Scottish One Health Antimicrobial Use and Antimicrobial Resistance in 2024

Public Health Scotland

NHS National Services Scotland

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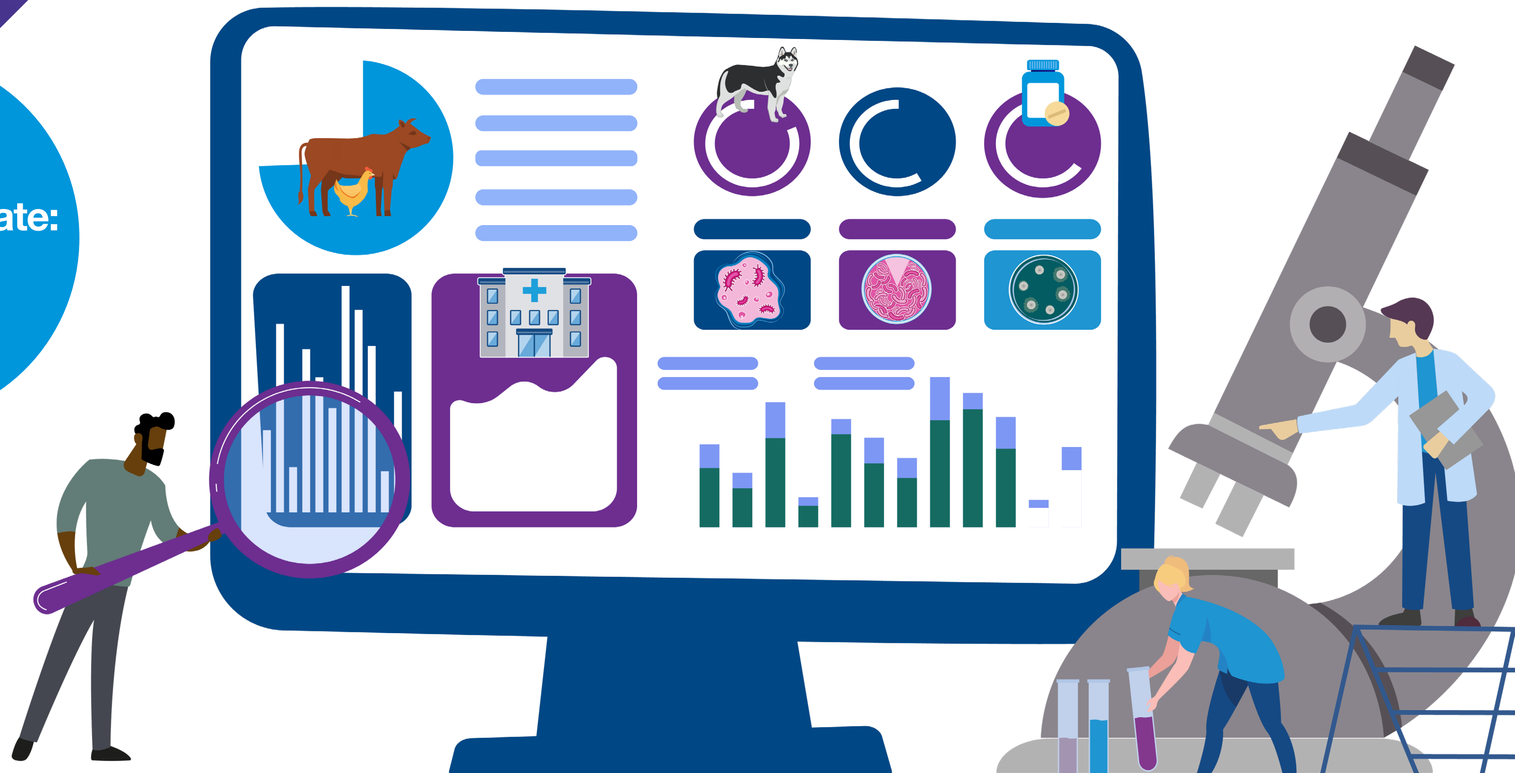

Antimicrobial Resistance and Healthcare Associated Infection (ARHAI) Scotland
An NHS Scotland Assure Service

Public Health Scotland

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Alternative formats

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About the 2024 SONAAR Report

The Scottish One Health Antimicrobial Use and Antimicrobial Resistance (SONAAR) Report continues Scotland's commitment to a collaborative approach in tackling antimicrobial resistance (AMR) and antimicrobial use (AMU). While the report has always benefited from multi agency contributions, 2024 marks the first year it has been jointly produced by Antimicrobial Resistance and Healthcare Associated Infection (ARHAI) Scotland and Public Health Scotland (PHS).

This enhanced partnership, together with contribution from sectors across Scotland, reflects the growing integration of Scotland's One Health strategy, bringing together data, expertise, and insights from human, animal, and environmental health sectors.

NHS National Services Scotland

ARHAI Scotland

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sepa

SRUC

Healthcare Improvement Scotland

Food Standards Scotland

Scotland's One Health approach to antimicrobial resistance and antimicrobial use

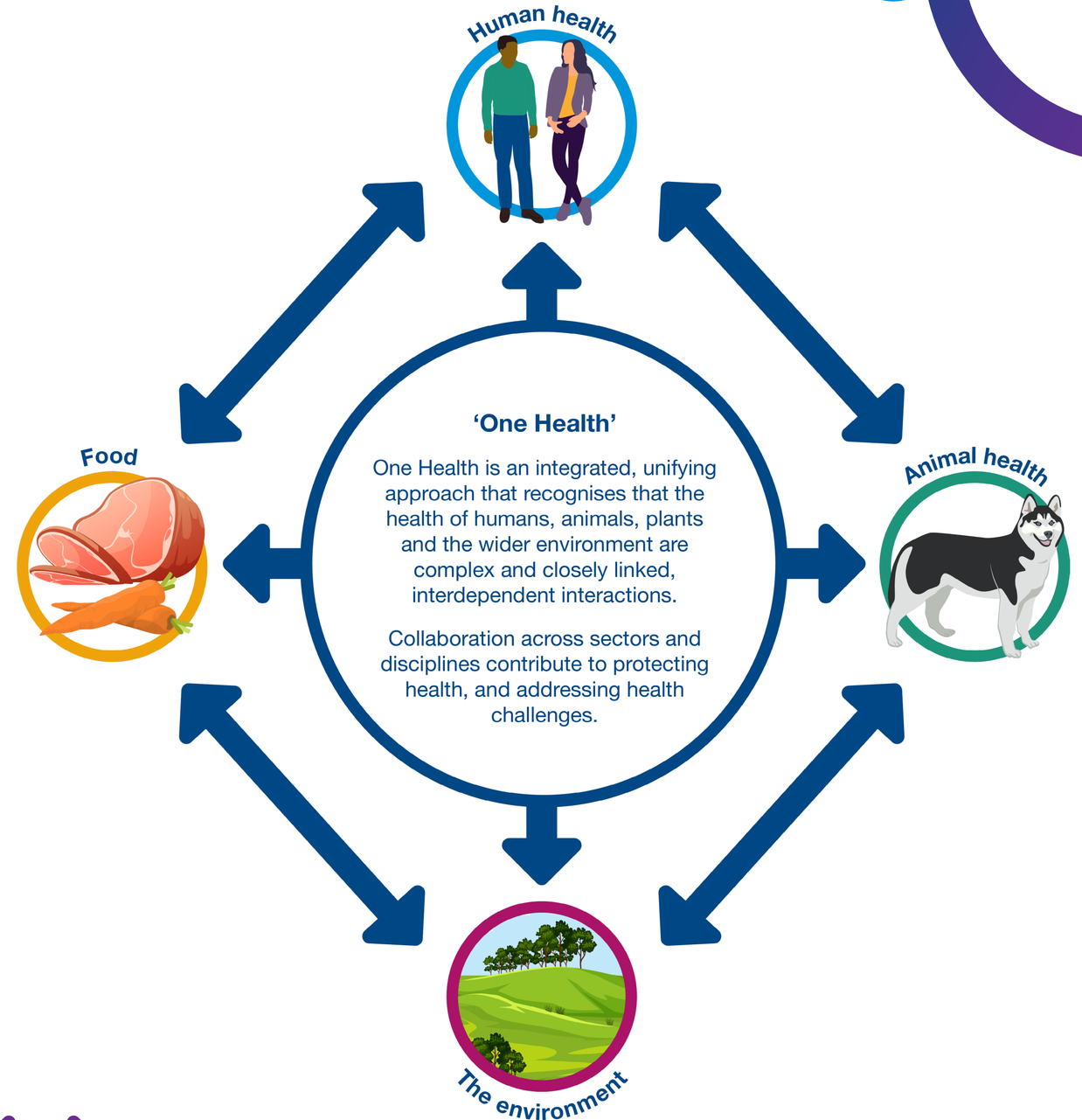
The SONAAR approach is a comprehensive, data driven approach aimed at reducing infections and tackling antimicrobial resistance (AMR) across healthcare, veterinary, and environmental settings. It draws on national and international intelligence to provide evidence for action in areas of policy, stewardship, population health, and the responsible use of antimicrobials.

Understanding AMR

AMR is a well-established global health threat that occurs when microorganisms such as bacteria, fungi, viruses and parasites develop resistance to treatments designed to eliminate them.

Antimicrobials are essential to modern medicine, enabling surgery, chemotherapy, organ transplants, and ensuring food safety and agricultural productivity. Drivers of AMR include overuse and misuse of antimicrobials in human, veterinary, and environmental contexts.

