or cultures from dip-slides or other agar plates. As in previous years, resistance to ampicillin was the most common trait in 2024, at 15% (Figure 4.11 and Table 4.30). Although the proportion of resistance in the tested isolates has varied somewhat between 2005 and 2024 there is still a slight decline in resistance for the four antibiotics ampicillin, enrofloxacin, nitrofurantoin and trimethoprim-sulphamethoxazole (Figure 4.11).

Seventy-eight percent (610/783) of the isolates were susceptible to all the tested antibiotics, and the proportion of multiresistance was 3% (24/783). Sixty-seven percent (16/24)

Figure 4.11. Resistance (%) in clinical isolates of *Escherichia coli* from dog urine 2005-2024. The number of isolates each year varies (n=304-1162, 2024 n=783).



of the multiresistant isolates were resistant to three antibiotics, 17% (4/24) to four, and 17% (4/24) to five antibiotics. For comparison of resistance in *E. coli* of different origin see "Comparative analysis".

The most common phenotype, resistance to ampicillin, tetracycline and trimethoprim-sulphamethoxazole, was detected in 58% (14/24) of the multiresistant isolates. Of the eight isolates resistant to four or more antibiotics, all had this phenotype.

Thirteen (2%) of the *E. coli* isolates were resistant to cefotaxime (MIC >0.25mg/L), and all were available for further testing. Genes conferring transferable ESC resistance were detected in seven of the isolates. Two carried the gene $bla_{\text{CTX-M-14}}$, one carried $bla_{\text{CTX-M-15}}$, one carried $bla_{\text{CTX-M-27}}$, one carried $bla_{\text{CMY-2}}$, one carried $bla_{\text{DHA-1}}$ and one carried $bla_{\text{CMY-4}}$, $bla_{\text{DHA-1}}$, $bla_{\text{TEM-176}}$. For more information about ESBL-producing Enterobacterales isolated from dogs in Sweden, see "Notifiable diseases" ESBL-producing Enterobacterales. None of the isolates were resistant to meropenem (MIC >0.12mg/L) and none of them were resistant to colistin (MIC >2mg/L).

Staphylococcus pseudintermedius

Isolates of *Staphylococcus pseudintermedius* are from clinical submissions of samples from skin lesions from dogs. Due to the implementation of an AMR panel for topical treatment (see Swedres Svarm 2022 In Focus p. 89, and Table 4.32) the number of isolates tested for systemical treatment has declined during 2023-2024.

Resistance to penicillin due to penicillinase production is high at 68% (Table 4.31), compared to other staphylococci in companion animals (Table 4.27 *S. aureus* in horses 22% and Table 4.36 *S. felis* in cats 17%). Although still high,

Table 4.30. Distribution of MICs and resistance (%) in *Escherichia coli* from dogs, 2024. Clinical isolates from urine.

Antibiotic	Resistance (%) 2024 n=783	Distribution (%) of MICs (mg/L) ≤0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	>64
Ampicillin	15						40.6	41.6	2.4	0.3	15.1		
Cefalexin	1							22.3	71.1	5.1	0.3	1.3	
Cefotaxime	2[b]			98.3	0.9	0.5	0.1	0.1					
Colistin	0					98.9	1.1						
Enrofloxacin	5		95.4	1.5	2.3	0.4	0.1		0.3				
Gentamicin	1						98.7	0.5	0.1	0.4	0.3		
Meropenem	0	99.4	0.6										
Neomycin	1							98.0	1.0	0.4	0.1	0.5	
Nitrofurantoin	<1										99.4	0.5	0.1
Tetracycline	4						93.7	1.3	0.8		4.2		
Trim-Sulph.[a]	9				91.1	1.3	1.3	0.1	6.3				

[a]Concentration of trimethoprim given, tested in concentration ratio 1/20 (trimethoprim/sulphamethoxazole); [b]All isolates (n=16) with MIC >0.25 mg/L were available for verification. Genes conferring transferable ESC resistance were detected in seven of them.

Table 4.31. Distribution of MICs and resistance (%) in *Staphylococcus pseudintermedius* from dogs 2024. Clinical isolates from skin lesions.

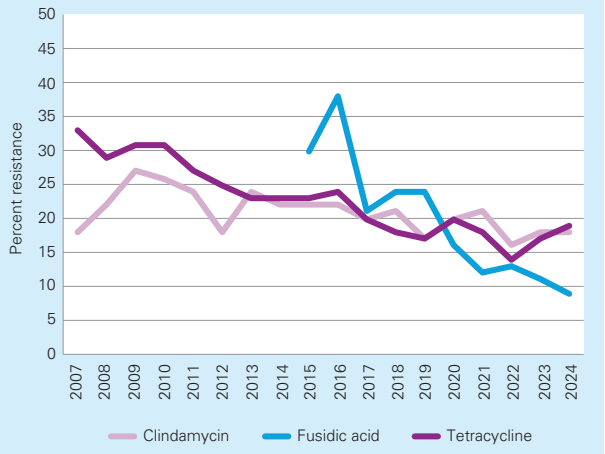
Antibiotic	Resistance (%) 2024 n=336	Distribution (%) of MICs (mg/L) ≤0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	>64
Cefalexin	<1						72.9	26.2	0.6	0.3				
Cefoxitin[a]								98.5	1.2	0.3				
Clindamycin	14[c]				83.9	3.0	0.9	0.3	11.9					
Enrofloxacin	2				94.9	3.3	1.2	0.6						
Erythromycin	14				71.7	14.0	0.3		14.0					
Fusidic acid	9				30.1	61.0	1.2	7.7						
Gentamicin	5						95.5	0.9	1.5	2.1				
Nitrofurantoin	0										97.9	2.1		
Oxacillin	1[d]				99.1	0.9								
Penicillin	68[e]	32.4	6.5	4.2	10.4	9.8	9.2	27.4						
Tetracycline	18				79.5	1.2	0.9	0.3	0.3	17.9				
Trim-Sulph.[b]	7				65.2	28.0	2.7	0.6		3.6				

[a]No cut-off available for *S. pseudintermedius*; [b]Concentration of trimethoprim given, tested in concentration ratio 1/20 (trimethoprim/sulphamethoxazole); [c]Denotes resistance, including inducible resistance (4 isolates); [d]The three isolates with MIC >0.25 for oxacillin were tested with PCR for detection of the *mecA* and *mecC* genes, one was positive and two were negative; [e]Denotes beta-lactamase production.

the proportion of resistance to penicillin for isolates from skin lesions has declined from 90% in 2009 to 68% in 2024. Compared to penicillin, resistance to clindamycin and tetracycline remains at lower levels, and has also declined since 2007 (see previous Swedres-Svarm reports). The proportion of resistance to fusidic acid is not comparable before 2015, due to a change in the tested range of concentrations and cut-off but has, since 2015, declined (Table 4.31 and Figure 4.12). Compared to other staphylococci isolated from companion animals, the proportion of resistance is high in the tested isolates. Only 24% (82/336) of the isolates were susceptible to all the tested antibiotics.

The proportion of multiresistance was 18% (61/336). This could be compared to 4% in *S. aureus* from horses and 4% in *S. felis* from cats. Sixty-two percent (38/61) of the multiresistant isolates were resistant to three antibiotics; 16% (10/61) to four; 15% (9/61) to five; and 5% (3/61) to six antibiotics. One isolate was resistant to nine antibiotics. The

Figure 4.12. Resistance (%) in *Staphylococcus pseudintermedius* from dogs, 2007-2024. Figures for fusidic acid 2015-2024. Clinical isolates from skin lesions. The number of isolates each year varies (n=220-567, 2024 n=336).



proportion of isolates resistant to five or more antibiotics has declined over the years. In 2016 almost one third of the multiresistant isolates were resistant to five or more antibiotics, compared to 14-22% in 2017-2023. In 2024 the proportion was 21% (13/61). Of the multiresistant isolates, resistance to penicillin, clindamycin and erythromycin was the most common phenotype 75% (46/61).

Three of the isolates were resistant to oxacillin (MIC >0.25 mg/L). All were tested with PCR for detection of the *mecA* and *mecC* genes, one was positive and two were negative. For more information on MRSP isolated from dogs in Sweden, see "Notifiable diseases", Methicillin-resistant *Staphylococcus pseudintermedius* (MRSP). The isolates were screened for erythromycin-induced clindamycin resistance. Four isolates (1%) displayed such resistance.

Susceptibility test for topical treatment

At SVA it is possible to choose antibiotic susceptibility testing of bacteria that is tailored for topical treatment. Both the antibiotics included in the test and the interpretation of the results differ from traditional testing for systemic treatment. The design of the panel for topical use covers substances included in veterinary medicinal products authorized for topical use and sold on veterinary prescription in Sweden, mainly for treatment of external eye and ear infections. In addition, some substances are included for the sole purpose of screening for methicillin resistance in coagulase positive staphylococci and ESBL in Enterobacterales.

It has been suggested by EUCAST that ECOFFs could be used to exclude acquired resistance to topical agents. They acknowledge that such an approach might underestimate the activity of the agents in some cases. However, it will at least demonstrate the presence of phenotypically detectable resistance mechanisms, which may result in a higher probability of clinical failure. Therefore, when bacteria are tested against substances for topical treatment at SVA, the breakpoints for interpretation are either EUCAST ECOFFs or, when no ECOFF is available, based on MIC distributions in Swedres-Svarm or other publications. As pharmacokinetic data have not been taken into consideration the interpretation cannot be applied for systemic treatment.

Some combinations of antibiotic substance and bacterial species are not reported to the clinician for systemic treatment. For example, gentamicin for *Pasteurella* spp. or streptococci, and fusidic acid for streptococci. This is because it is not possible to reach therapeutic concentrations systemically against these bacteria while with topical treatment the concentration at the site of the infection is much higher. Furthermore, some substances, such as chloramphenicol and tobramycin, are not tested for systemic treatment because they are only used for topical treatment.

Occurrence of resistance varies among bacterial species and substances. However, in most cases there are products available on the Swedish market that would be effective if topical antibiotic treatment is considered necessary.

Staphylococcus pseudintermedius – susceptibility test for topical treatment

Isolates of *Staphylococcus pseudintermedius* are from clinical submissions of samples from external ear from dogs in 2024.

Resistance to tetracycline (21%) was the most common trait in 2024, followed by neomycin (15%), fusidic acid (11%) and chlorampenicol (11%) (Table 4.32). The proportion of multiresistance was 5% (30/599). Seventy-three percent (22/30) of the multiresistant isolates were resistant to three antibiotics; 10% (3/30) to four and 13% (4/30) to five. One isolate

was resistant to six antibiotics. Of the multiresistant isolates, resistance to tetracycline, neomycin, and chloramphenicol was the most common phenotype 47% (14/30).

Six of the isolates were resistant to oxacillin (MIC >0.25 mg/L). All were tested with PCR for detection of the *mecA* and *mecC* genes, five were positive and one was negative. For more information on MRSP isolated from dogs in Sweden, see "Notifiable diseases", Methicillin-resistant *Staphylococcus pseudintermedius* (MRSP).

Table 4.32. Distribution of MICs and resistance (%) in *Staphylococcus pseudintermedius* from dogs 2024. Clinical isolates from external ear, susceptibility test for topical treatment.

Antibiotic	Resistance (%) 2024 n=599	Distribution (%) of MICs (mg/L)									
		≤0.12	0.25	0.5	1	2	4	8	16	32	>32
Cefoxitin[a]							98.7	1.3			
Enrofloxacin	2	92.5	4.5	1.3	0.5	0.2		1.0			
Florfenicol	0				1.8	86.3	11.4	0.5			
Fusidic acid	11		88.3	0.7	0.8	10.2					
Gentamicin	5				94.8	1.2	1.7	1.8	0.5		
Chloramphenicol	11					0.2	71.3	16.9	0.7	11.0	
Neomycin	15					84.8	9.0	5.2	1.0		
Oxacillin	1[b]		99.0	0.5	0.2	0.3					
Tetracycline	21				79.3	1.5	0.2	0.3	18.7	18.7	
Tobramycin	3				95.3	1.7	1.5	1.5			

[a]No cut-off available for *S. pseudintermedius*. [b]The six isolates with MIC >0.25 for oxacillin were tested with PCR for detection of the *mecA* and *mecC* genes, five were positive and one was negative.

Pseudomonas aeruginosa

Isolates of *Pseudomonas aeruginosa* are from clinical submissions of samples from the external ear canal in dogs. *Pseudomonas aeruginosa* is inherently resistant to trimethoprim-sulphonamides, tetracyclines and aminopenicillins (including combinations with clavulanic acid). The isolates of *P. aeruginosa* were prior to 2014 tested for polymyxin B susceptibility and all tested isolates have been sensitive throughout the years (see previous Swedres-Svarm reports). In 2014, polymyxin B was replaced by the equivalent antibiotic colistin and since then, 0-1% of the isolates have been resistant to colistin. The proportion of resistance to enrofloxacin has gradually declined from 25% in 2009 to 9% in 2024. The figures for gentamicin have stabilized at ≤1-2% over the recent years (see Table 4.33 and previous Swedres-Svarm reports). None of the isolates were resistant to more than one of the tested antibiotics.