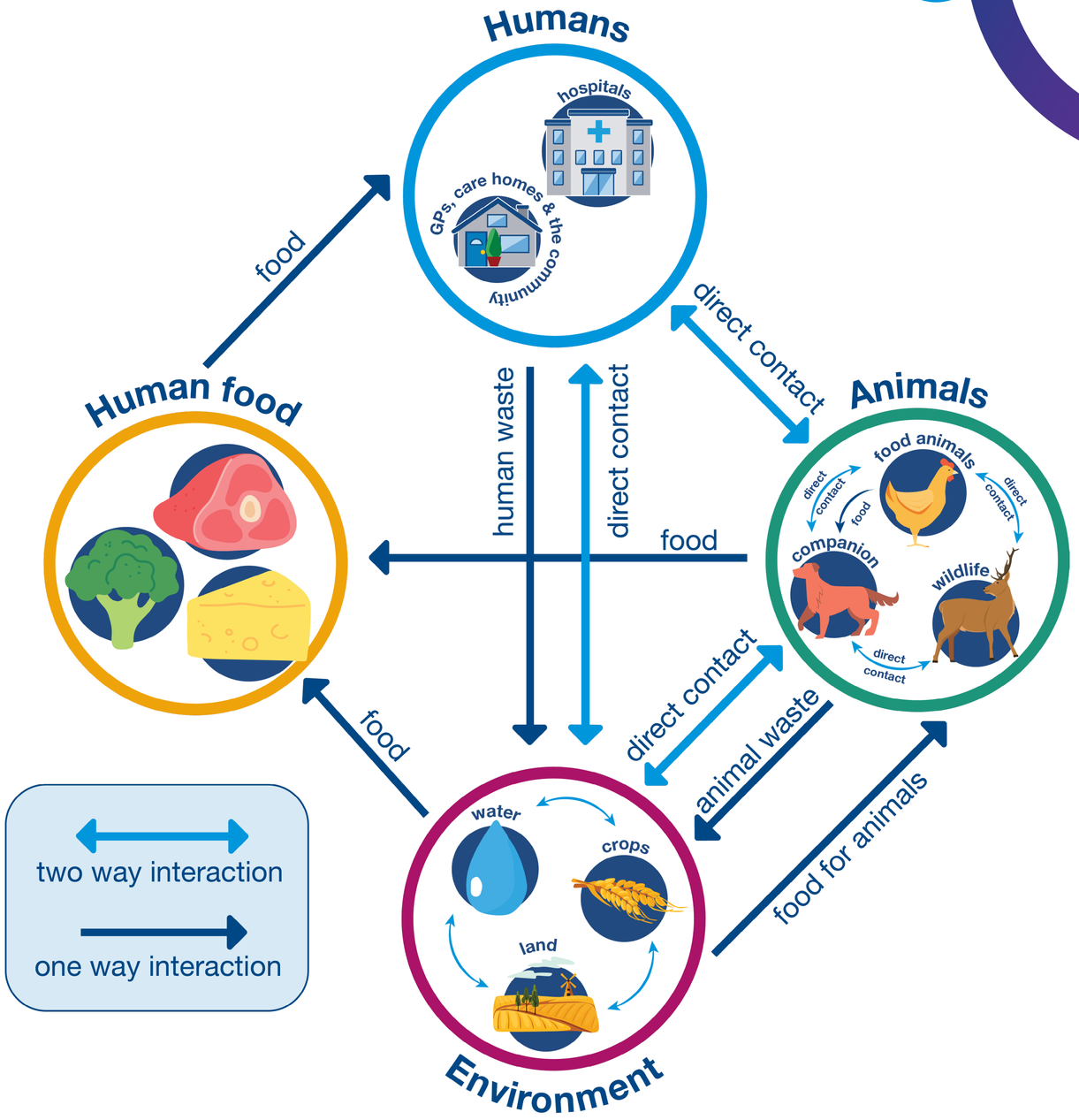
The spread of resistant organisms across humans, animals, food systems, and the environment underscores the need for coordinated, cross-sectoral responses. This is called a 'One Health' approach.



Scotland's One Health objectives

Scotland's One Health approach for AMR and antimicrobial use (AMU) surveillance aims to:

- embed One Health principles into national policy and surveillance frameworks.
- strengthen surveillance infrastructure to ensure consistent, high-quality data collection and collaboration across all relevant sectors.
- translate surveillance insights into evidence-based policies and provide intelligence for targeted interventions.
- promote sustainable antimicrobial stewardship in collaboration with the Scottish Antimicrobial Prescribing Group (SAPG).
- tackle the burden of drug resistant infections through coordinated efforts across human, animal, and environmental health.

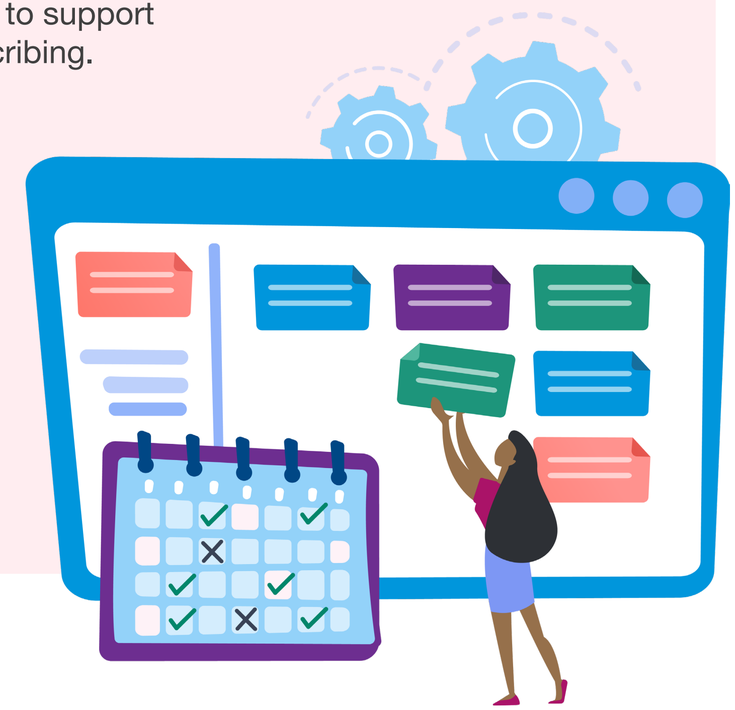


SONAAR priorities in 2024

- Building robust epidemiological evidence to monitor AMU and AMR trends and support interventions.
  - Real-time monitoring of antimicrobial use for respiratory infections, in collaboration with SAPG.
  - Provision of data and intelligence on antimicrobial prescribing directly to GP practices, enabling improved antimicrobial stewardship.
  - Surveillance of unusual AMR phenotypes in clinical isolates via the AMR Early Warning System, supporting rapid clinical and public health responses. This includes regular feedback to NHS boards and the Scottish Microbiology and Virology Forum.
  - Provision of intelligence on animal health AMU and AMR by Public Health Scotland (PHS) in collaboration with partners at Scotland's Rural College (SRUC), Food Standards Scotland (FSS) and national reference laboratories in Scotland.

- Monitoring and reporting on Scotland's progress against the UK AMR National Action Plan 2024-2029.

- Providing intelligence to optimise antimicrobial use and contain resistance.
  - In 2024, ARHAI Scotland collaborated with key partners across the United Kingdom to integrate the UK-adapted World Health Organization Access, Watch and Reserve (AWaRe) classification of antimicrobials, contributing to the conservation of key treatments in human healthcare.
  - SAPG revised and promoted new recommendations on antimicrobial duration to support evidence-based prescribing.



The UK National Action Plan: confronting antimicrobial resistance

The United Kingdom's approach to confronting AMR is underpinned by a long-term strategy that combines vision with measurable action.

Delivery approach:

- 20-year vision (to 2040): **AMR will be controlled and contained**
- **successive 5-year National Action Plans (NAPs):**
  - 2019–2024: Tackling antimicrobial resistance
  - 2024–2029: Confronting antimicrobial resistance

The 2024–2029 National Action Plan sets out human health targets to be achieved by 2029. Its publication marks the transition from the 2019–2024 NAP and continues to advance the UK's 20-year vision. Within Scotland, ARHAI Scotland plays a pivotal role in supporting delivery of this strategy.

The SAPG has also established supplementary targets to help achieve the UK NAP objectives. Progress will be monitored jointly by ARHAI Scotland and SAPG.

Antimicrobial use in humans

Total antibiotic use in humans in Scotland

The use of antibiotics exerts selective pressure that drives the emergence and spread of antimicrobial resistance (AMR). This includes the inappropriate use of antibiotics through overprescription and misuse. Effective stewardship involves limiting prescriptions to bacterial infections, selecting the shortest effective treatment duration, and prioritising narrow spectrum agents when suitable.

Total antibiotic use in humans

In **2024**, **23.2 defined daily doses (DDDs) per 1,000 population per day (DDDs/1,000/ day)** were used.

There has been a **5.5% increase** in the rate between **2023** and **2024**. The rate was **5.2% higher** compared to **2019**.

In **2024**, **83.5%** of antibiotic use (**DDDs**) was in primary care, while **16.5%** was in secondary care.

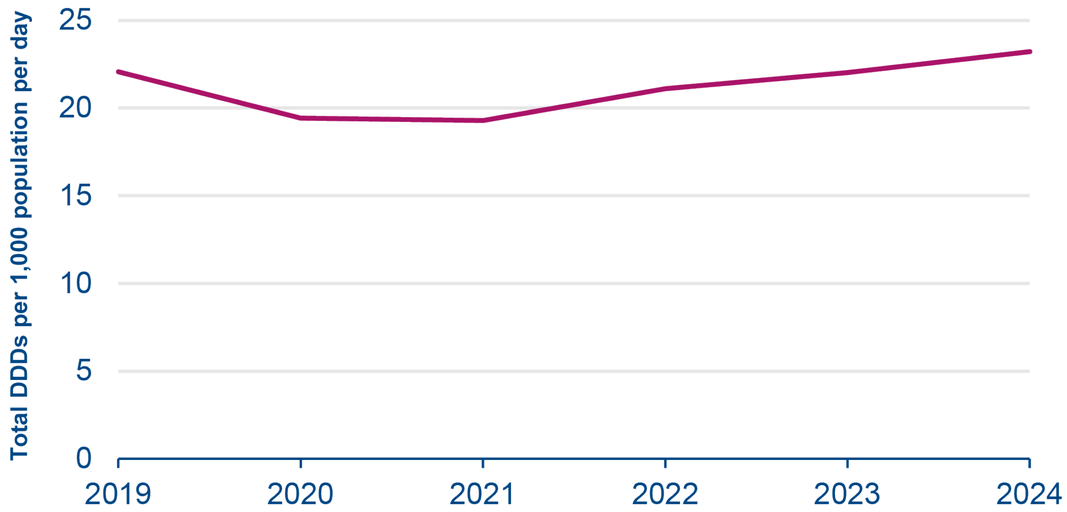
83.5%

Primary care

16.5%

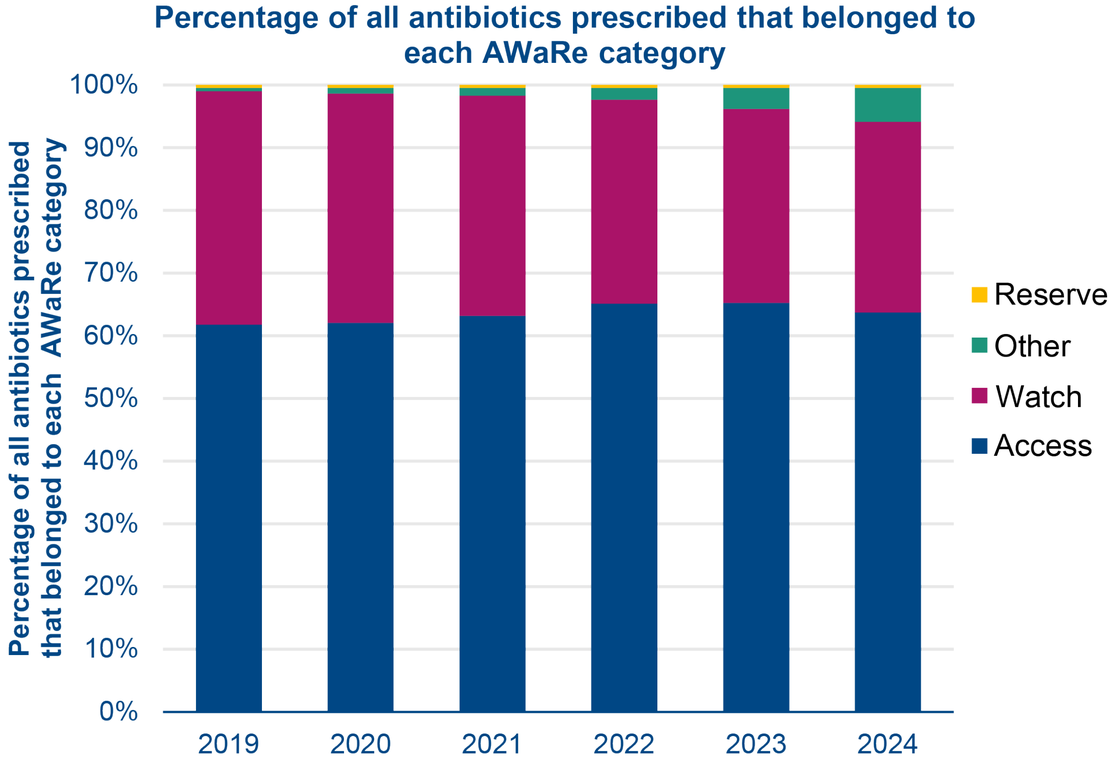
Secondary care

Total defined daily doses per 1,000 population per day for all antibiotics prescribed in Scotland



Percentage of all antibiotics in Scotland that belonged to the Access group

To avoid unnecessary use of broad-spectrum antibiotics an adapted version of the World Health Organization (WHO) Access, Watch, Reserve (AWaRe) classification of antibiotics is used to monitor antibiotic use in Scotland. Access antibiotics should be used as **first line treatment** for most common infections. The UK Access list was updated in 2024. Compliance in this report has been updated in line with the 2024 update. For details on this revision and for how the data has changed see Appendix 2.



In **2024**, **Access antibiotics** accounted for **63.7%** of **total antibiotic use**.

This is a **decrease** from **65.2%** in **2023**.

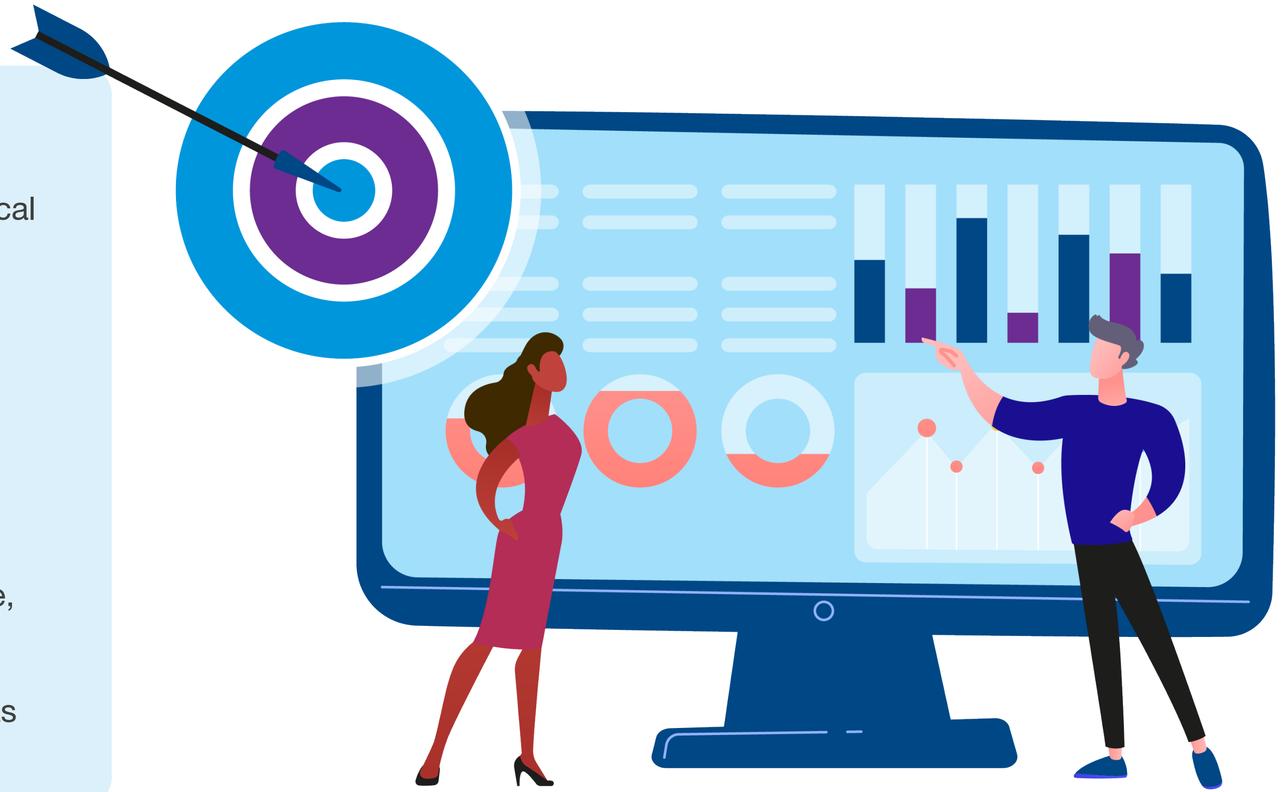
Compliance remains **higher** than **2019**, where compliance was **61.7%**.

This change is reflected in the expanded use of antibiotics in the 'Other' category. This is primarily due to increased use of methenamine hippurate, a urinary antiseptic for preventing recurrent urinary tract infections (UTIs). This reflects improved adherence to National Institute for Health and Care Excellence (NICE) guidelines for prophylactic treatment and supports safer, evidence-based prescribing practices.

ARHAI Scotland continues to maintain a suite of interactive Discovery Dashboards to raise awareness of antimicrobial use (AMU) in humans, providing NHS boards and prescribers with quarterly updates on both local and national AMU trends.

These insights are regularly shared with the Scottish Antimicrobial Prescribing Group (SAPG), the Association of Scottish Antimicrobial Pharmacists (ASAP), and the Scottish Antimicrobial Nurses Group (SANG) to inform strategic decision making and strengthen antimicrobial stewardship efforts across Scotland.

This enables NHS boards to monitor progress against AMR National Action Plan targets and Scottish Government standards on antibiotic use, while identifying opportunities for targeted local improvement. In future, there will be a continued focus on identifying unwarranted variation, with a move towards reporting intelligence on antibiotic use by factors such as deprivation, age, gender, geography, region, and care setting.



For detailed information on use of different antibiotics see Supplementary Data.