Due to the introduction of an AMR panel with substances and cut-off values for topical treatment, the number of isolates tested for systemical treatment has gradually declined during the past two years (2022 n=202, 2023 n=151, 2024 n=45).

Pasteurella canis/oralis

Isolates of *Pasteurella* spp. are from clinical submissions of samples from various anatomical sites from dogs, mainly wounds (57%), abscesses (14%), and skin and external ear canal (12%). *Pasteurella canis/oralis* was the most common *Pasteurella* sp. iso-

Table 4.33. Distribution of MICs and resistance (%) in *Pseudomonas aeruginosa* from dogs, 2024. Clinical isolates from the external ear canal.

Antibiotic	Resistance (%) 2024 n=45	Distribution (%) of MICs (mg/L)								
		≤0.12	0.25	0.5	1	2	4	8	16	>16
Colistin[a]	0				66.7	26.7	6.7			
Enrofloxacin	9	2.2	4.4	40.0	31.1	13.3		8.9		
Gentamicin	0					93.3	4.4	2.2		

[a]Colistin is equivalent to polymyxin B.

Table 4.34. Distribution of MICs and resistance (%) in *Pasteurella canis/oralis* from dogs, 2024. Clinical isolates from various anatomical sites.

Antibiotic	Resistance (%) 2024 n=250	Distribution (%) of MICs (mg/L)								
		≤0.016	0.03	0.06	0.12	0.25	0.5	1	2	4	>4
Ampicillin	0			88.4	9.6	2.0					
Enrofloxacin	1	90.8	7.6	0.8			0.4	0.4			
Gentamicin	NR							95.2	2.0	2.8	
Penicillin	0		79.6	16.4	2.8	0.4	0.8				
Tetracycline	0				8.4	76.8	14.4	0.4			
Trim-Sulph.[a]	2		92.8	4.4	0.4	1.2		1.2			

NR, not relevant as *Pasteurella* spp. have a low inherent susceptibility to aminoglycosides, as gentamicin. [a]Concentration of trimethoprim given, tested in concentration ratio 1/20 (trimethoprim/sulphamethoxazole).

lated in samples from dogs, 79% (250/317). The isolates were species identified with MALDI-TOF MS and *P. canis* and *P. oralis* cannot be separated by the method.

The cut-off values for *Pasteurella multocida* have been applied for all *Pasteurella* spp. *Pasteurella* spp. have a low inherent susceptibility to aminoglycosides, e.g. gentamicin. If not including gentamicin, 98% (244/250) of the isolates were susceptible to all antibiotics tested.

The proportion of resistance to enrofloxacin is generally low, with variations between <1% (2014), 4% (2020) and 1% (2024). Resistance to trimethoprim-sulphamethoxazole has been detected in one isolate each year 2020-2021. In 2022 it was detected in two isolates, in 2023 in seven isolates and in 2024 in six isolates (Table 4.34 and previous Swedres-Svarm reports). Before 2020, all tested isolates were susceptible to trimethoprim-sulphamethoxazole (see previous Swedres-Svarm reports). Out of six resistant isolates, two were resistant to both enrofloxacin and trimethoprim-sulphamethoxazole, the other four were resistant to trimethoprim-sulphamethoxazole only.

Cats

Escherichia coli

Isolates are from clinical sampling of urine, submitted either as urine or cultures from dip-slides or other agar plates. As in previous years, and in *Escherichia coli* isolated from urine in dogs (Table 4.30), resistance to ampicillin was the most common trait in 2024 (Table 4.35 and Figure 4.13). In comparison, in *E. coli* isolated from the genital tract of horses (mares) resistance to trimethoprim-sulphamethoxazole was most common (Table 4.25 and Figure 4.9). The proportions of resistance in the *E. coli* isolated from cat urine have differed somewhat throughout the years and trends are difficult to estimate (Figure 4.13).

Seventy-seven percent (288/376) of the *E. coli* isolates were susceptible to all the tested antibiotics. The proportion of multiresistance was 1% (4/376). All of the multiresistant isolates were resistant to three antibiotics. No specific phenotype was noticed. For comparison of resistance in *E. coli* of different origin see "Comparative analysis".

Four of the *E. coli* isolates were resistant to cefotaxime (MIC >0.25 mg/L). A gene conferring transferable ESC resistance was detected in one of the isolates ($bla_{CTX\text{-}M\text{-}14}$). For more information on ESBL isolated from cats in Sweden, see Notifiable diseases, ESBL-producing Enterobacterales. No isolate was resistant to colistin (MIC >2mg/L) or meropenem (MIC >0.12mg/L).

Figure 4.13. Resistance (%) in clinical isolates of *Escherichia coli* from urine of cats, 2007-2024. The number of isolates each year varies (n=131-545, 2024 n=376).

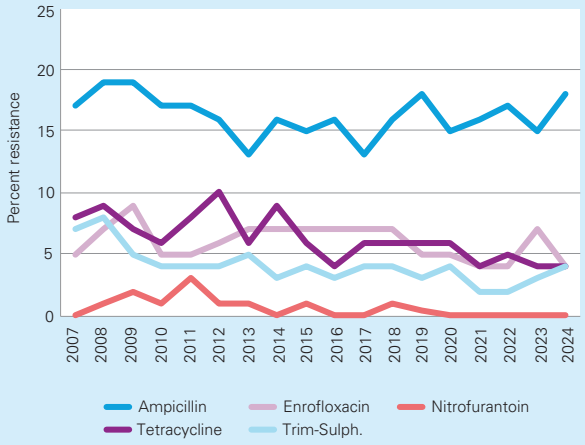


Table 4.35. Distribution of MICs and resistance (%) in *Escherichia coli* isolated from cats, 2024. Clinical isolates from urine.

Antibiotic	Resistance (%) 2024 n=376	Distribution (%) of MICs (mg/L) ≤0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	>64
Ampicillin	18						50.3	30.1	1.6		18.1		
Cefalexin	2							36.4	56.9	4.8	0.3	1.6	
Cefotaxime	1[b]			98.9	0.5	0.3		0.3					
Colistin	0					99.2	0.8						
Enrofloxacin	4		96.0	2.1	1.3	0.3			0.3				
Gentamicin	<1						99.7	0.3					
Meropenem	0	100.0											
Neomycin	<1							99.2	0.5			0.3	
Nitrofurantoin	<1										99.2	0.5	0.3
Tetracycline	4						94.7	1.3			4.0		
Trim-Sulph.[a]	4				96.3	0.5	0.5	0.3	2.4				

[a]Concentration of trimethoprim given, tested in concentration ratio 1/20 (trimethoprim/sulphamethoxazole); [b]Four isolates with MIC >0.25mg/L were available for verification. A gene conferring transferable ESC resistance was detected in one of the isolates.

Staphylococcus felis

Isolates of *Staphylococcus felis* are from clinical submissions of samples from various anatomical sites, mainly abscesses and wounds (37%), the external ear canal (20%) and urine (29%) in cats.

The proportions of resistance to the tested antibiotics in isolates of *S. felis* (Table 4.36) were, as in previous years, lower than for *S. pseudintermedius* in dogs (Table 4.31 and previous Swedres-Svarm reports). Resistance to penicillin due to penicillinase production was 17% in *S. felis*, compared to 68% in *S. pseudintermedius* in dogs.

Seventy-eight percent (178/228) of the *S. felis* isolates were susceptible to all the tested antibiotics. The proportion of multiresistance has varied between <1 and 7% during 2015-2023 (see previous Swedres-Svarm reports). In 2024, multiresistance was detected in 4% (9/228) of the isolates. The most common phenotype was resistance to penicillin, clindamycin, and erythromycin (8/9). The isolates were screened for erythromycin-induced clindamycin resistance. Two isolates (1%) displayed such resistance.

Pasteurella multocida

Isolates of *Pasteurella* spp. are from clinical submissions of samples from various anatomical sites, but mainly from wounds or skin lesions, abscesses, and the external ear canal (83%) in cats.

Pasteurella multocida was the most common *Pasteurella* sp. isolated in samples from cats, 89%. The proportion of resistance was low in the tested isolates except for trimethoprim-sulphamethoxazole which has increased to 16% (Table 4.37), compared to 6% in 2023 and 4% in 2022. No resistance to penicillin was detected. *Pasteurella* spp. have a low inherent susceptibility to aminoglycosides, e.g. gentamicin.

Table 4.36. Distribution of MICs and resistance (%) in *Staphylococcus felis* from cats, 2024. Clinical isolates from various locations.

Antibiotic	Resistance (%) 2024 n=228	Distribution (%) of MICs (mg/L) ≤0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	>64
Cefalexin	0						100							
Cefoxitin[a]	NA							98.7	0.9	0.4				
Clindamycin	5[c]				94.3	1.8	0.9	0.4	2.6					
Enrofloxacin	1				96.9	2.2	0.9							
Erythromycin	5				51.8	43.4	0.9		3.9					
Fusidic acid	3				31.6	65.8	1.3	1.3						
Gentamicin	<1						99.6	0.4						
Nitrofurantoin	0										99.6	0.4		
Oxacillin	0				99.1	0.4	0.4							
Penicillin	17[d]	82.9	0.9	0.9	3.1	2.2	2.2	7.9						
Tetracycline	0				98.2	1.8								
Trim-Sulph.[b]	1				96.1	2.6	0.9			0.4				

NA, not applicable. [a]No cut-off available for *S. felis*; [b]Concentration of trimethoprim given, tested in concentration ratio 1/20 (trimethoprim/sulphamethoxazole); [c]Denotes resistance, including inducible resistance (2 isolates); [d]Denotes beta-lactamase production.

Table 4.37. Distribution of MICs and resistance (%) in *Pasteurella multocida* from cats, 2024. Clinical isolates from various locations.

Antibiotic	Resistance (%) 2024 n=409	Distribution (%) of MICs (mg/L) ≤0.016	0.03	0.06	0.12	0.25	0.5	1	2	4	>4
Ampicillin	<1			1.5	15.6	74.1	8.6		0.2		
Enrofloxacin	2	75.1	20.5	2.2	1.5	0.5	0.2				
Gentamicin	NR							2.0	4.6	67.0	26.2
Penicillin	0		1.0	19.1	65.8	13.4	0.7				
Tetracycline	0				2.0	54.3	43.5	0.3			
Trim-Sulph.[a]	16		39.4	31.5	12.7	4.6	3.2	2.7	5.9		

NR, not relevant as *Pasteurella* spp. have a low inherent susceptibility to aminoglycosides, e.g. gentamicin. [a]Concentration of trimethoprim given, tested in concentration ratio 1/20 (trimethoprim/sulphamethoxazole).

Beta-haemolytic streptococci

Isolates of beta-hemolytic streptococci are from clinical submissions of samples from various anatomical sites, but mainly (74%) from wounds/skin lesions, urine and the external ear canal in cats. The same cut-offs as for *Streptococcus equi* subsp. *zooepidemicus* have been applied for the tested beta-haemolytic streptococci isolates.

Resistance data for beta-haemolytic streptococci isolated from cats were included in Swedres-Svarm 2011 (n=184), 2022 (n=128) and in 2023 (n=96). As in earlier years, all the tested isolates were susceptible to penicillin in 2024 (Table 4.38). Any reduced susceptibility to penicillin in beta-hemolytic streptococci should be controlled, i.e. if tested on pure culture and ensuring that organism identification and antimicrobial susceptibility test are accurate and reproducible. The isolates were screened for erythromycin-induced clindamycin resistance. Two isolates (2%) displayed such resistance.

Beta-haemolytic streptococci have a low inherent susceptibility to fluoroquinolones (e.g. enrofloxacin), aminoglycosides (e.g. gentamicin) and tetracyclines.

Table 4.38. Distribution of MICs and resistance (%) in beta-haemolytic streptococci isolated from cats, 2024. Clinical isolates from various locations.

Antibiotic	Resistance (%) 2024 n=94	Distribution (%) of MICs (mg/L)												
		≤0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	>64
Cefalexin	0						100							
Clindamycin	13[b]				86.2	3.2		1.1	9.6					
Enrofloxacin	NR				3.2	59.6	35.1	2.1						
Erythromycin	12				84.0	4.3	1.1		10.6					
Gentamicin	NR						5.3	18.1	48.9	27.7				
Nitrofurantoin	0										96.8	3.2		
Penicillin	0	100												
Tetracycline	NR				7.4	2.1	3.2	24.5	31.9	30.9				
Trim-Sulph.[a]	0				96.8	3.2								

NR, not relevant as the inherent susceptibility is above concentrations that can be obtained during therapy. [a]Concentration of trimethoprim given, tested in concentration ratio 1/20 (trimethoprim/sulphamethoxazole); [b]Denotes resistance, including isolates with inducible resistance (2 isolates).