Antibiotic use in primary care in Scotland

The volume of antibiotic prescribing in primary care accounts for a substantial proportion of overall AMU in Scotland and is recognised as a contributing factor in the development and spread of AMR.

As prescribing responsibilities expand to include a wider range of healthcare professionals, this underscores the urgent need for robust community level surveillance systems capable of monitoring prescribing behaviours. This will help inform targeted antimicrobial stewardship interventions.

Antibiotic use in primary care (excluding dental)

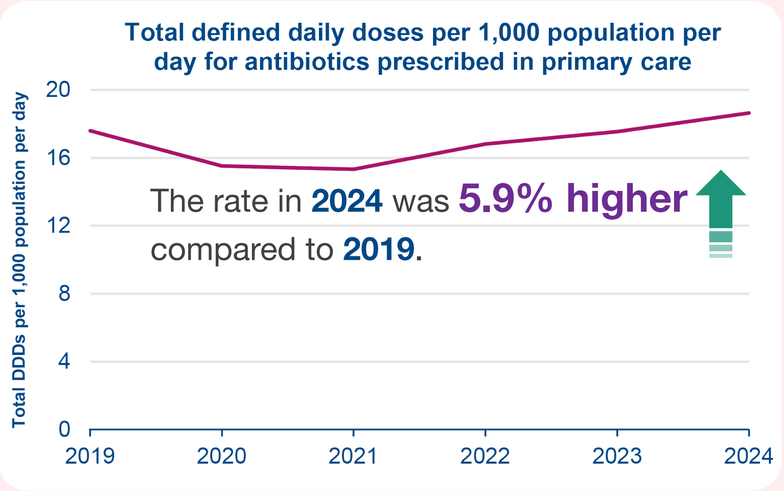
A key approach to optimising antibiotic use in primary care is to minimise use for symptoms such as coughs, colds, sore throats, and earache in otherwise fit and healthy people.

In **2024**, **31.8%** of the Scottish population received **at least one course of antibiotics** in primary care (excluding dental) compared to **31.0%** in **2023**.

Antibiotic use by defined daily doses (DDDs)

In **2024**, **18.6 DDDs per 1,000 population per day** were used.

There has been a **6.3% increase** in the rate between **2023** and **2024**.



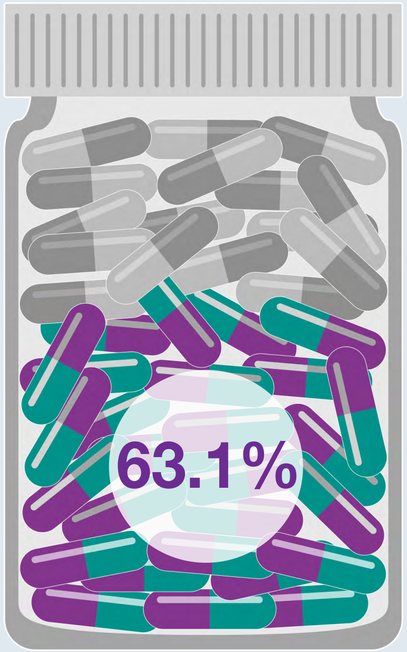
Antibiotic use by number of items

In **2024**, **2.0 antibiotic items per 1,000 population per day** were used, a **4.2% increase** from **2023**.

The rate in **2024** was **9.8% higher** compared to **2019**.

Use of Access antibiotics in primary care

In **2024**, **63.1%** of **antibiotic DDDs** in primary care were from the **Access category**, compared to **65.0%** compliance in **2023**.



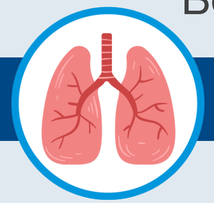
As primary care accounts for the majority of the total antibiotic use, improving adherence in this sector to evidence-based prescribing guidelines is essential to increase the proportion of Access antibiotics used in human medicine.

For detailed information on antibiotic use in primary care see Supplementary Data.

Duration of treatment

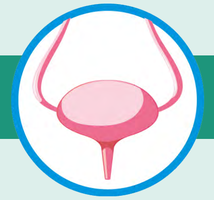
To reduce unnecessary exposure to antibiotics and minimise AMR, clinical guidelines recommend that where antibiotics are required for respiratory infection, treatment should be for five days, and where they are used for a simple UTI, the treatment should be for three days.

Between **2023** and **2024**:



Prescriptions for 5-day courses:

- **increased** from **72.6%** to **77.5%** for **amoxicillin** 500mg capsules
- **increased** from **36.9%** to **42.9%** for **doxycycline** 100mg capsules and tablets



Prescriptions for 3-day courses:

- **increased** from **72.0%** to **74.1%** for **trimethoprim** 100mg and 200mg tablets
- **increased** from **50.9%** to **53.2%** for **nitrofurantoin** 50mg and 100mg capsules and tablets

These findings demonstrate an improved alignment with antimicrobial stewardship guidelines, with a notable rise in shorter, evidence-based courses for commonly used antibiotics in the treatment of respiratory and urinary tract infections.

The SAPG agreed upon new methodology for identifying five-day courses of amoxicillin, and three-day courses of trimethoprim. This has been updated retrospectively in this report. For details on this revision see Appendix 2.

For detailed information on use of different antibiotics see Supplementary Data.

Antibiotic use in acute hospitals in Scotland

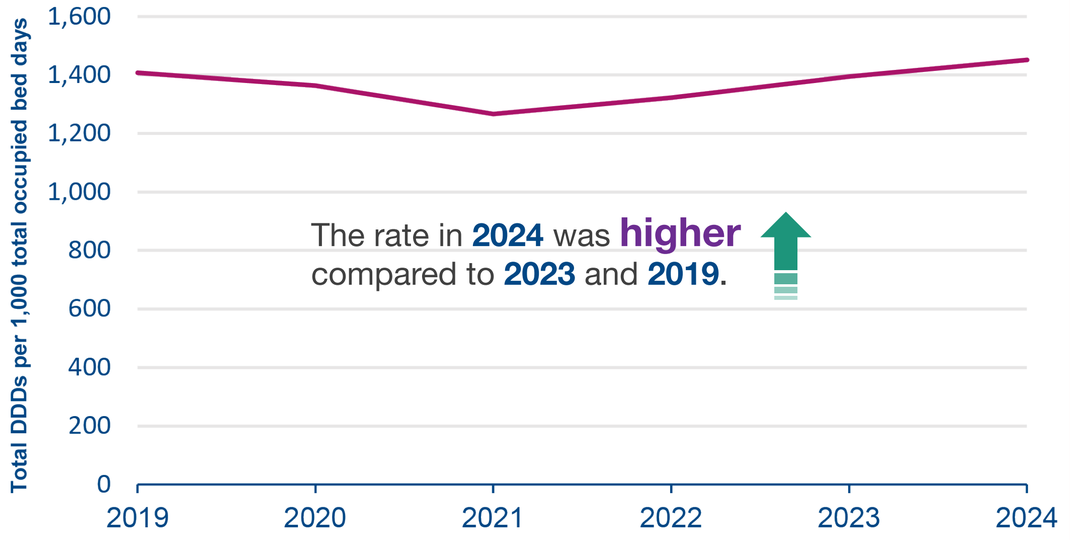
Optimising antibiotic use in acute hospital settings is a complex process that begins with accurate diagnosis to determine clinical requirements. When antibiotics are indicated, empiric prescribing should be guided by evidence-based local protocols that prioritise narrow-spectrum agents where appropriate, ensure correct route and duration of therapy, and support timely step down based on clinical progress and microbiological results. This structured, multidisciplinary approach is essential for reducing antimicrobial resistance and enhancing patient outcomes.

Antibiotic use in acute hospitals

In **2024**, antibiotic use was **1,451.5 DDDs per 1,000 total occupied bed days**.

There has been a **4.1% increase** in the rate between **2023** and **2024**. The rate was **3.1% higher** compared to **2019**.

Total defined daily doses per 1,000 total occupied bed days for antibiotics prescribed in acute hospitals



Access antibiotic use in acute hospitals

Access antibiotics accounted for **64.8%** of **total antibiotic DDDs** in **2024**, compared to **64.4%** in **2023**.

Route of administration

In **2024**, **421.2 DDDs per 1,000 occupied bed days** were for antibiotics given intravenously in acute hospitals compared to **410.5** in **2023.**

Regular clinician review of hospital patients receiving antibiotics by IV injection to prompt switching to oral therapy or discontinuing antibiotics remains an important element of antimicrobial stewardship in Scotland.

For detailed information on antibiotic use in acute hospitals see Supplementary Data.

UK National Action Plan targets

The UK AMR National Action Plan 'Confronting antimicrobial resistance 2024–2029' sets out measures of success to ensure progress, including targets on antimicrobial use.

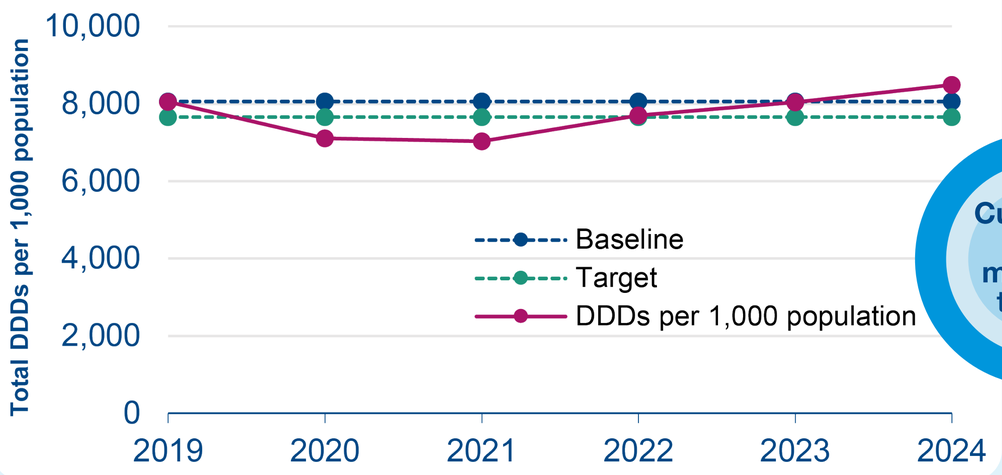
By 2029…

We aim to reduce total antibiotic use in human populations by 5% from the 2019 to 2020 financial year baseline.

In **2024**, **8,494.8 defined daily doses (DDDs) of antibiotics per 1,000 population** were used.

This was **5.4% higher** compared to **the baseline year (financial year 2019/20)**.

Target to reduce total antimicrobial use in humans by 5% by 2029[1]

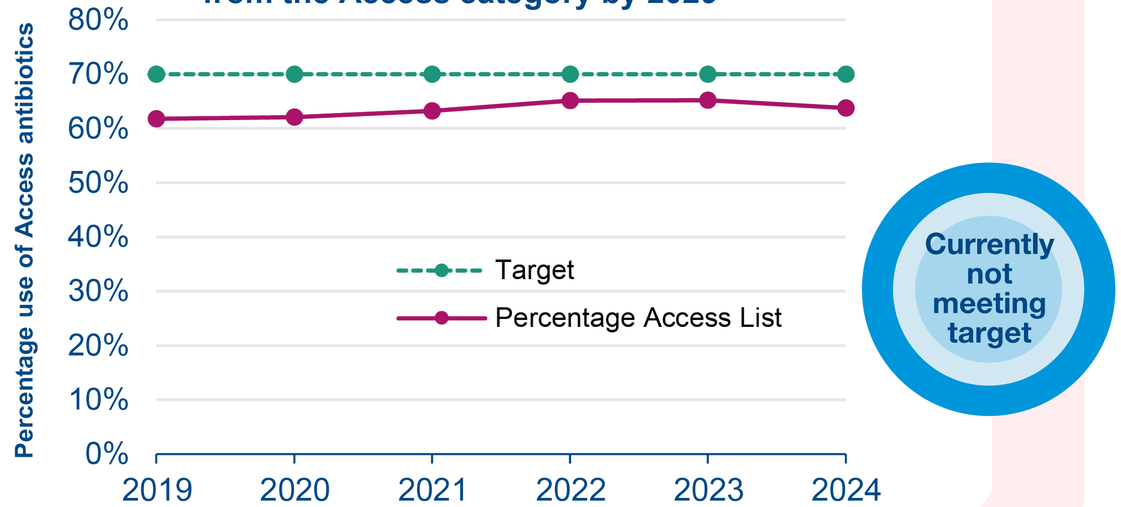


By 2029…

We aim to achieve 70% of total use of antibiotics from the Access category (new UK category) across the human healthcare system.

In **2024**, **63.7%** of the **total antibiotic DDDs** used in Scotland were for **Access antibiotics**.

Target to achieve 70% of total use of antibiotics from the Access category by 2029



[1] Financial year 2019/20 has been used as the baseline year for the target.

Antimicrobial resistance in humans

Antimicrobial resistant infections remain a serious global health threat, complicating treatment, prolonging hospital stays, increasing healthcare costs, and worsening patient outcomes. Tackling this challenge is essential to curb the spread of resistance and preserve the effectiveness of last line antibiotics. Success depends on strong surveillance systems, timely access to actionable data, and clear metrics to guide and evaluate intervention efforts.

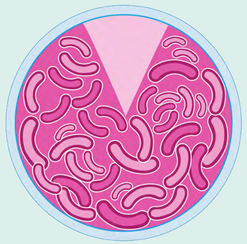
Antimicrobial resistance burden

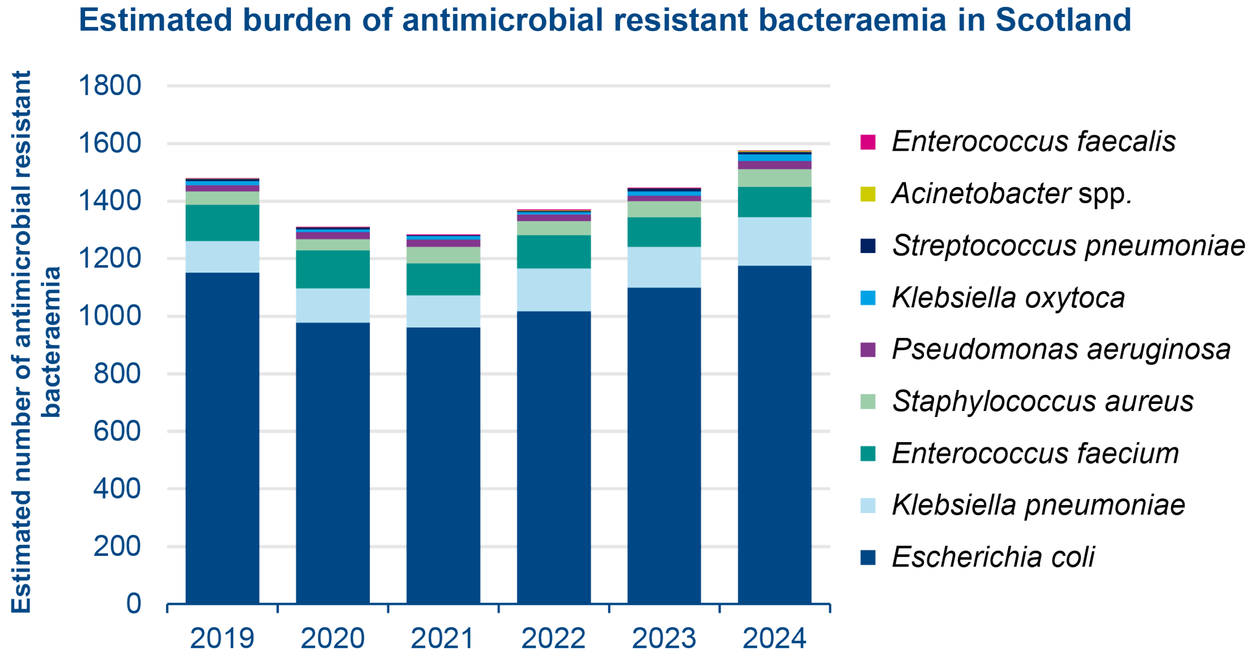
In **2024**, **17.9%** of **bacteraemia** in select priority organisms of public health importance, were resistant to **at least one key antibiotic**, an estimated **1,576 resistant bacteraemia**.

Of those, **88.9%** were caused by drug resistant **Gram-negative bacteria**.

The most common organism causing drug resistant bacteraemia was ***Escherichia coli* (*E. coli*)**, followed by ***Klebsiella pneumoniae* (*K. pneumoniae*)** and ***Enterococcus faecium* (*E. faecium*)**.

26.9% of ***E. coli* bacteraemia** in Scotland were **resistant to at least one key antibiotic**.





For more detailed information on priority organisms and antimicrobial resistance (AMR) burden see Appendix 2 and Supplementary Data.

UK National Action Plan targets

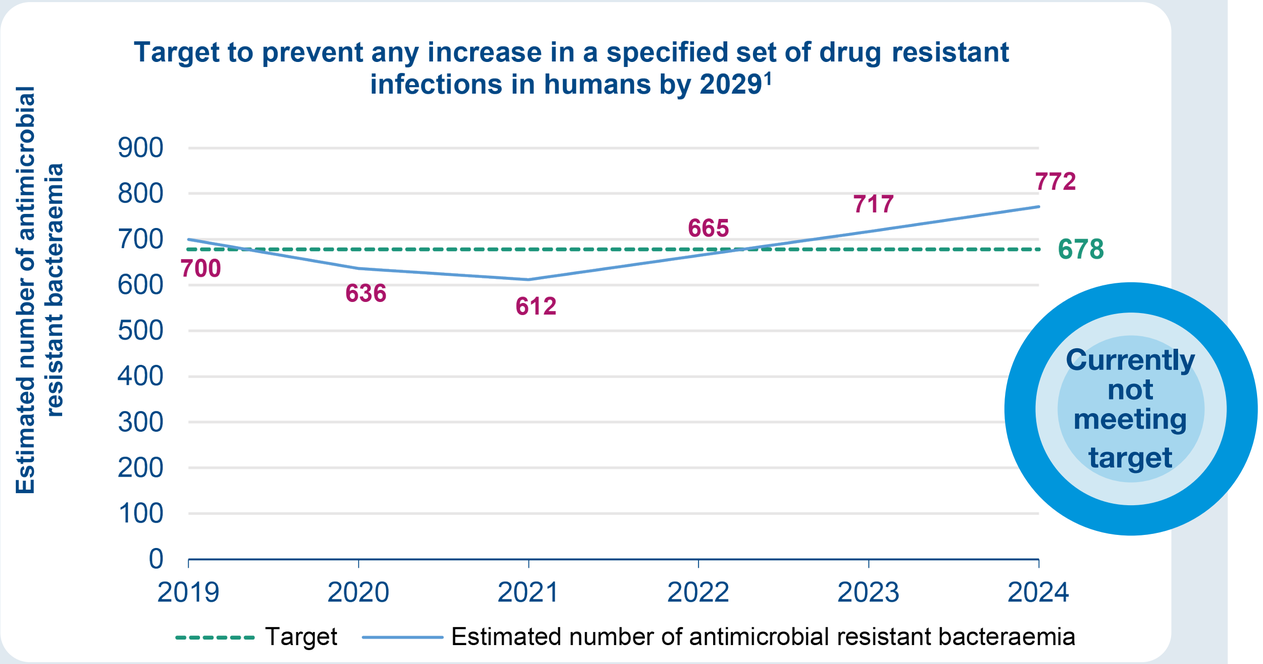
The second UK antimicrobial resistance National Action Plan (NAP) 'Confronting antimicrobial resistance 2024-2029' sets out a new target to reduce antimicrobial resistant infections, following on from the first UK NAP which concluded in 2024. This new target aims at preventing an increase in the estimated total number of antimicrobial resistant infections caused by a specified set of organisms (see Appendix 2 for further details).