Indicator bacteria from animals

In programmes monitoring antibiotic resistance in the veterinary field, *Escherichia coli*, *Enterococcus faecalis* and *Enterococcus faecium* from the enteric flora of healthy animals, or bacteria contaminating food, serve as indicators of the presence of acquired resistance. The level of resistance in these so-called indicator bacteria reflects the magnitude of the selective pressure from antibiotic use in an animal population. Moreover, although these bacteria are unlikely to cause disease, they can be reservoirs for resistance genes that may spread to bacteria pathogenic to animals or humans. Resistance in indicator bacteria contaminating meat indicates the potential exposure of humans through the food chain.

During 2024, indicator *E. coli* from healthy broilers and turkeys were studied.

Samples from broilers were collected at slaughter within the Swedish Campylobacter programme in which whole caeca are collected from each batch of broilers slaughtered. Each sample was from a unique flock but not always from a unique production site. Samples cultured were collected at five abattoirs that in 2024 accounted for approximately 98% of the total volume of broilers slaughtered. The number of samples from each abattoir was roughly proportional to the annual slaughter volume of the abattoir and the sampling was distributed over the year.

Samples from turkey consist of caecal content of healthy turkeys sampled at slaughter. Each sample is from a unique flock but not always from a unique production site. Sampling was performed from January to December at one abattoir that in 2024 accounted for approximately 80% of the total volume of turkeys slaughtered in Sweden.

All samples analysed for indicator *E. coli* were also screened for *E. coli* resistant to ESCs by selective culture on media supplemented with cefotaxime. For details on methodology see Material and methods, resistance in bacteria from animals.

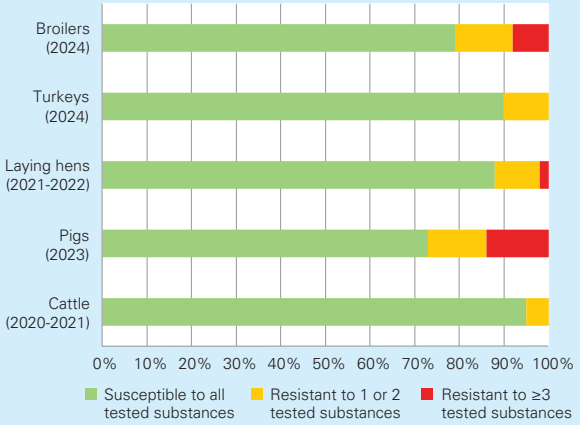
In 2024, no consignments of poultry meat from countries outside the EU were imported via border control posts in Sweden. Hence, no sampling of poultry meat was performed.

Escherichia coli

Broilers

Escherichia coli was isolated from 173 (96%) of 180 cultured caecal samples from broilers. The majority of the isolates (79%) was susceptible to all antibiotics tested (Table 4.39 and Figure 4.14). Resistance to ampicillin (11%), sulphonamides (11%), trimethoprim (8%) and quinolones (ciprofloxacin and nalidixic acid, 7%) were the most common traits (Table 4.39 and 4.40). Thirteen isolates (8%) were multiresistant, i.e. resistant to three or more antibiotics (Table 4.39 and Figure 4.14). All of these had resistance to ampicillin, sulphonamides,

Figure 4.14. Proportion (%) of indicator *Escherichia coli* from broilers, turkey, laying hens, pigs and cattle under one year of age with resistance to none, one-two, or three or more tested substances.



and trimethoprim in their phenotype. Six of the isolates also had resistance to tetracyclines in their phenotype. From an international perspective, levels of resistance in *E. coli* from broilers are low in Sweden. The proportion of isolates susceptible to all antibiotics tested has been stable in the latest years (75% in 2014, 71% in 2016, 69% in 2018, 72% in 2020, 69% in 2022, and 77% in 2024). Yet, for some substances the situation has become less favourable compared to twenty years ago (Figure 4.15). More precisely, occurrence of resistance to ampicillin, sulphonamides and trimethoprim in *E. coli* from broilers has increased considerably since 2007. Likewise, occurrence of resistance to tetracycline has increased during these years even if the occurrence has dropped considerably since 2018.

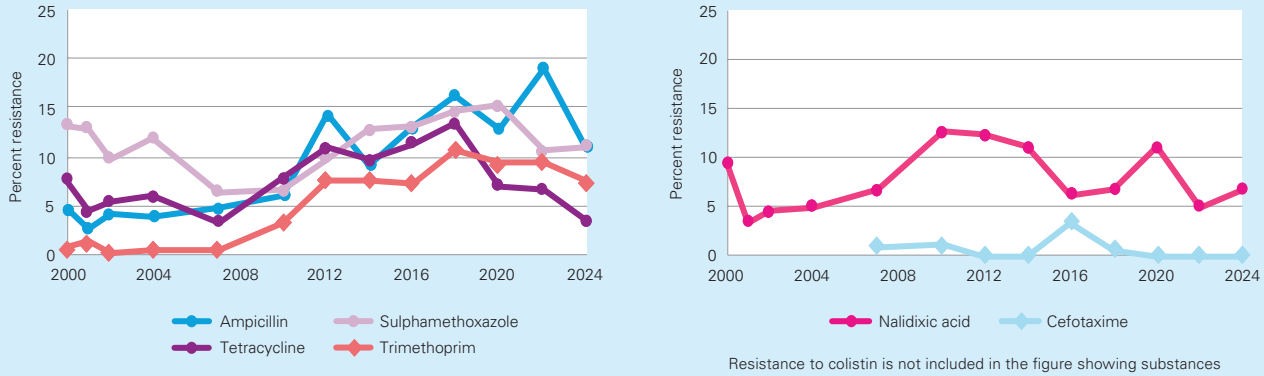
Regarding substances in the category B (restrict) of the AMEG classification (EMA, 2019), resistance to polymyxins (colistin) has been tested for since 2010 but has not been detected, and resistance to cefotaxime (tested since 2007) has been stable at a low occurrence (Figure 4.15). However, the occurrence of resistance to quinolones has varied over the years. Quinolones have not been used in Swedish broiler production since at least 2011 and the reason(s) for these variations in resistance is not known.

In 2024, none of the isolates were resistant to cefotaxime or ceftazidime. However, using selective culture, ESC resistant *E. coli* was isolated from 9 (3%) of 305 samples. In all of the isolates, transferable genes for resistance to ESC were found. Eight isolates had the $bla_{\text{TEM-52}}$ gene and one the $bla_{\text{CTX-M-65}}$ gene. For more details and comments on occurrence of resistance to ESC, see section Antibiotic resistance in animals, Notifiable diseases.

Turkeys

Escherichia coli was isolated from 29 (100%) of 29 cultured caecal samples from turkeys. The majority of the isolates (90%) was susceptible to all antibiotics tested (Table 4.39 and Figure 4.14). The only substances to which resistance were detected were ampicillin, gentamicin, sulphonamides, and trimethoprim (3% each) (Table 4.39 and 4.40). None of the isolates were multiresistant, i.e. resistant to three or more antibiotics (Table 4.39 and Figure 4.16). From an international perspective, levels of resistance in *E. coli* from turkeys are low in Sweden. The proportion of isolates susceptible to

Figure 4.15. Resistance (%) in *Escherichia coli* from broilers 2000-2024. The number of isolates each year varies (n=172-307, 2024 n=173).

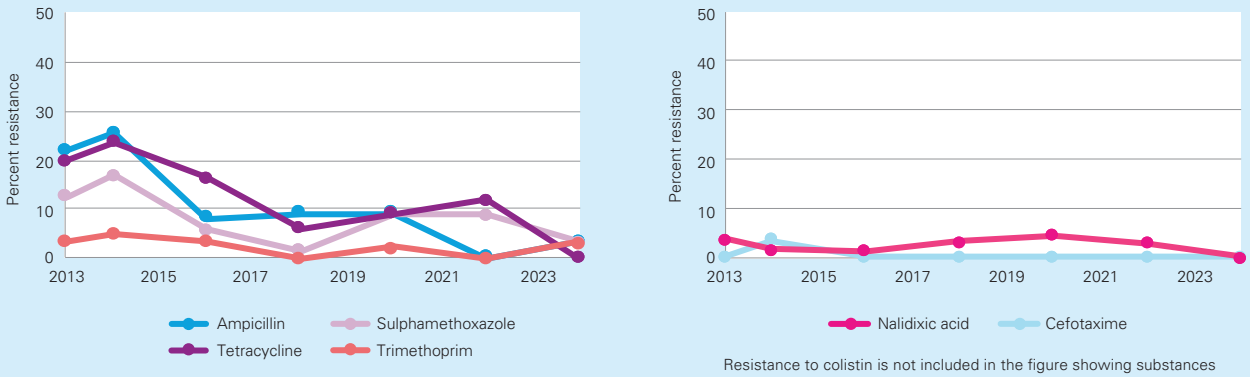


Resistance to colistin is not included in the figure showing substances in category B of the AMEG categorisation (EMA, 2019) as it has not been detected during the years it has been investigated (2010-2024).

all antibiotics tested has increased considerably since 2014 and increased even further the latest years (44% in 2014, 71% in 2016, 80% in 2018, 80% in 2020, 85% in 2022, and 90% in 2024). This change is driven by decreased occurrence of resistance to some substances, namely ampicillin, sulphonamides and tetracycline (Figure 4.16). The differences over time are statistically significant (p<0.05, X2). The reason(s) for these changes is not known but historically the use of antibiotics for turkeys was higher than in recent years.

None of the isolates were resistant to cefotaxime or ceftazidime. Moreover, also when using selective culture, no ESC resistant *E. coli* was isolated from the 29 samples. For more details and comments on occurrence of resistance to ESC, see section Antibiotic resistance in animals, Notifiable diseases.

Figure 4.16. Resistance (%) in *Escherichia coli* from turkeys 2013-2024. The number of isolates each year varies (n=29-85, 2024 n=29).



Resistance to colistin is not included in the figure showing substances in category B of the AMEG categorisation (EMA, 2019) as it has not been detected during the years it has been investigated (2013-2024).

Table 4.39. Resistance (%) and multiresistance (%) in indicator *Escherichia coli* from broilers and turkeys, 2024. Most recent data on indicator *E. coli* from other sample categories are given for comparison.

Antibiotic	ECOFF (mg/L)	Resistance (%) Broilers 2024 n=173	Cattle[b] 2020-21 n=101	Laying hens 2021-22 n=110	Pigs 2023 n=174	Sheep 2006-09 n=115	Turkeys 2024 n=29	Dogs 2012 n=74	Horses 2010-11 n=274
Amikacin	>8	1	0	0	0	-	0	-	-
Ampicillin	>8	11	2	3	18	2	3	9	2
Azithromycin	>16	0	0	0	<1	-	0	-	-
Cefotaxime	>0.25	0	0	0	0	0	0	1	0
Ceftazidime	>1	0	0	0	0	-	0	-	-
Chloramphenicol	>16	0	0	1	3	0	0	0	<1
Ciprofloxacin	>0.06	7	0	2	2	<1	0	3	<1
Colistin	>2	0	0	0	0	-	0	0	<1
Gentamicin	>2	1	0	0	0	3	3	0	<1
Meropenem	>0.12	0	0	0	0	-	0	-	-
Nalidixic acid	>8	7	0	2	1	0	0	0	<1
Sulphamethoxazole	>64	11	2	3	17	7	3	4	15
Tetracycline	>8	3	2	5	12	<1	0	8	2
Tigecycline	>0.5	0	0	0	0	-	0	-	-
Trimethoprim	>2	8	2	4	17	2	3	1	16
Resistance (%) to 0->3 antibiotics[a]									
Susceptible to all above		79	95	88	73	89	90	84	83
Resistant to 1		13	4	8	7	8	7	8	2
Resistant to 2		1	2	2	6	3	3	7	12
Resistant to 3		4		2	6	<1			2
Resistant to >3		3			7			<1	1

[a]Ciprofloxacin and nalidixic acid as well as cefotaxime and ceftazidime were considered as one antibiotic class. [b]Cattle between 6 and 12 months.

Table 4.40. Distribution of MICs and resistance (%) in *Escherichia coli* from intestinal content from broilers (n=173) and turkeys (n=29), 2024.