By 2029…

We aim to prevent any increase in a specified set of drug resistant infections in humans from the 2019 to 2020 financial year baseline.

Of the specified set in the NAP, there were an estimated **772 antimicrobial resistant bacteraemia** in **2024** in Scotland, compared with the target of **678** in the **financial year 2019/2020**.

As of **2024**, this target is currently not on track. ARHAI Scotland will continue to monitor the burden of AMR bacteraemia, in line with this NAP target. Improvement planning is led by the Scottish Government under the Healthcare associated infection (HCAI) Strategy 2023 to 2025.



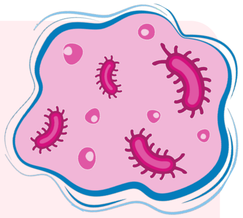
[1] Financial year 2019/20 has been used as the baseline year for the target.

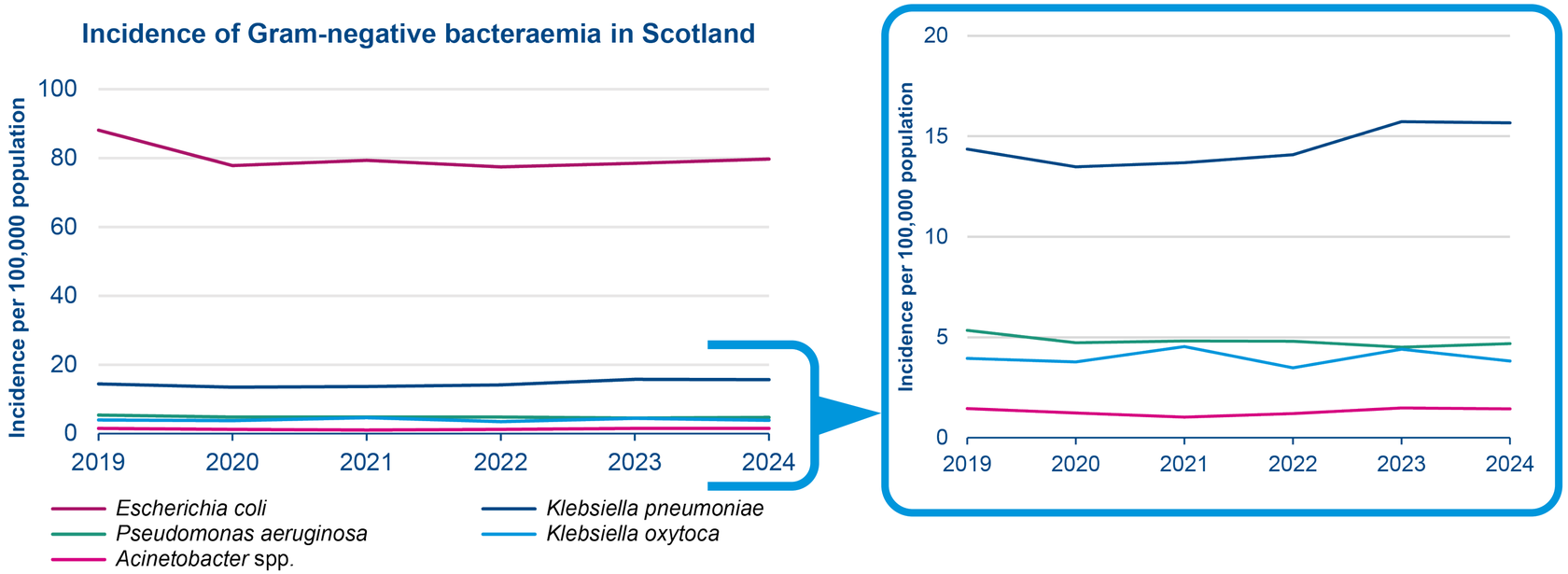
For more information see Supplementary Data.

Antimicrobial resistance in Gram-negative organisms

Gram-negative bacteria are a common cause of serious infection in both healthcare and community settings. AMR in Gram-negative bacteria, particularly *E. coli* significantly contributes to the overall burden of AMR.

In **2024**, there were **5,781 Gram-negative bacteraemia** in Scotland, caused by five key pathogens: ***E. coli***, ***Pseudomonas aeruginosa* (*P. aeruginosa*)**, ***K. pneumoniae***, ***Klebsiella oxytoca* (*K. oxytoca*)** and ***Acinetobacter* species**.





Between **2023** and **2024**, the **incidence remained unchanged**.

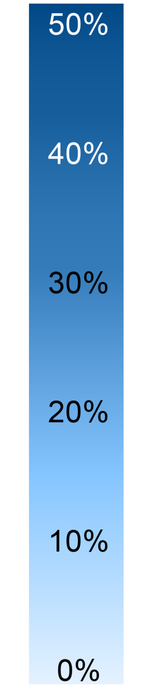
Comparing **2024** to **2019**:

- **incidence** of ***E. coli* bacteraemia** was **9.5% lower** compared to **2019**.
- **no change** in the **incidence** of ***K. pneumoniae***, ***K. oxytoca***, ***P. aeruginosa***, and ***Acinetobacter* species bacteraemia** compared to **2019**.

See ARHAI Scotland 2024 Annual Report for further information on *E. coli* bacteraemia in Scotland.

Resistance of Gram-negative bacteraemia to key antibiotics in 2024

	Meropenem	Temocillin	Ceftazidime	Cefotaxime/ Ceftriaxone	Gentamicin	Piperacillin Tazobactam (tazocin)	Ciprofloxacin	Trimethoprim	Co-amoxiclav
Escherichia coli	<0.1%	3.0%	9.1%	9.5%	11.6%	10.1%	18.9%	37.2%	48.1%
Klebsiella pneumoniae	0.1%	0.7%	10.1%	10.7%	7.9%	18.5%	15.6%	24.2%	21.9%
Klebsiella oxytoca	0.0%	0.6%	2.0%	7.7%	1.9%	16.1%	3.3%	6.5%	17.2%
Pseudomonas aeruginosa	2.9%		10.1%		4.2%	11.8%	9.4%		
Acinetobacter spp.	2.6%				1.3%		12.3%		



Between **2023** and **2024**, **resistance** to key antibiotics in **Gram-negative bacteraemia** has **remained unchanged**. ⟷

Comparing **2024** to **2019**:

for ***E. coli*** **bacteraemia**:

» **no change** in **resistance** to **cefotaxime/ceftriaxone**, **ciprofloxacin**, **ceftazidime** and **trimethoprim** compared to **2019**.

» **resistance** to **co-amoxiclav** in **2024** was **lower** compared to **2019**.

» **meropenem resistance** was not compared as **resistance remained low**.

for ***K. pneumoniae*** **bacteraemia**:

» **no change** in **resistance** to **co-amoxiclav** and **trimethoprim**, and **resistance** to **ciprofloxacin** was **higher**.

» **cefotaxime/ceftriaxone** and **ceftazidime resistance** were **higher** in **2024** than in **2019**.

» **meropenem resistance** was not compared as **resistance remained low**.

for ***K. oxytoca*** **bacteraemia**:

» **no change** in **resistance** to **trimethoprim**, **cefotaxime/ceftriaxone** and **co-amoxiclav**.

» **resistance** to **temocillin**, **ceftazidime**, **ciprofloxacin** and **gentamicin** was not compared as **resistance remained low**.

» **no resistance** to **meropenem** was reported between **2019** and **2024**.

for ***Acinetobacter*** **spp. bacteraemia**:

» **resistance** to **ciprofloxacin**, **meropenem**, and **gentamicin** was not compared as **resistance remained low**.

for ***P. aeruginosa*** **bacteraemia**:

» **no change** in **resistance** to **ceftazidime**, **ciprofloxacin**, and **piperacillin-tazobactam**.

» **meropenem resistance** was not compared as **resistance remained low**.

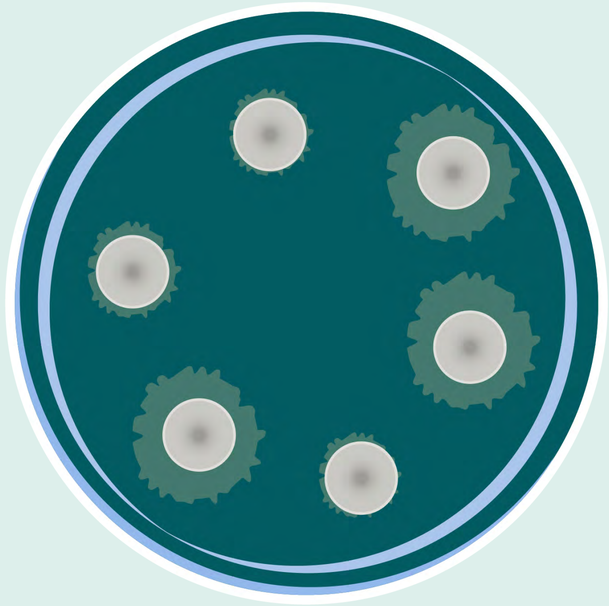
For more information on AMR in Gram-negative bacteraemia see Appendix 2, and Supplementary Data.