Antibiotic	Source	Resistance %	Distribution (%) of MICs (mg/L)																
			≤0.016	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	512	>512
Amikacin	Broilers	1									92.5	6.9	0.6						
	Turkeys	0									93.1	6.9							
Ampicillin	Broilers	11							4.6	34.1	48.0	2.3		0.6	10.4				
	Turkeys	3							6.9	37.9	51.7				3.4				
Azithromycin	Broilers	0								3.5	20.8	61.3	14.5						
	Turkeys	0								3.4	24.1	65.5	6.9						
Cefotaxime	Broilers	0					100												
	Turkeys	0					100												
Ceftazidime	Broilers	0					98.3	1.7											
	Turkeys	0					100												
Chloramphenicol	Broilers	0										100							
	Turkeys	0										100							
Ciprofloxacin	Broilers	7	83.2	9.8		4.0	2.3			0.6									
	Turkeys	0	86.2	13.8															
Colistin	Broilers	0							99.4	0.6									
	Turkeys	0							100										
Gentamicin	Broilers	1						60.7	34.7	3.5	0.6			0.6					
	Turkeys	3						48.3	34.5	13.8	3.4								
Meropenem	Broilers	0		100															
	Turkeys	0		100															
Nalidixic acid	Broilers	7									93.1			0.6	2.3	4.0			
	Turkeys	0									100								
Sulphamethoxazole	Broilers	11										77.5	11.6						11.0
	Turkeys	3										79.3	17.2						3.4
Tetracycline	Broilers	3								96.0	0.6				3.5				
	Turkeys	0								100									
Tigecycline	Broilers	0					100												
	Turkeys	0					100												
Trimethoprim	Broilers	8					69.9	21.4	1.2					7.5					
	Turkeys	3					86.2	6.9	3.4					3.4					
			≤0.016	**0.03**	**0.06**	**0.12**	**0.25**	**0.5**	**1**	**2**	**4**	**8**	**16**	**32**	**64**	**128**	**256**	**512**	**>512**

Antibiotic resistance in *Escherichia coli* in Swedish wild boar minced meat

Sweden's wild boar population has increased dramatically and is leading to a large cost, including damage to agricultural land (The Swedish Board of Agriculture, 2025). At the same time wild boar meat is considered a valuable resource. There is an aim from the Swedish government to make wild boar meat more publicly available, for example in restaurants and public meals such as in preschools, schools and retirement homes. This will lead to a larger consumer exposure, including potentially vulnerable populations, to wild boar meat. This meat is likely more faecally contaminated than for example pork due to factors such as the placement of the bullet and challenges of hygienic evisceration in the field (Needham et al., 2023). Hence there was a survey conducted on the occurrence of zoonotic pathogens in frozen Swedish wild boar minced meat, which is the type of wild boar meat typically found in the supermarkets in Sweden today. Apart from pathogenic bacteria and hepatitis E virus, the occurrence of antibiotic resistance in indicator commensal *Escherichia coli* and the occurrence of *E. coli* with resistance to extended spectrum cephalosporins (ESCs) were investigated (Swedish Food Agency, 2025).

Method

Sampling was carried out between June 2023 and November 2024. Altogether 144 frozen minced wild boar meat samples from individual batches were sent by game handling and ground meat establishments to the Swedish Food Agency for bacterial analysis. *Escherichia coli* was enumerated using standard methods on Chromocult® Coliform ES (Enhanced Selectivity) agar with a quantification limit of 10 colony forming units per gram (CFU/g). One colony from each positive sample was frozen for further antibiotic susceptibility testing at the Swedish Veterinary Agency using broth microdilution. Resistance was assessed using epidemiological cut-offs (ECOFF) from the European Committee on Antimicrobial Susceptibility Testing (EUCAST). In cases where such cut-offs were missing, the cut-offs applicable in the harmonised resistance surveillance in the EU (Implementing Decision 2020/1729/EU as amended) were used.

Further, all minced meat samples were screened for *E. coli* resistant to ESCs by culture on MacConkey agar (Oxoid) with cefotaxime (1 mg/L) after prior enrichment in buffered peptone water (BPW). Briefly, 25 g of minced meat was homogenized in 225 mL BPW and incubated at 37°C overnight. Ten µL from the pre-enrichment broth were spread onto the agar plate and incubated overnight at 44°C. No specific screening for meropenem resistance or bla_{OXA48}-producers was performed.

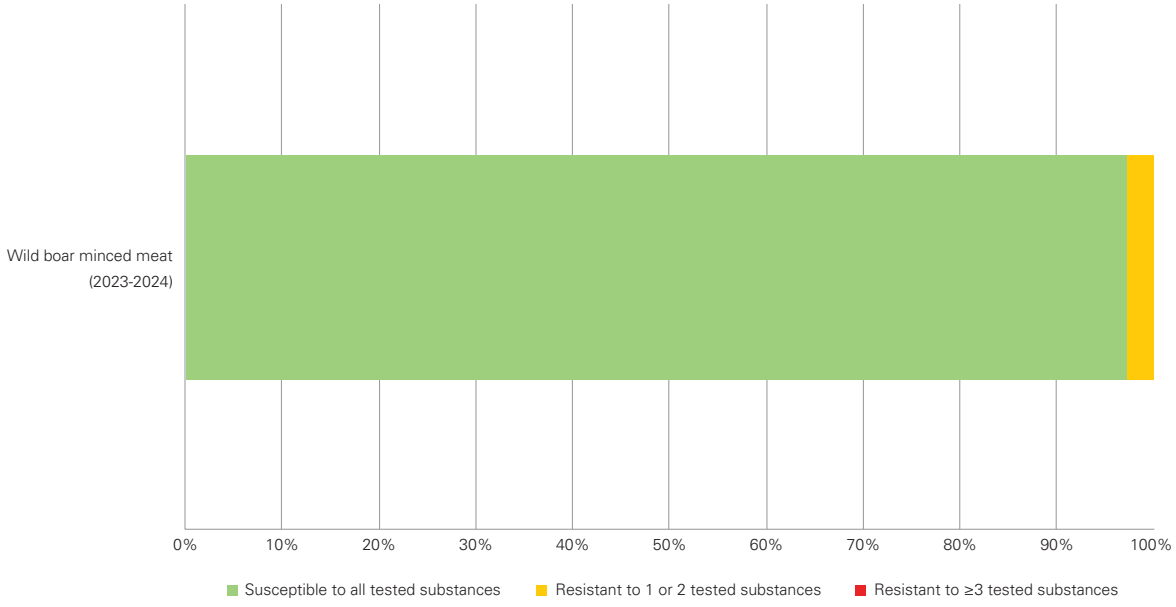
Results and comments

Escherichia coli could be enumerated (>10 CFU/g) in 110 samples (76%). Of the 110 isolates, 107 isolates (97%) were susceptible to all antibiotics tested whereas three isolates were resistant to one or two substances (Figure 1). Two of these isolates were resistant to one substance each (amikacin and trimethoprim, respectively) and one to two substances (tetracycline and sulfamethoxazole). No isolate was resistant to 3 or more substances. Further, no minced meat sample contained *E. coli* resistant to ESCs (0%; 95% confidence interval, 0-2.5%).

The low resistance in indicator *E. coli* and no findings of ESC resistance in the present study indicates a low selection pressure as well as spill-over from the environment in which the wild boars live. As a comparison, Mercato et al. (2022) isolated *E. coli* resistant to ESCs from 16 out of 60 (23%) wild boars, including human pathogenic *E. coli* strains, in a high-density area of Northern Italy.

Although a low occurrence of antibiotic resistant *E. coli* in the wild boar meat, other pathogens were found and the high numbers of *E. coli* in a majority of the samples indicate a need for a better hygiene all along the chain from the placement of the shot to the table (Swedish Food Agency, 2025). One specific challenge is the hygienic removal of the intestines which can be difficult to perform in the field (Needham et al., 2023). Consumers and people working in kitchens, are advised to maintain good kitchen hygiene and to cook minced meat thoroughly. The whole report (in Swedish but with an English summary) is available at www.livsmedelsverket.se.

Figure. Proportion (%) of indicator *Escherichia coli* from Swedish wild boar minced meat with resistance to none, one-two, or three or more tested substances.



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Comparative analysis

Comparison of antibiotic sales in human and veterinary medicine

Data included and calculations

For human medicinal products with antibiotics, the numbers on the total amount of antibiotics consumed for systemic use to humans (ATC group J01 excluding methenamine, and A07AA oral glycopeptides; sales to hospitals and on prescriptions to individuals; ATC/DDD index version 2025) were retrieved as defined daily doses and calculated to kg active substance.

For veterinary medicinal products with antibiotics, data on sales of antibiotics for use in animals (QJ01 and QA07AA) are those presented in Sales of antibiotics for animals except products for intramammary and intrauterine use (QG01 and QJ51). Sales for aquaculture were not included, nor were sales of drugs authorised for human use but sold for use in animals, except for the comparison of azoles (see below).

To estimate the biomass of the human population, data on population numbers by age were multiplied with the corresponding average body weights from studies made by Statistics Sweden in 2016. For animal body mass, the data on population correction unit for 2023 was used as a proxy for 2024 (EMA, 2025). This unit roughly corresponds to the total biomass of major animal populations, excluding dogs and cats.

For the section on azoles, ATC- and ATCvet codes and products with such substances were identified and selected. Calculation to kg active substance of the azole-component was performed as above. Products sold on special license were only included for veterinary prescribers. The datasets included both products for parenteral use and for various topical uses including medicinal shampoos.

Total sales

A total of 63.5 and 9.0 tonnes of antibiotics were consumed in human and veterinary medicine, respectively, in 2024 from the included ATC classes. Beta-lactam antibiotics remain the most commonly prescribed antibiotics in both human and veterinary medicine and represent the largest volumes consumed, measured in kilograms. Other antibiotic products were consumed in smaller quantities than beta-lactams but considering their chemical and pharmacological properties, they could have a greater impact on the environment and the emergence of antibiotic resistance. The largest difference is noted for fluoroquinolones, where sales for humans are more than 150 times higher than for animals and constitute approximately 4% of total sales for humans included in this analysis. For animals, sales of fluoroquinolones constitute 0.2% of the total sales.

In total, 96.4 and 11.9 mg active antibiotic substance per kg estimated biomass were sold in 2024 in human and veterinary medicine, respectively. Total sales data do not take the heterogeneity of likelihood of exposure within the population into account. This is especially true for data on sales for use in animals, as certain substances may only or mainly be sold for use in one particular animal species. Consequently, the selective pressure in a particular subset of the population (i.e. a particular animal species) could be far larger than in the total population. Both in tonnes active substance and in mg per kg estimated biomass, antibiotic sales are higher for humans than for animals in Sweden.

Sales of azoles as medicinal products

Antifungal medicinal products with substances belonging to the class azoles are used for treatment of various mycoses in humans and animals. Azoles are also used in plant protection products, as biocides for e.g. wood preservation, as industrial chemicals and in cosmetics. In human medicine, one indication for products with azoles is aspergillosis. Resistance to substances in the azole class has been increasingly reported in the main pathogen *Aspergillus fumigatus*, thereby reducing the options for treatment. Resistance in yeasts such as *Candida albicans* and *C. auris* is also an increasing concern.

In Table 5.1, data on sales of azoles for use in human or veterinary medicine in Sweden during 2024 are presented as aggregated kg active substance, and the substances included are shown in Table 5.2. Most of the sales were human medicinal products sold without prescription (72%). It cannot be excluded that some of those products have been used for companion animals, in particular products formulated as shampoos. Products prescribed by veterinarians (human and veterinary medicinal) constituted only 2% of the total sales, and most of that was products for companion animals and horses.

Given that azoles are used across sectors, five EU agencies have jointly recently reviewed their use outside human medicine (EFSA et al., 2025). The report shows that use for plant protection and as a biocide by far outweighs use in human and veterinary medicine. This is also true for Sweden, where

Table 5.1. Sales of azoles as medicinal products per type of product and prescriber during 2024.

Type of sales	kg active substance (azoles)
Human medicinal products, prescribed or bought on requisition by others than veterinarians	555
Human medicinal products, prescribed or bought on requisition by veterinarians[a]	5
Veterinary medicinal products, prescribed or bought on requisition by veterinarians	49
Human medicinal products sold without prescription	1 581
Total sales	2 190

[a]Includes negligible amounts of non-prescription products

Table 5.2. Substances in the azole class in the included human and veterinary medicinal products.

	Human medicinal products	Veterinary medicinal products
Econazole	Yes	No
Fluconazole	Yes	No
Isavuconazole	Yes	No
Itraconazole	Yes	Yes
Ketoconazole	Yes	Yes
Clotrimazole	Yes	Yes
Miconazole	Yes	Yes
Posaconazole	Yes	No
Voriconazole	Yes	No

use of azoles described in the report from EU agencies outside medicine and veterinary medicine amounted to approximately 85 000 kg in 2023 (Swedish Chemicals Agency, 2024). The majority of these products were sold for use in agriculture, as fungicides and seed dressings.

Comparison of antibiotic resistance in human and veterinary medicine

ESBL-producing Enterobacterales

Enterobacterales with $ESBL_A$ or $ESBL_M$, and their corresponding genes, can transfer between animals and humans (EFSA, 2011; de Been, 2014). The main route would be via food, but the possibility for direct transfer when handling animals should be kept in mind.

The available data show that ESBL-producing bacteria are generally rare in animals and food in Sweden. Previously, the occurrence in intestinal samples from broilers was high but it has decreased considerably in recent years. Moreover, previous investigations when the occurrence was higher has shown that $ESBL_A$ or $ESBL_M$-producing *E. coli* constitute a small part of all the *E. coli* in the intestinal flora in a majority of the broiler samples. Finally, it has previously been shown that most isolates from humans in Sweden are not of the same types of $ESBL_A$ or $ESBL_M$ as in broilers. Hence, nothing indicates a need to revise the conclusion that food on the Swedish market is a limited source for ESBLs for humans (Börjesson et al., 2016). Nevertheless, continued vigilance against development of reservoirs of ESBL-producing Enterobacterales in animals is warranted.

MRSA

Zoonotic transmission of MRSA occurs by direct or indirect contacts. MRSA is reported globally in farm animals, companion animals, horses and wildlife. During the year, MRSA was isolated from pigs and sporadically from dogs, horses and cats. From dogs and cats, different *spa*-types were isolated, most of them previously found in humans. The situation among humans is also favourable.

Livestock-associated MRSA

In the last two decades, the zoonotic aspects on MRSA in farm animals has widened in many countries, largely due to spread of livestock-associated MRSA, and primarily clonal complex (CC) 398. This mainly concerns pigs but veal calves, broilers and dairy cows are also affected.

Based on surveillance of MRSA in livestock, with occasional findings in samples from cow, pig, goat and sheep, the situation has been considered favourable in Sweden. However, the prevalence in especially pigs is insufficiently studied but in 2025 a baseline study is carried out with sampling at slaughterhouses. During 2024, MRSA CC398 was isolated from pigs. Furthermore, MRSA CC398 occurs among horses and *spa*-type t011 (n=10) was the most common in 2024. MRSA CC398 acquired in Sweden is uncommon in humans. Among all MRSA cases with available typing results in 2024, there were 29 cases with *spa*-types t034 (n=16), t011 (n=6), t4652 (n=2), t1451 (n=1), t1793 (n=1), t2970 (n=1), t3625 (n=1) and t899 (n=1). Nineteen of the isolates were PVL-negative while no information on PVL status was available for the remaining ten isolates. In addition, five isolates belonging to CC398 were detected by whole genome sequencing performed locally. The possibility of animal contacts as a source is often not pursued, consequently epidemiological information regarding this is scarce. Nevertheless, the low number of MRSA CC398 in humans in Sweden may indicate that MRSA is not widespread among animals in Sweden, as a high occurrence would lead to transmission to humans in contact with animals.

MRSA with *mecC*

Isolates of MRSA with *mecC* were first reported internationally from dairy cows and humans in 2011 (García-Álvarez et al., 2011; Shore et al., 2011; Ito et al., 2012). Throughout the years, MRSA with *mecC* have been isolated from several animal species (cat, cow, dog, hedgehog, goat, pig and sheep). From cats, in 2024 half of the MRSA isolates were MRSA with *mecC*. The total number of cases are low even if there are a number of isolates from hedgehogs in research projects and from goats in an outbreak at a zoo.

In humans, cases of MRSA acquired in Sweden with *mecC* are also uncommon. In 2024, there was one reported case with *spa*-type t843 (n=1). The epidemiological information concerning possible animal contacts is scarce but some of the *spa*-types in cases from humans have also been found in cases from animals. However, even if there would be zoonotic transfer, it is not currently considered a public health problem, as the number of cases of MRSA with *mecC* in humans in Sweden is low.

MRSA-types typically associated with humans

MRSA isolated from dogs and cats often belong to *spa*-types seen in MRSA from humans. This supports the view that humans often are the source of MRSA in companion animals (EFSA, 2009; CVMP, 2009). Spread can subsequently occur from animals to humans. However, the impact of companion animals as vectors for spread between humans is not known.

Conclusions

The MRSA situation in Sweden is in general still favourable both in humans and in animals. Biosecurity, with caution in trade of live animals and measures to prevent introduction by indirect routes, is important for preventing introduction and spread of MRSA in animal populations. Furthermore, antibiotic stewardship as well as hygiene and infection prevention and control measures are important to prevent health care related spread between people, between animals or between people and animals.

For more information on MRSA in Sweden, see Antibiotic resistance in humans and Antibiotic resistance in animals.

MRSP

Staphylococcus pseudintermedius may act as an opportunistic pathogen in humans and there are several reports in the literature of infections in humans with a varying degree of severity. However, MRSP is not generally considered to be a zoonotic pathogen.

VRE

Using selective media, VRE have historically been isolated from a large proportion of broilers in Sweden. This occurrence has however decreased considerably. The occurrence in humans varies between years, mainly due to nosocomial outbreaks of causing high occurrence in some years. However, based on genotypical investigations of isolates, there are no indications that the presence of VRE in broilers in Sweden has affected the situation in Swedish health care.

Salmonella

Occurrence of *Salmonella* among farm animals, as well as among other animals, is low in Sweden and few incidents involve multiresistant strains. In 2024, the majority of the isolates (84 of 101; 83%) were susceptible to all antibiotics tested. Resistance to fluoroquinolones (e.g. ciprofloxacin) is rare and in 2019, a strain with ESBL was detected for the first time, in an environmental sample from a farm. Thus, the overall situation in the veterinary sector is favourable, largely due to the strategies in the Swedish salmonella control programme initiated in the 1950s.

In 2024, more than half, 55%, of the notifiable cases of *Salmonella enterica* were reported as domestic cases and 43% originated from abroad. The origin of the isolates used in generating AST results from Svebar are not known. Considering the low occurrence of *Salmonella* in food-producing animals in Sweden, the majority of food-related infections presumably have a foreign source. The high occurrence of resistance to fluoroquinolones in isolates from humans (24%) in comparison to the very rare occurrence of such resistance in isolates from Swedish food-producing animals also suggests that most of these isolates from human infections do not have a domestic origin.

Campylobacter

Resistance to fluoroquinolones, tetracycline and erythromycin among faecal isolates of *Campylobacter jejuni* from humans was 47%, 29% and 2.2% respectively. From animals, 175 isolates of *C. jejuni* and 5 of *C. coli* from healthy broilers were tested. The resistance found in *C. jejuni* from broilers was against fluoroquinolones (15%), tetracycline (1%) and ertapenem (1%).

Resistance to erythromycin, the drug of choice for treatment of human campylobacteriosis, is rare among isolates from humans as well as animals in Sweden. In animals, macrolide resistance has only been found in four isolates, two from Swedish broiler meat (Svarm, 2013) and from pigs in one isolate each in 2017 and 2023. The isolates have been genome sequenced and no transferable macrolide reistance gene has been found.

Clinical resistance in *Escherichia coli* from humans and animals

Comparison of resistance in bacteria from humans and different animal categories may indicate the magnitude of possible transfer of resistance between sectors and give insight into the drivers for resistance in the specific populations. However, in Swedres-Svarm, direct comparison of resistance is hampered because different interpretative criteria are used for bacteria from humans and animals. Data for bacteria from humans are interpreted with clinical breakpoints and presented as the proportion of isolates with clinical resistance. In contrast, data for bacteria from animals are mainly interpreted with epidemiological cut-off values (ECOFF) and presented as the proportion of isolates of non-wild type. For further information on interpretive criteria, see sections Guidance for readers and Materials and methods.

For the purpose of the comparison in this section, some data sets for *E. coli* from animals presented in Swedres-Svarm have been interpretated using clinical breakpoints for humans (Table 5.3).

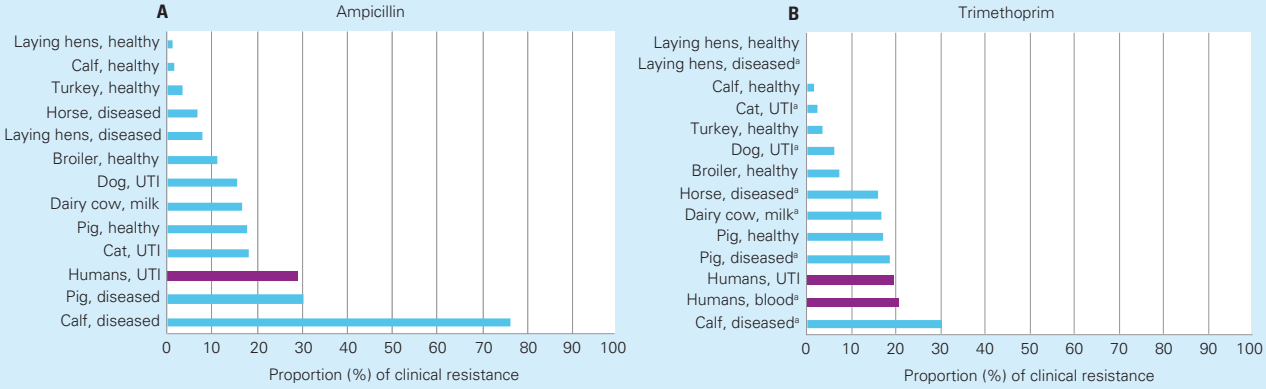
Resistance was generally more common in *E. coli* from humans than in isolates from animals (Table 5.3). Notably, clinical resistance to fluoroquinolones or 3rd generation cephalosporins was considerably more common in *E. coli* from humans than in isolates from animals with the highest occurrence in blood stream isolates from humans (Table 5.3). This is in line with the very low use of these antibiotic classes in animals (see Sales of antibiotics for animals). However, although few isolates of *E. coli* from animals show clinical resistance to fluoroquinolones, reduced susceptibility (i.e. non wild-type) is more common in some categories of diseased and healthy animals (see Antibiotic resistance in animals in this and previous reports). Possibly, the selection pressure from use of fluoroquinolones in animal populations is not sufficient to select for further mutations to clinical resistance in isolates with reduced susceptibility.

For the antibiotics commonly used in both animals and humans, e.g. ampicillin and trimethoprim, resistance is more frequent. In particular, the occurrence of resistance is high among clinical isolates from calves, pigs and humans (Table 5.3, Figure 5.1). When comparing resistance to trimethoprim, it should be considered that for some categories (i.e. clinical isolates from animals and blood isolates from humans), trimethoprim-sulphamethoxazole was tested. This could possibly result in a lower occurrence of resistance than if susceptibility to only trimethoprim had been tested. The comparatively high level of trimethoprim resistance in *E. coli* from the genital tract of mares most likely reflects the relatively common use of trimethoprim-sulphamethoxazole combinations in horses.

Occurrence of resistance to ampicillin or trimethoprim could also be due to co-selection by use of other antibiotics or to other factors selecting for resistance. For example, although exact data are missing, use of ampicillin or amoxicillin in cattle is believed to be low in Sweden. Nevertheless, resistance to ampicillin is common in both isolates from diseased calves and dairy cows. However, it is well known that multiresistant *E. coli* is common in pre-weaned dairy calves but that resistant strains are cleared as calves mature.

Moreover, the high occurrence of resistance to ampicillin or trimethoprim may be influenced in somce categories by a low number of isolates and possible sampling bias, where animals are sampled due to therapeutic failures, inferring a selection of problematic cases.

Figure 5.1. A and B. Proportion of resistance (%) to ampicillin and trimethoprim in *Escherichia coli* from humans and animals interpreted with clinical breakpoints. For details see Table 5.3.



[a]Trimethoprim-sulphamethoxazole tested, BP >4 mg/L, NordicAST v. 14.0.

Table 5.3. Resistance (%) in *Escherichia coli* from various sample types from humans and different animal categories interpreted with clinical breakpoints (in brackets, mg/L) according to NordicAST v. 14.0 if not indicated by footnotes that other interpretive criteria were used.

Category	Sample type	Year	Number of isolates	Amp (>8)	Cip (>0.5)	Ctx (>2)	Gen (>2)	Mer (>8)	Nit (>64)	Tmp (>4)
Cat (UTI)	Urinary	2024	376	18.1	0.3[a]	0.3	0.3	0	0.3	2.4[b]
Dog (UTI)	Urinary	2024	783	15.4	0.1[a]	0.1	1.3	0	0.1	6.3[b]
Horse (e.g., endometritis)	Genital tract	2024	218	6.9	0[a]	0	5.1	0		16.1[b]
Calf (enteritis)	Faeces/Post-mortem	2021-22	46	76.1	0[a]	0	0	0		30.4[b]
Dairy cow (mastitis)	Milk	2024	36	16.7	0[a]	0	0	0		16.7[b]
Laying hens	Post-mortem	2022-24	114	7.9	0.9[a]	0	1.8	0		0[b]
Pig (enteritis)	Faeces/Post-mortem	2024	69	30.4	0[a]	0	0	0		18.8[b]
Broiler (healthy)	Intestinal content	2024	173	11.0	0.6	0	1.2	0		7.5
Cattle under 1 year (healthy)	Intestinal content	2020-21	56	1.7	0	0	0	0		1.8
Laying hens (healthy)	Intestinal content	2022-23	86	1.2	0	0	2.3	0		0
Pig (healthy)	Intestinal content	2023	174	17.8	0	0	0	0		17.2
Turkey (healthy)	Intestinal content	2022	29	3.4	0	0	3.4	0		3.4
Humans (UTI)	Urinary	2024	223 902	28.8	11.4	4.7[c]			1.2	19.6
Humans (bloodstream infections)	Blood	2024	10 503		15.6	9.2	6.9	0		20.6[b]

[a]Enrofloxacin tested, BP >1mg/L; [b]Trimethoprim-sulphamethoxazole tested, BP >4 mg/L, NordicAST v. 14.0; [c]Data from only five laboratories.