Data on Gram-negative bacteraemia in Scotland:

- are shared via Discovery Dashboards enabling board comparisons.
- inform quality improvement initiatives.
- guide empirical antibiotic use to improve patient outcomes.

For information on AMR in Gram-negative organisms see Supplementary Data.

For further information on Discovery Dashboards see What is Discovery?



Urinary tract infections caused by *E. coli*

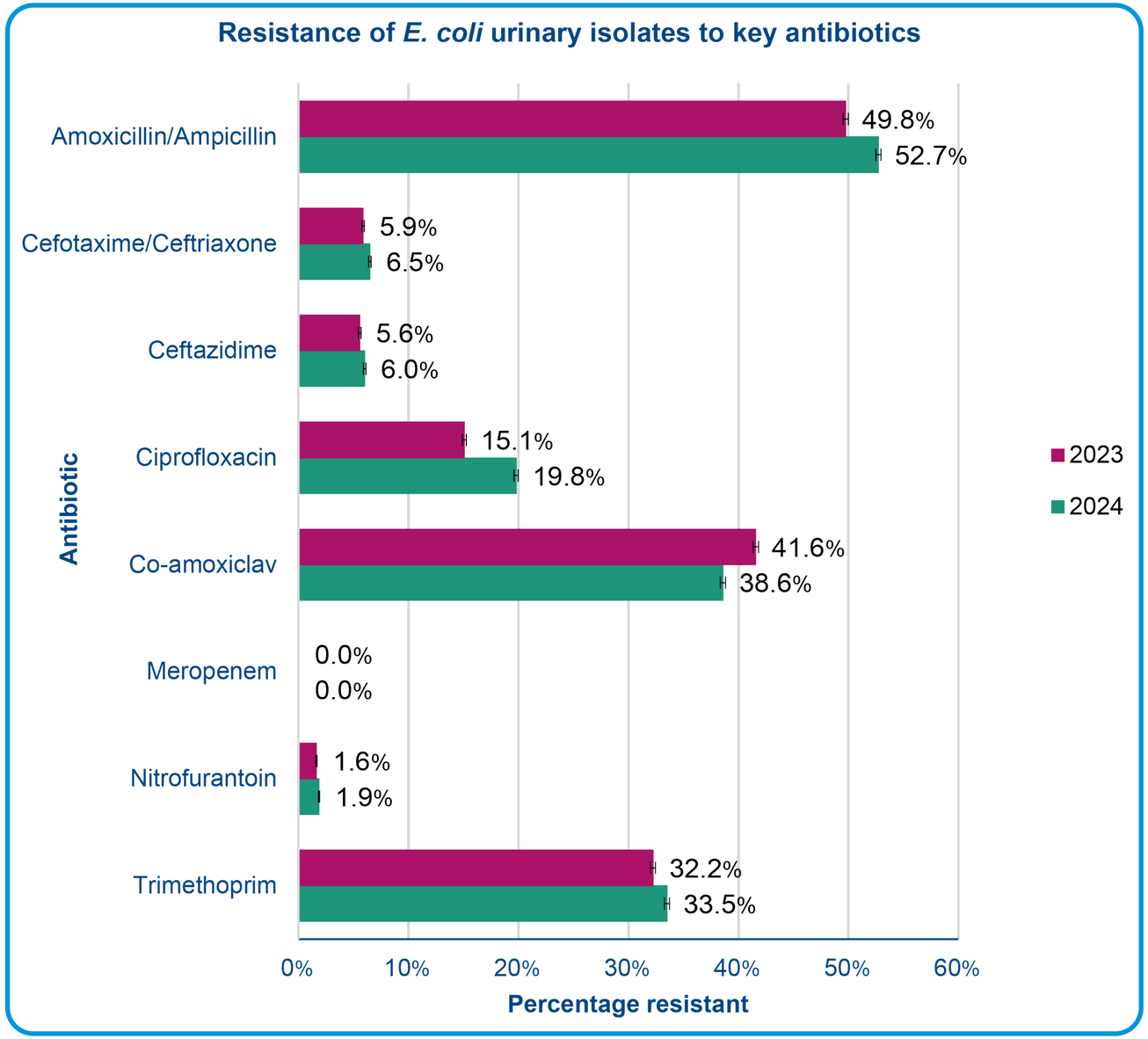
Urinary tract infections (UTIs) are frequently diagnosed in community and healthcare settings and AMR in urinary isolates contributes substantially to the overall AMR burden. Monitoring AMR in urinary isolates provides intelligence that underpins decision making and local prescribing policies.

E. coli was the most commonly reported organism in urinary isolates.

In **2024**, there were **171,132 episodes of *E. coli*** isolated from urine, compared with **167,602** in **2023**.

Between **2023** and **2024**:

- **resistance** in ***E. coli*** to key antibiotics including **amoxicillin/ampicillin**, **cefotaxime/ceftriaxone**, **ceftazidime**, **ciprofloxacin**, **nitrofurantoin** and **trimethoprim** **increased**.
- **resistance** to **co-amoxiclav** **decreased**.
- **resistance** to **meropenem** has **remained unchanged**.



ARHAI Scotland use these data to support Scottish Antimicrobial Prescribing Group (SAPG) and NHS boards' Antimicrobial Management Teams (AMTs) to optimise antibiotic prescribing and stewardship ensuring empiric guidelines are based on current trends in AMR.

Data on AMR in *E. coli* urinary isolates are shared via Discovery Dashboards.

For further information on AMR in *E. coli* urinary isolates see Supplementary Data.

Carbapenemase-producing organisms

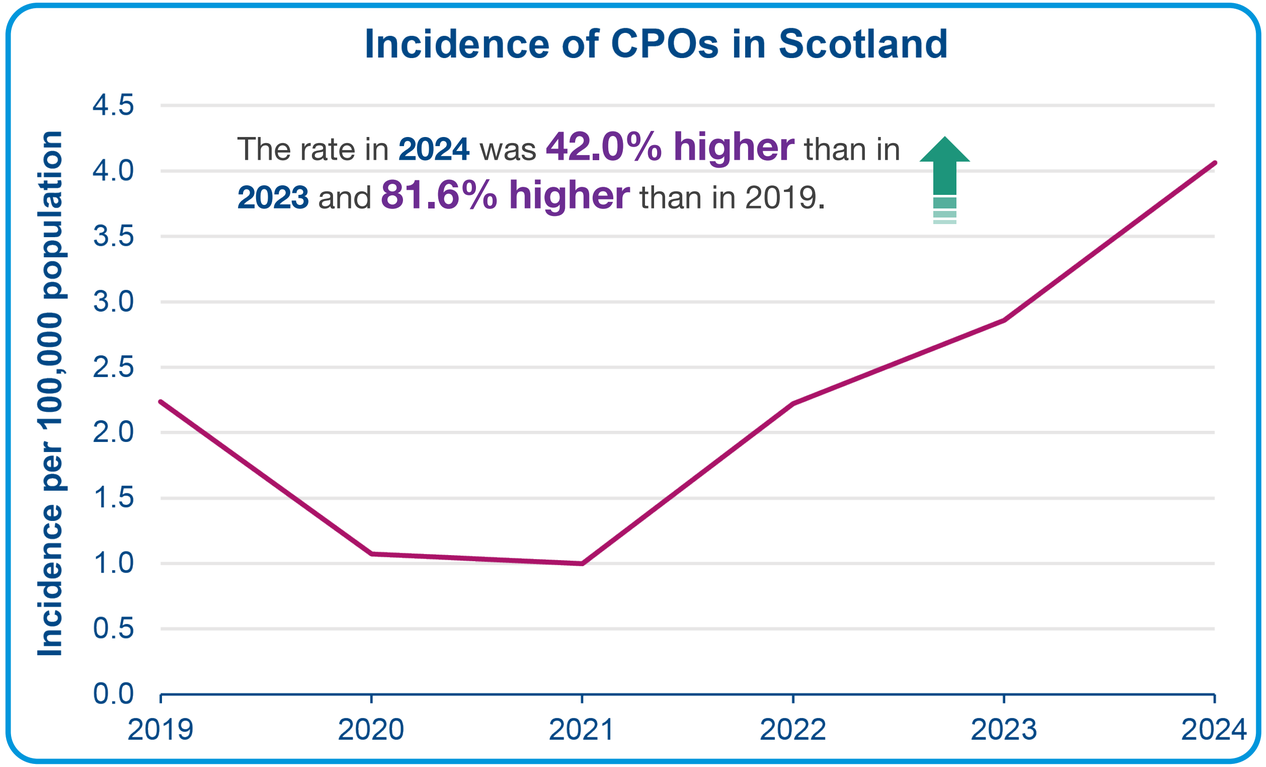
Carbapenems are beta-lactam antibiotics with a very broad spectrum of activity, often reserved as last-line agents for the treatment of bacterial infections. The primary mechanism of carbapenem resistance is the production of acquired carbapenemases, enzymes which inactivate carbapenem antibiotics rendering many beta-lactams ineffective. Bacteria that have this ability are referred to as carbapenemase-producing organisms (CPOs).