Background data, material, methods and references

Demographics and denominator data

Humans

Table 6.1. Denominator data (population in Sweden per region and age group) for calculation of antibiotic sales in humans, 2024. Data from the eHealth Agency.

	<1 years	1-4 years	5-19 years	20-44 years	45-64 years	65-84 years	≥85 years	All age groups	0-6 years
Blekinge	1 309	6 151	27 282	44 593	39 673	33 402	5 563	157 973	10 800
Dalarna	2 450	11 607	49 412	79 679	70 007	64 510	9 588	287 253	20 549
Gotland	463	2 126	9 888	16 529	15 415	14 548	2 060	61 029	3 845
Gävleborg	2 299	11 191	48 675	80 163	71 783	62 436	9 095	285 642	19 831
Halland	3 097	15 161	63 314	97 952	86 045	67 665	10 512	343 746	26 306
Jämtland	1 160	5 289	22 922	38 842	32 321	28 099	3 939	132 572	9 507
Jönköping	3 606	16 654	67 771	113 349	88 677	67 784	11 015	368 856	29 070
Kalmar	2 111	9 914	41 447	67 913	61 120	55 560	8 602	246 667	17 413
Kronoberg	1 976	9 240	37 079	62 807	48 284	37 938	6 362	203 686	15 981
Norrbotten	2 045	9 622	39 177	73 624	61 616	54 306	8 090	248 480	16 576
Skåne	14 041	63 161	256 207	460 337	345 268	245 502	37 265	1 421 781	110 633
Stockholm	25 802	111 301	438 552	860 318	610 424	358 366	50 058	2 454 821	193 937
Södermanland	2 568	12 894	55 748	86 124	74 370	61 324	8 916	301 944	22 851
Uppsala	3 865	17 539	71 481	143 394	91 715	67 269	9 326	404 589	30 805
Värmland	2 288	11 072	47 077	82 245	70 305	60 736	9 825	283 548	19 611
Västerbotten	2 395	11 741	46 801	93 688	63 772	52 717	7 615	278 729	20 322
Västernorrland	1 961	9 413	41 430	67 069	61 299	53 112	7 864	242 148	16 635
Västmanland	2 582	12 230	50 026	85 372	68 631	53 529	8 443	280 813	21 486
Västra Götaland	17 477	77 541	307 128	583 506	427 122	307 837	46 405	1 767 016	135 079
Örebro	2 837	13 177	54 301	96 541	73 670	59 221	8 369	308 116	23 052
Östergötland	4 324	19 993	82 868	151 903	113 231	86 582	13 397	472 298	34 789
Sweden	**100 656**	**457 017**	**1 858 586**	**3 385 948**	**2 574 748**	**1 892 443**	**282 309**	**10 551 707**	**799 078**

Table 6.2. Denominator data (population in Sweden) for calculation of antibiotic sales in humans, 2000-2024. Data from the eHealth Agency.

Year	Population	Year	Population
2000	8 861 426	2013	9 555 893
2001	8 882 792	2014	9 644 864
2002	8 909 128	2015	9 747 355
2003	8 940 788	2016	9 851 017
2004	8 975 670	2017	9 995 153
2005	9 011 392	2018	10 120 242
2006	9 047 752	2019	10 230 185
2007	9 113 257	2020	10 327 589
2008	9 182 927	2021	10 379 295
2009	9 256 347	2022	10 452 326
2010	9 340 682	2023	10 521 556
2011	9 415 570	2024	10 551 707
2012	9 482 855		

Animals

Official statistics on agriculture in Sweden is provided by the Board of Agriculture. The Board of Agriculture maintains a statistical database accessible online (www.jordbruksverket.se). Annual figures on the number of animals are given in Table 6.3, on animals slaughtered in Table 6.4 and 6.5 and average herd size in Table 6.6. Readers are referred to the Board of Agriculture for further information.

In brief, the number of dairy cows and pigs has decreased notably over the last three decades but herd size has increased. During the same period, the number of beef cows has increased, as well as the number of chickens slaughtered.

Estimates of the number of dogs and cats are available from the Board of Agriculture for 2006 and 2012, and in a study by the company Novus in 2017. In 2012 the numbers of dogs and cats in Sweden were estimated to 784 000 and 1 159 000, respectively. The corresponding figures for 2017 were 881 000 and 1 443 000.

Table 6.3. Number of livestock and horses (in thousands) 1980-2024. From the statistical database of the Board of Agriculture.

Animal Species	1980[a]	1985[a]	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023	2024
Cattle													
Dairy cows	656	646	576	482	428	393	348	338	303	302	297	296	289
Beef cows	71	59	75	157	167	177	197	184	207	210	213	210	200
Other cattle >1 year	614	570	544	596	589	527	513	487	480	476	482	480	477
Calves <1 year	595	563	524	542	500	509	479	466	462	465	458	459	444
Total, cattle	1 935	1 837	1 718	1 777	1 684	1 605	1 537	1 475	1 453	1 453	1 449	1 444	1 410
Sheep													
Ewes and rams	161	173	162	195	198	222	273	289	263	272	264	264	241
Lambs	231	252	244	266	234	249	292	306	238	252	245	222	214
Total, sheep	392	425	406	462	432	471	565	595	501	523	510	486	455
Pigs													
Boars and sows	290	260	230	245	206	188	156	142	131	129	127	113	118
Fattening pigs >20 kg	1 254	1 127	1 025	1 300	1 146	1 085	937	830	869	845	895	852	861
Piglets <20 kg	1 170	1 113	1 009	769	566	539	427	384	368	376	371	339	359
Total, pigs	2 714	2 500	2 264	2 313	1 918	1 811	1 520	1 356	1 368	1 351	1 393	1 304	1 338
Hens for egg production													
Laying hens	5 937	6 548	6 392	6 100	5 670	5 065	6 061	7 571	8 403	6 363	7 919	7 717	8 044
Chickens reared for laying	2 636	2 159	2 176	1 812	1 654	1 697	1 647	1 842	2 420	2 390	1 722	2 700	2 557
Total, hens for egg-production	8 573	8 708	8 568	7 912	7 324	6 762	7 707	9 413	10 823	8 753	9 641	10 417	10 601
Horses													
Total, horses						283[a]	363	356[b]					

[a]Data from 2004; [b]Data for 2016

Table 6.4. Number of animals slaughtered (in thousands) at slaughterhouses, 1980-2024. From the statistical database of the Board of Agriculture.

Animal Species	1980	1985	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023	2024
Cattle													
Cattle > 1 year	574	584	523	502	490	433	425	406	420	400	401	410	415
Calves < 1 year	130	152	70	30	39	33	27	22	13	11	11	11	10
Total, cattle	704	736	593	532	529	466	453	428	434	412	412	421	425
Sheep	302	328	280	189	202	206	255	256	240	227	227	229	201
Pigs	4 153	4 283	3 653	3 743	3 251	3 160	2 936	2 560	2 623	2 651	2 672	2571	2579
Broilers	40 466	36 410	38 577	61 313	68 617	73 458	78 507	95 974	110 335	115 629	112 852	109 380	111 467
Turkeys							495	475	521	528	533	526	477

Table 6.5. Quantity of livestock slaughtered (in 1000 tonnes) at slaughterhouses, 1995-2024. From the statistical database of the Board of Agriculture.

Animal Species	1995	2000	2005	2010	2015	2020	2021	2022	2023	2024
Cattle	142	150	136	138	133	141	136	135	421	140
Cattle > 1 year	140	145	131	134	130	138	134	133	136	138
Calves < 1 year	3	4	5	4	4	2	2	2	2	2
Sheep	4	4	4	5	4	5	5	5	5	4
Pigs	309	277	275	264	233	247	253	254	243	246
Broilers	74	90	96	112	138	167	180	172	172	181
Turkeys				3	4	5	5	5	5	4

Table 6.6. Average number of animals per holding 1995-2024. From the statistical database of the Board of Agriculture.

Animal Species	1995	2000	2005	2010	2015	2020	2021	2022	2023	2024
Cattle										
Dairy cows	27	34	46	62	82	98	102	106	110	113
Beef cows	9	12	14	16	18	21	21	22	21	21
Ewes and rams	20	25	29	32	32	33	32	32	32	31
Boars and sows	31	63	156	156	186	185	173	175	156	154
Fattening pigs	157	294	471	664	845	945	942	951	990	968

Materials and methods, sales of antibiotics

Legal framework and distribution of drugs

Marketing of drugs in Sweden is regulated by the Medicinal Products Act, which applies both to human and veterinary medicinal products. According to this Act, a medicinal product may not be sold unless it has been granted marketing authorisation by the Medical Products Agency (MPA). In case there are no authorised medicinal products for a certain condition, the MPA can permit sales on special license for a pharmacy to sell a product that is otherwise not authorised in Sweden. There are several different license types based on whether it is for an individual, an animal or a whole clinic. The medical product can be prescribed and obtained from any pharmacy or ordered to clinics using requisitions.

Medicinal and veterinary medicinal products in which an antibiotic is the active substance are only dispensed through pharmacies, which are supplied by drug wholesalers or manufacturers. In outpatient care, antibiotic drugs (including veterinary medicinal premixes for production of mecicated feed) may only be sold on prescriptions, automated dose dispensing (individually packed doses of drugs often dispensed to the elderly) or requisitions. Prescribers (veterinarians or medical doctors) are not permitted to own a pharmacy or to otherwise sell medicinal products for profit. In hospital care, both for humans and animals, antibiotics are usually bought on requisition from pharmacies, although some regions manage drug supplies to human hospitals independently. Veterinarians may deliver products to the animal caretaker in relation to the examination of a case for self-cost (no profit) and such products are also bought on requisition.

All pharmacies in Sweden are required to provide statistics on sales of all products on a regular basis to the Swedish eHealth Agency (eHälsomyndigheten). This agency maintains a national database with sales statistics for all drugs and provides statistics to the competent national and regional authorities and, on a commercial basis, to others. These data are protected by the Public Access to Information and Secrecy Ordinance and publication of data needs to be carefully reviewed to avoid risk of disclosure of sensitive information. For this publication, measures for protection of information have been taken and for sales of antibiotics for humans, consent has been obtained from the legal entities concerned.

The ATC classification system and defined daily doses (DDD)

Since 1988, the Anatomical Therapeutic Chemical (ATC) and ATCvet classification systems recommended by the WHO are used in Sweden for national drug statistics. For drugs sold for use in humans, to facilitate drug utilisation studies from a medical point of view, the measure defined daily dose (DDD) is used as a unit of comparison in drug statistics. The DDD for a drug is established on the basis of the assumed average dose per day for the drug given to adults for its main indication. If possible, the DDD is given as the amount of active substance. The DDDs are usually equal for all dosage forms of a preparation. The statistical data systems of the Swedish eHealth Agency are upgraded annually according to the recommendations made by the WHO Collaborating Centre for Drug Statistics Methodology in Oslo, Norway. Sales figures are presented as number of DDDs per 1 000 inhabitants per day, which gives an estimate of the proportion of the population daily exposed to a particular drug. This number is a rough estimate and should be interpreted with caution.

All data on the number of DDDs in this report are displayed in the 2025 version of the ATC/DDD index, available at https://www.whocc.no/atc_ddd_index/.

Antibiotic sales in humans

Sales statistics on medications have been monitored and compiled since 1975, initially by the National Corporation of Swedish Pharmacies. The sales are registered as number of DDDs, cash value and number of packages. Outpatient care data include information on the sales of prescribed drugs from all Swedish pharmacies by the prescription survey, running since 1974. The statistical material was until 1995 based on samples of dispensed prescriptions. From 1996, all prescriptions dispensed by pharmacies are included. From 1999, individually packed doses of drugs dispensed e.g. to the elderly are also included in the survey. Recorded data are trade name, quantity, patient fee, total cost, sex and year of birth of the patient. Data can be expressed as DDD per 1 000 inhabitants per day or number of prescriptions per 1 000 inhabitants per year. Inpatient care data include drugs delivered by all hospital pharmacies to the hospital departments (see the section "Completeness of data" below). The sales are expressed as cash value, number of packages and number of defined daily doses.

Following the de-monopolisation of the pharmacy market in Sweden in July 2009, the responsibility for collection of drug statistics was transferred to the core infrastructure supplier for all pharmacies, Apotekens Service. In January 2014, the activities in the state-owned company Apotekens Service were transferred to the Swedish eHealth Agency. The Swedish eHealth Agency aims to contribute to improved health care, improved public health and better caring by pursuing development of a national e-health infrastructure. The agency is also responsible for Sweden's national drug statistics.

Completeness of data reported to the Swedish eHealth Agency

In Sweden, pharmacies are required by law to report sales statistics to the Swedish eHealth Agency. Concerns have been raised that after the re-regulation of the pharmacy market, the statistics on sales of medical products to hospitals in Sweden is less complete than before. After the re-regulation, regions can choose to manage drug supplies to hospitals independently. If so, the regions are not required to report data to the national database. However, to the best of our knowledge, all regions are currently reporting data to the Swedish eHealth Agency.

Data sources and inclusion criteria

Data on sales of antibiotics in outpatient and inpatient care as well as population data were obtained from the Swedish eHealth Agency during the period of Febuary to March of 2025. For the overall statistics, the data include all antibacterial products marketed in Sweden in the ATC class J01. The data on sales of antibiotics for humans include all sales, even if the antibacterial (J01) is prescribed by a veterinarian. Throughout this report, methenamine is excluded in all displays of J01 as a group. Measures used are defined daily dose per 1 000 inhabitants per day (DDD/1 000 inhabitants per day) and prescriptions per 1 000 inhabitants per year. Every purchase of a drug prescribed in outpatient care is also recorded in the Prescribed Drug Register, maintained by the Swedish National Board of Health and Welfare. This register provides the opportunity to link each prescription to an individual, which makes it possible to study the actual number of individuals or the fraction of the population treated with a specific drug. Thus, some of the data are presented as treated inhabitants per 1 000 total inhabitants per year. Data on the age-adjusted average body weight of the population in Sweden were obtained from Statistics Sweden, the agency responsible for official statistics in Sweden. Antibiotic sales to inpatient care are measured in DDD per 1 000 inhabitants per day. The number of DDDs is obtained from the Swedish eHealth Agency.

For antibiotics sold in Sweden on a special license, information regarding strength and package size may be incomplete, preventing proper DDD calculation. Therefore, when data is obtained from the Swedish eHealth Agency in DDD, these products sold on special license are not properly included and usage of certain antibiotics could be underestimated. For most antibiotic classes, this difference is negligible. However, for some antibiotic substances, such as several cephalosporins, this underestimation has a notable effect on data represented in DDD.

Trend analysis

In the report, some general regression models were executed in the section "Sales of antibiotics". Time was used as explanatory variable and the outcome was the sales of antibiotics, adjusted for population size in Sweden, data on population provided by the eHealth Agency. The analyses were executed on a basis of a negative binomial distribution.

The Swedish Prescribed Drug Register

Since July 2005 the National Board of Health and Welfare supplies an individual based register on all drugs prescribed and dispensed in outpatient care. The register includes information on the number of individuals treated with at least one course of antibiotics during a specific period of time, i.e. number of treated inhabitants per 1 000 total inhabitants per year (Inhabitants/1 000/year). It is also possible to follow the number of purchases per person.

Definitions of DDD 2024

Table 6.7. DDD for all antibiotic substances (J01) registered in Sweden in 2024.

	DDD (g)		DDD (g)
J01AA02- doxycycline	0.1	J01EA01- trimethoprim	0.4
J01AA04- lymecycline	0.6	J01EC02- sulfadiazine	0.6
J01AA07- tetracycline	1	J01EE01-sulfamethoxazole and trimethoprim	1.92
J01AA08- minocycline	0.2	J01FA01- erythromycin	1
J01AA12- tigecycline	0.1	J01FA01- erythromycin erythylsuccinate tablets	2
J01AA15- omadacycline	0.3	J01FA06- roxithromycin	0.3
J01CA01- ampicillin- parenteral	6	J01FA09- clarithromycin- oral	0.5
J01CA01- ampicillin- oral	2	J01FA10- azithromycin- parenteral	0.5
J01CA04- amoxicillin	1.5	J01FA10- azithromycin- oral	0.3
J01CA08- pivmecillinam	0.6	J01FF01- clindamycin- parenteral	1.8
J01CA12- piperacillin	14	J01FF01- clindamycin- oral	1.2
J01CE01- benzylpenicillin	3.6	J01FG01- pristinamycin	2
J01CE02- phenoximethylpenicillin (penicillin V)	2	J01GB01- tobramycin- parenteral	0.24
J01CE08- benzathine benzylpenicillin	3.6	J01GB01- tobramycin- oral inhalation solution	0.3
J01CF02- cloxacillin	2	J01GB01- tobramycin- oral inhalation powder	0.112
J01CF05- flucloxacillin	2	J01GB03- gentamicin	0.24
J01CR02- amoxicillin and enzyme inhibitor	1.5	J01GB06- amikacin	1
J01CR05- piperacillin and enzyme inhibitor	14	J01MA01- ofloxacin	0.4
J01DB03- cefalexin	4	J01MA02- ciprofloxacin- parenteral	0.8
J01DB04- cefazolin	3	J01MA02- ciprofloxacin- oral	1
J01DB05- cefadroxil	2	J01MA06- norfloxacin	0.8
J01DC01- cefoxitin	6	J01MA12- levofloxacin- oral/parenteral	0.5
J01DC02- cefuroxime- parenteral	3	J01MA12- levofloxacin- inhalation	0.24
J01DC02- cefuroxime- oral	0.5	J01MA14- moxifloxacin	0.4
J01DD01- cefotaxime	4	J01XA01- vancomycin	2
J01DD02- ceftazidime	4	J01XA02- teicoplanin	0.4
J01DD04- ceftriaxone	2	J01XA04- dalbavancin	1.5
J01DD08- cefixime	0.4	J01XB01- colistin- parenteral	9 MU
J01DD14- ceftibuten	0.4	J01XB01- colistin- Inhalation	3 MU
J01DD52- ceftazidime and enzyme inhibitor	6	J01XB02- polymyxin B	0.15
J01DF01- aztreonam- parenteral	4	J01XC01- fusidic acid	1.5
J01DF01- aztreonam- inhalation	0.225	J01XD01- metronidazole	1.5
J01DH02- meropenem	3	J01XE01- nitrofurantoin	0.2
J01DH03- ertapenem	1	J01XX01- fosfomycin- parenteral	8
J01DH51- imipenem and enzyme inhibitor	2	J01XX01- fosfomycin- oral	3
J01DH52- meropenem and enzyme inhibitor	3	J01XX04- spectinomycin	3
J01DH56- imipenem and enzyme inhibitor	2	J01XX05- methenamine- hippurate	2
J01DI01- ceftobiprole medocaril	1.5	J01XX05- methenamine- mandelate	3
J01DI02- ceftaroline fosamil	1.2	J01XX08- linezolid	1.2
J01DI04- cefiderocol	6	J01XX09- daptomycin	0.28
J01DI54- ceftolozane and enzyme inhibitor	3	J01XX11- tedizolid	0.2

Sales of antibiotics for animals

Data sources, inclusion criteria and analysis

For the overall statistics, the data include all products with antibiotics as active substance marketed in Sweden and sold for use in terrestrial animals in the ATCvet classes QA07, QJ01, QG01A and QJ51. Products that are authorised in other countries and sold on special license are also included. Medicinal products authorised for human use but prescribed for use in animals are not included in the overall statistics.

Data are retrieved as the number of packages sold per product-presentation. Calculation to kg active substance is done based on information on strength and package size obtained from the national product register of the MPA, or for products sold on special license from other sources, e.g. the Union Product Database and pharmacies.

Updates and uncertainties

Antibiotic products sold with special licence (products prescribed and sold on exemption from Swedish market authorisation) are included in the dataset. However, in 2011 it was noticed that the information on sales of products with special licence was less complete than in previous years. Figures for 2011 are therefore likely to be a slight underestimate. Between 2012 and 2014, efforts were made to obtain sales data for major products on license from pharmaceutical companies to adjust the data on pharmacy sales. The reporting system was adjusted, and it is assumed that from 2015 data from the eHealth Agency on sales of products with special licence is no less complete than for products with general marketing authorisation.

Following a re-regulation of the Swedish pharmacy market in 2010, there were indications of a lack of completeness regarding data on pharmacy sales. This mainly affected injectable products sold in requisition. As from 2015, completeness seemed to be as high as before the re-regulation.

Investigations into indications of lack of completeness of data for 2022 revealed a significant lack of completeness for in particular 2020-2021. The causes for this latter lack of completeness were identified and data corrected, leading to historical updates in Swedres-Svarm 2022.

Materials and methods, resistance in bacteria from animals

Isolation and identification of bacteria

Antibiotic resistance as notifiable diseases

ESBL

$ESBL_A$, $ESBL_M$ and $ESBL_{CARBA}$-producing *Escherichia coli* were isolated by culture on MacConkey agar (Oxoid) with cefotaxime (1 mg/L) (MacC ctx), and MacConkey agar (Oxoid) with meropenem (0.12 mg/L) (MacC mp) with prior enrichment in buffered peptone water (BPW).

Intestinal samples: Briefly, 1 g of intestinal content was diluted in 9 ml BPW and incubated at 37°C overnight. From the BPW solution 10 µl was spread each on a plate of MacC ctx and MacC mp. The plates were incubated overnight at 44°C (MacC ctx agar) or 37°C (MacC mp). From MacC ctx up to three lactose positive colonies with morphology typical for *E. coli* were sub-cultured on MacC ctx and then sub-cultured again on horse-blood agar (5% v/v), after which the isolate was tested for production of tryptophanase (indole). One isolate per sample was selected for susceptibility tests and further tested for ESBL production. Isolates suspected to be Enterobacterales species on MacC mp were sub-cultured on MacConkey agar and then sub-cultured again on horse blood agar. These isolates were species-identified by MALDI-TOF MS and if positive for any Enterobacterales species the isolate would be tested for antibiotic susceptibility and ESBL production.

Meat samples: Briefly, 25 g of surface meat was homogenised in 225 ml BPW and incubated at 37°C overnight. From the BPW overnight culture 10 µl per agar plate was spread on MacC ctx and MacC mp and incubated overnight at 44°C (MacC ctx) or 37°C (MacC mp). From MacC ctx up to three lactose positive colonies with morphology typical for *E. coli* were sub-cultured on MacC ctx and then sub-cultured again on horse blood agar (5% v/v), after which the isolate was tested for production of tryptophanase (indole). One isolate per sample was selected for susceptibility tests and further tested for ESBL production. *E. coli* like colonies on MacC mp were sub-cultured on MacConkeyagar, and if they were lactose-positive, they were sub-cultured on horse blood agar. Lactose positive isolates were species-identified by MALDI-TOF MS. Only *E. coli* was selected for susceptibility tests and tests for ESBL production.

Clinical isolates from cats, dogs, and horses were submitted to the Dept. of Animal Health and Antimicrobial Strategies, SVA, as bacterial strains. Isolates were species-identified by MALDI-TOF MS.

MRSA and MRSP

Isolates were species-identified by MALDI-TOF MS and tested for presence of *mecA* and *mecC* with PCR (see below, Genotyping). Isolates were susceptibility-tested using microdilution (see below, Susceptibility testing).

Zoonotic pathogens

Salmonella

Salmonella was isolated and identified at the Dept. of Microbiology, SVA or at regional laboratories in accordance with standard procedures. All samples within official control programmes are cultured according to the procedures detailed by the MSRV (ISO 6579-1:2017). Confirmatory identification and serotyping were performed according to the procedures of White-Kauffmann-Le Minor. For certain isolates, the serovar was verified by whole genome sequencing.

Campylobacter

Campylobacter jejuni and *Campylobacter coli* were isolated and identified at the Dept. of Microbiology, SVA, from caecal content from healthy broilers sampled at slaughter within the Swedish Campylobacter programme. Ten whole caeca were collected from each batch of broilers slaughtered and pooled at analysis. Samples were cultured according to ISO 10272-1:2017 for detection of thermophilic *C. jejuni* and *C. coli* by direct cultivation on mCCDA and Butzler agar followed by incubation at 41,5°C for 44 h in a microaerophilic environment. Identification was based on colony morphology and microscopic appearance including motility. All isolates were species-identified by MALDI-TOF MS. Selection of colonies was randomly distributed between the selective agars. The isolates were stored in -70°C until tested.

In 2024, 284 flocks were positive for *C. jejuni* or *C. coli*, from these 175 *C. jejuni* and 5 *C. coli* were susceptibility-tested.

Clinical isolates from animals

Clinical isolates were isolated and identified with accredited methodology following standard procedures at SVA.

Indicator bacteria

Escherichia coli

After the initial dilution in BPW and incubation (see screening for ESBL above), 10 µL was spread on MacConkey agar and incubated overnight at 44°C.

Up to three lactose positive colonies with morphology typical for *E. coli* were sub-cultured on horse blood agar (5% v/v), after which the isolates were tested for production of tryptophanase (indole). Only lactose and indole positive isolates with typical morphology were selected for susceptibility tests.

Susceptibility testing

Microdilution

At SVA, fast growing aerobic bacteria, *Campylobacter* and bacteria from fish are tested for antibiotic susceptibility with accredited methodology using dilution methods in cation adjusted Mueller-Hinton broth (CAMHB) (Difco). Tests are performed following the standards for microdilution of the Clinical and Laboratory Standards Institute (CLSI, 2024a). The microdilution panels used are produced by Thermo SCIENTIFIC Trek diagnostics systems (Sensititre) and for *Brachyspira* spp. the panels are produced by Merlin, Bruker. Different panels are used depending on the bacterial species tested and the purpose of the investigation (monitoring or clinical diagnostics). Minimum inhibitory concentration (MIC) is recorded as the lowest concentration of an antibiotic that inhibits bacterial growth.

Some adaptations from the CLSI standard are employed. For *Pasteurella* spp. the tests are made by dilution in CAMHB supplemented with 5-10% horse serum followed by incubation in CO_2, 37°C for 16-18 hours. For testing of *A. pleuropneumoniae* dilution in HTM broth was performed followed by incubation in CO_2 at 37°C for 18-24 hours. *Streptococcus* spp. were tested using CAMHB supplemented with 5-10% horse serum followed by incubation at 35°C for 16-18 hours.

Susceptibility of *C. jejuni* and *C. coli* were tested according to the CLSI standard M45 Ed3 for fastidious bacteria (CLSI, 2015).

Susceptibility of *Brachyspira hyodysenteriae* and *B. pilosicoli*, was tested by a broth dilution method described by Karlsson et al. (2003), in tissue culture trays with 48 wells per plate. The wells were filled with 0.5 ml of a suspension of bacteria ($1x10^6$-$5x10^6$ CFU/ml) in brain heart infusion broth (BHI) with 10% foetal calf serum and incubated in an anaerobic atmosphere at 37°C for four days on a shaker.

Bacteria from fish are tested for antibiotic susceptibility by broth microdilution adapted for aquatic bacteria according to CLSI (2020a).

Phenotypic confirmatory tests for production of extended spectrum beta-lactamases (ESBLs) in Enterobacterales were performed with and without clavulanic acid in Sensititre EUVSEC2 microdilution panels and interpreted according to EUCAST.

Genotyping

Suspected index isolates of MRSA and MRSP were confirmed by detection of the *mecA* or *mecC* genes applying real-time PCR as described by Pichon et al. (2012). Isolates of Enterobacterales with AmpC phenotypes were subjected to PCR detecting genes encoding $ESBL_M$ (Perez-Perez & Hanson, 2002) and $ESBL_A$ (Woodford et al., 2006; Fang et al., 2008). Isolates positive in PCR for ESBL-encoding genes, *mecA*, *mecC*, phenotypically confirmed as $ESBL_A$ or suspected of being $ESBL_{CARBA}$ were subjected to genome sequence analysis.

DNA was extracted from overnight cultures on horse blood agar using EZ1 DNA tissue kit (Qiagen, Halden, Germany), according to the recommendations of the manufacturer. DNA was sent to Clinical Genomics Stockholm, Science for Life Laboratory (Solna, Sweden) for library preparation and paired-end sequencing using Illumina technologies. Reads were trimmed with Fastp v0.24.0 (Chen, 2023) and assembled with SKESA v2.4.0 (Souvorov et al., 2018). Assemblies were searched for potential contamination using Kraken2 with the MiniKraken database (Wood et al., 2019).

ESBL-encoding genes and point mutations conferring elevated MIC for third generation cephalosporins were determined using AMRFinder+ v4.0.19 with database version 2024-12-18.1 (Feldgarden et al., 2021) with the species-specific --organism option where applicable, and by using Staramr v0.11.0 (Bharat et al., 2022) with the ResFinder database from December 13th 2024 (Zankari et al., 2012)

and the PointFinder database from August 8th 2024 (Zankari et al., 2017), all with the cutoff values ≥98% identity and ≥95% coverage. *Spa*-typing, a single locus sequence typing method using the polymorphic region X of the *spa* gene encoding Protein A, was performed on MRSA assemblies using SeqSphere+ v10 software (Ridom GmbH, Germany, https://spa.ridom.de). Sequence types (ST) were found in MRSA and MRSP assemblies using MLST (Seemann T, mlst Github https://github.com/tseemann/mlst) or given STs by submitting data to Public databases for molecular typing and microbial genome diversity (www.pubmlst.org) developed by Keith Jolley (Jolley & Maiden, 2010), sited at the University of Oxford and funded by the Wellcome Trust.

Quality assurance system

Laboratories performing antibiotic susceptibility testing at SVA are accredited according to ISO/IEC 17025:2017 by the Swedish Board for Accreditation and Conformity Assessment (SWEDAC) to perform antibiotic susceptibility tests with microdilution methods. The Dept. of Microbiology is accredited for isolation and identification of animal pathogens and of *Salmonella* according to the same standard. The Dept. of Animal Health and Antimicrobial Strategies is accredited for isolation of *E. coli* in the monitoring program, both ESBL and indicator *E. coli*.

For susceptibility tests of zoonotic, pathogenic and indicator bacteria, *Escherichia coli* ATCC 25922, *Enterococcus faecalis* ATCC 29212, *Staphylococcus aureus* CCUG 15915 (analogue to ATCC 29213), *Actinobacillus pleuropneumoniae* ATCC 27090, *Trueperella pyogenes* CCUG 13230, *Acinetobacter baumannii* 2012-70-100-69 - EURL 69 (used for control of higher concentrations of cephalosporins and carbapenems), *Aeromonas salmonicida* subsp. *salmonicida* CCUG 2116 (analogue to ATCC 14174), *Flavobacterium psycrophilum* CCUG 35200 (analogue to ATCC 49418), *Mycoplasma bovis* Donetta PG45^{T} ATCC 25523^{T} and *Campylobacter jejuni* CCUG 11284 (analogue to *Campylobacter jejuni* ATCC 33560) were included as quality controls. When testing animal pathogens relevant control strains were included and evaluated at least once weekly. For testing of *Brachyspira*, the *B. hyodysenteriae* type strain B78T ATCC 27164^{T} was used for quality control.

The Dept. of Animal Health and Antimicrobial Strategies participates yearly in two proficiency tests for antibiotic susceptibility testing, one for isolation and antibiotic susceptibility testing and one comparative test for antibiotic susceptibility testing. These are arranged by the European Union Reference Laboratory - Antimicrobial Resistance and as a national ring trial. We also participate in the DTU genomic proficiency test once a year. Likewise, the Dept. of Microbiology participates in proficiency tests concerning isolation and identification of *Salmonella* and general clinical veterinary bacteriology and susceptibility tests.

Data handling

Records such as source of cultured sample, identification results, antibiotic susceptibility etcetera were registered in a laboratory information management (LIM) system at SVA.

Cut-off values for resistance

For interpretation of MICs from susceptibility testing of zoonotic bacteria (*Salmonella* and *Campylobacter*) and indicator bacteria (*Escherichia coli* and enterococci) epidemiological cut-off values (ECOFFs) issued by EUCAST (www.eucast.org) or values suggested by the European Food Safety Authority are used. For some antibiotics, values based on MIC distributions obtained in Svarm are used.

ECOFFs are used when available also for clinical isolates from animals. When ECOFFs are not available, or the range of concentrations tested precludes use of a recommended value, values based on MIC distributions obtained in Svarm are used, but clinical breakpoints issued by CLSI (CLSI, 2024b) or epidemiological cut-offs (ECVs) issued by CLSI (CLSI, 2020b) are also taken into consideration.

ECOFFs and ECVs classify isolates with acquired reduced susceptibility as non-wild type. In Svarm, non-wild type isolates are called resistant. This classification is relevant for monitoring purposes, but it should be understood that resistance defined in this manner not always implies clinical resistance.

Svarm 2000–2024

The number of isolates of different matrices reported in Svarm since 2000 is available as supplementary material on the SVA web page (www.sva.se/svarm).

Table 6.8. Cut-off values (mg/L) for resistance. Values in red are current EUCAST epidemiological cut-off values (ECOFFs) or tentative ECOFFs, (T)ECOFFs, values in blue are CLSI ECVs, black underlined values deviate from ECOFFs and ECVs, and for values in black, ECOFFs or ECVs are not defined.

Antibiotic	*Actinobacillus pleuropneumoniae*	*Brachyspira hyodysenteriae*	*Campylobacter coli*	*Campylobacter jejuni*	*Escherichia coli* (indicator)	*Escherichia coli* (pathogen)	*Flavobacterium psychrophilum*	*Klebsiella pneumoniae*	*Mannheimia haemolytica*	*Pasteurella multocida*	*Pseudomonas aeruginosa*	*Rhodococcus equi*	*Salmonella enterica*	*Staphylococcus pseudintermedius*	*Staphylococcus felis*	*Staphylococcus aureus*	*Streptococcus suis*	*Streptococcus zooepidemicus*
Amikacin					>8								>4					
Ampicillin	>0.5				>8	>8				>0.5			>4					
Azithromycin					>16								>16					
Cefalexin						>32								>4	>4	>4		>2
Cefepime					>0.12													
Cefotaxime					>0.25	>0.25		>0.25					>0.5					
Cefoxitin																>4		
Ceftazidime					>1								>2					
Ceftiofur										0.12								
Chloramphenicol			>16	>16	>16								>16			>16		
Clarithromycin												>0.5						
Ciprofloxacin			>0.5	>0.5	>0.06								>0.06			>2		
Clindamycin														>0.5	>0.5	>0.5[c]	>0.5	>0.5
Colistin					>2	>2		>2			>4							
Doxycycline	>2	>0.5																
Enrofloxacin	>0.12				>0.12	>0.12		>0.12	>0.12	>0.06	>2			>0.5	>0.5	>0.5		
Ertapenem			>0.5	>0.5	>0.03													
Erythromycin			>8	>4								>1		>0.5	>0.5	>1	>0.5	>0.5
Florfenicol	>1						>2		>2	>1								
Fusidic acid														>0.5	>0.5	>0.5		
Gamithromycin	>4									>4								
Gentamicin			>2	>2	>2	>2		>2			>8		>2	≥1	>1	>2		
Imipenem					>0.5													
Linezolid																>4		
Meropenem					≥0.12	≥0.12							>0.12					
Nalidixic acid					>8								>8					
Neomycin						>8		≥4										
Nitrofurantoin						>64								>32 (UTI)	>32 (UTI)	>32 (UTI)		>32
Oxacillin														>0.25	>1			
Oxolinic acid							>0.25											
Oxytetracycline							>0.12											
Penicillin	>1								>0.5	>0.5				[b]	[b]	[b]	>0.12	>0.03
Rifampicin												>1						
Sulphamethoxazole					>64								>256					
Temocillin					>16													
Tetracycline	>2		>2	>1	>8	>8		>8	>2	>2			>8	>1	>1	>1	≥0.5	
Tiamulin		>0.25																
Tigecycline					>0.5								>0.5					
Trimethoprim					>2								>2			>2		
Trim & sulpha[a]	>0.25					>0.5		>0.5		>0.12				>0.5	>0.5	>0.25	>0.25	>0.5
Tylosin		>16																
Tylvalosin		>1																
Valnemulin		>0.12																

[a]Concentration of trimethoprim given, tested with sulphamethoxazole in concentration ratio 1/20; [b]beta-lactamase production; [c]EUCAST ECOFFs are used for MRSA (clindamycin >0.25).

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SWEDRES|SVARM 2024

This annual report describes the monitoring of antibiotic resistance and antibiotic sales in human and veterinary medicine in Sweden in 2024.

This year will be the last chance to get a printed report as we are planning to present data in a new format online. This will be gradually developed, and aimed at being a useful source of One Health data on both antimicrobial use and resistance. A further ambition for this site will be to use it in international contacts to inform on Swedish work regarding antimicrobial resistance.

The total sales of antibiotics for both humans and animals have decreased continually from a long-term perspective, and prescribers' choices of antibiotics are broadly in line with policies and recommendations.

From an international perspective, the situation in Sweden regarding antibiotic resistance in bacteria from humans and animals is favourable. In spite of this, there are still problems with increasing resistance. Thus, the preventive efforts must continue, and in some instances be intensified. The efforts to optimise antibiotic use, prevent infections and minimise dissemination of antibiotic resistance are now back at pre-pandemic levels. It is increasingly important to address the slow pandemic that antibiotic resistance constitutes.

Focus areas:

- Antibiotic Smart Sweden – A collaborative and innovative approach for engaging the whole society
- Antibiotic use in humans in Sweden without a prescription
- Antibiotic resistance in *Escherichia coli* in Swedish wild boar minced meat
- ESBL- and pAmpC-producing Enterobacterales in dogs and cats 2017–2021
- SvarmPat – monitoring of resistance in pathogens from farm animals

The Public Health Agency of Sweden (PHAS) has a national responsibility for public health issues. The Agency promotes good public health by generating and disseminating knowledge to professionals involved in the field of public health, including infectious disease prevention.

The Swedish Veterinary Agency (SVA) is an expert authority within the field of risk assessment and diagnostics, as well as the prevention and control of infectious animal diseases. The Agency strives for good animal and human health through research, contingency planning and communication of knowledge.