In **2024**, there were **223 cases of CPOs** reported in Scotland, compared to **157** in **2023**. The annual **CPO incidence** was **4.1 per 100,000 population**.

The incidence of **CPO** reduced during the COVID-19 pandemic in line with fewer hospital admissions and restrictions on international travel.

91.5% of **CPOs** identified in **2024** were **carbapenemase-producing Enterobacterales (CPE)**.

The remaining were **non-fermenters** (***Acinetobacter* species** and ***Pseudomonas* species**).

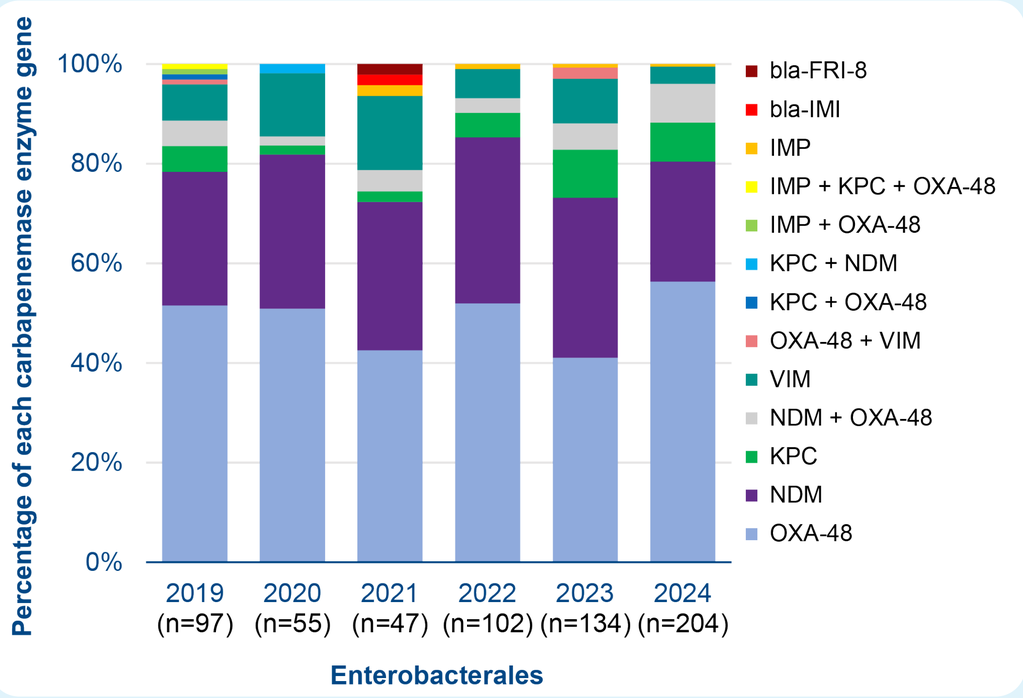


In 2024, the most frequently detected carbapenemase genes in…

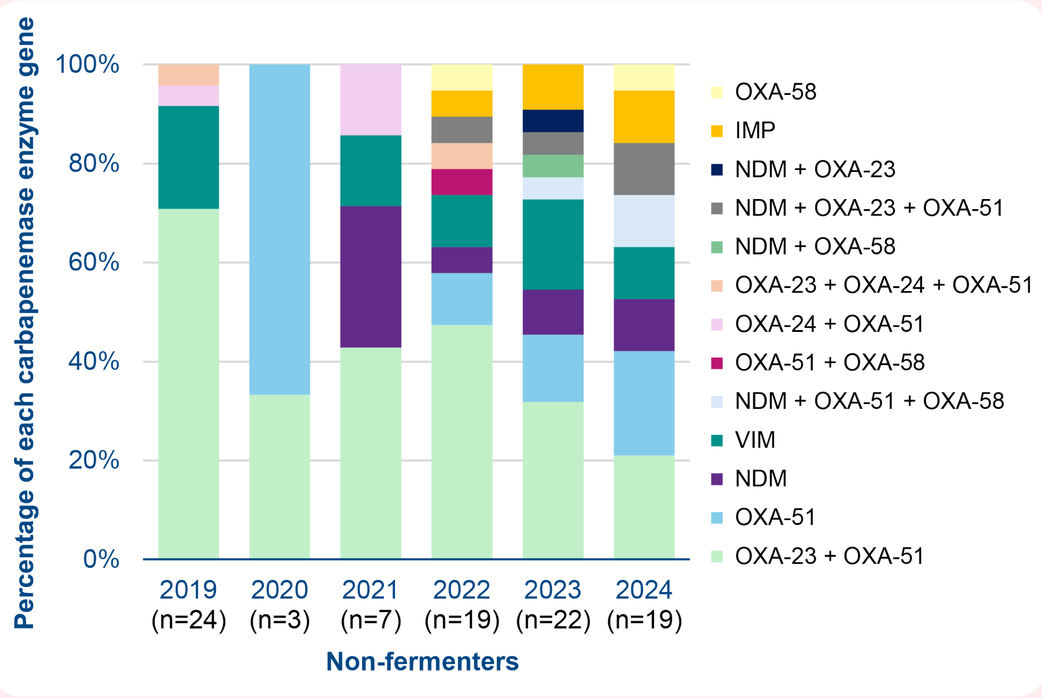
…Enterobacterales were oxacillinase (OXA)-48-like and New Delhi Metallo-beta-lactamase (NDM).

…non-fermenters were combinations containing OXA-51 and OXA-23.

Percentage of carbapenemase enzyme genes detected from Enterobacterales in Scotland



Percentage of carbapenemase enzyme genes detected from non-fermenters in Scotland



For further information including AMR data on CPOs see Supplementary Data.

In 2025, ARHAI Scotland is continuing to develop further intelligence relating to CPO epidemiology in Scotland. The findings will be used to support SAPG and the Scottish Microbiology and Virology Forum, driving forward the antibiotic stewardship agenda.

Antimicrobial resistance in Gram-positive organisms

Enterococcal bacteraemia

Enterococci are opportunistic pathogens commonly found in the gastrointestinal tract of humans and animals. While typically harmless, they can cause serious infections such as UTI, endocarditis and bacteraemia, particularly in vulnerable or hospitalised patients. Their ability to survive in harsh environments and resist multiple antibiotics, including vancomycin, makes enterococcal bacteraemia a significant concern in clinical settings.

Enterococcus faecalis and *Enterococcus faecium*

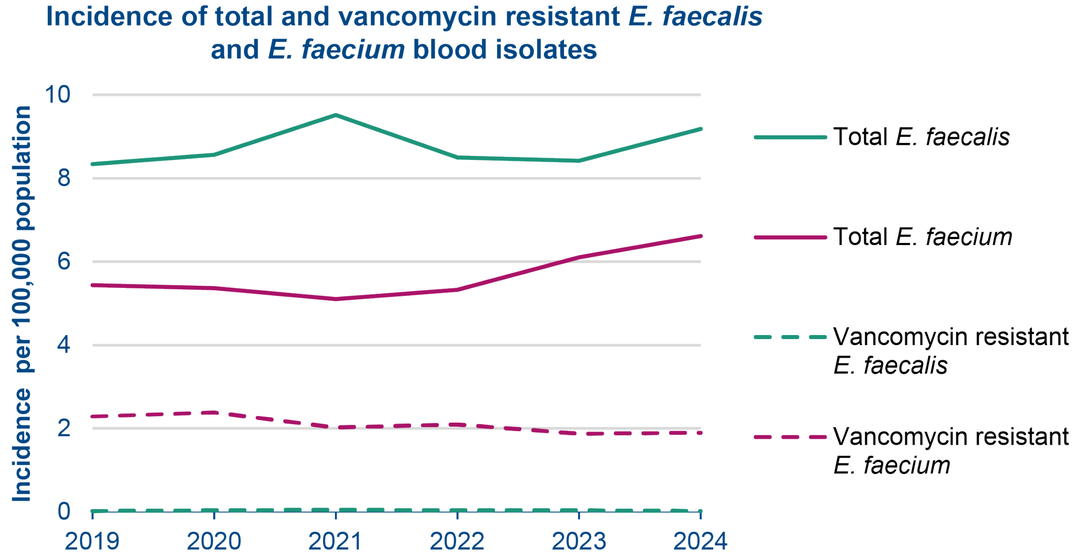
In **2024**, the incidence of ***Enterococcus faecalis* (*E. faecalis*)** and ***E. faecium* blood isolates** was **9.2** and **6.6 per 100,000 population**, respectively.

Incidence has **remained unchanged** compared to **2023**.

Comparing **2024** to **2019**:

- **no change** to the **incidence** of ***E. faecalis*** compared to **2019**.
- **incidence** of ***E. faecium*** was **21.7% higher** compared to **2019**.

In **2024**, the **incidence** of **vancomycin resistant *E. faecalis*** and ***E. faecium* blood isolates** were **0.02** and **1.89 per 100,000 population**, respectively.



AMR in *E. faecalis*

In **2024**, **vancomycin resistance** was reported in **0.2%** of ***E. faecalis*** **blood isolates**.

In ***E. faecalis*** **blood isolates** between **2023** and **2024**:

- **high level gentamicin resistance** has **remained unchanged**.
- **resistance** to **teicoplanin**, **vancomycin** and **linezolid** was not compared as **resistance** has **remained low.**.

Comparing **2024** to **2019**:

- **resistance** to **teicoplanin** and **vancomycin** was not compared as **resistance** has **remained low.**
- **no change** in **resistance** to **high level gentamicin** compared to **2019**.

AMR in *E. faecium*

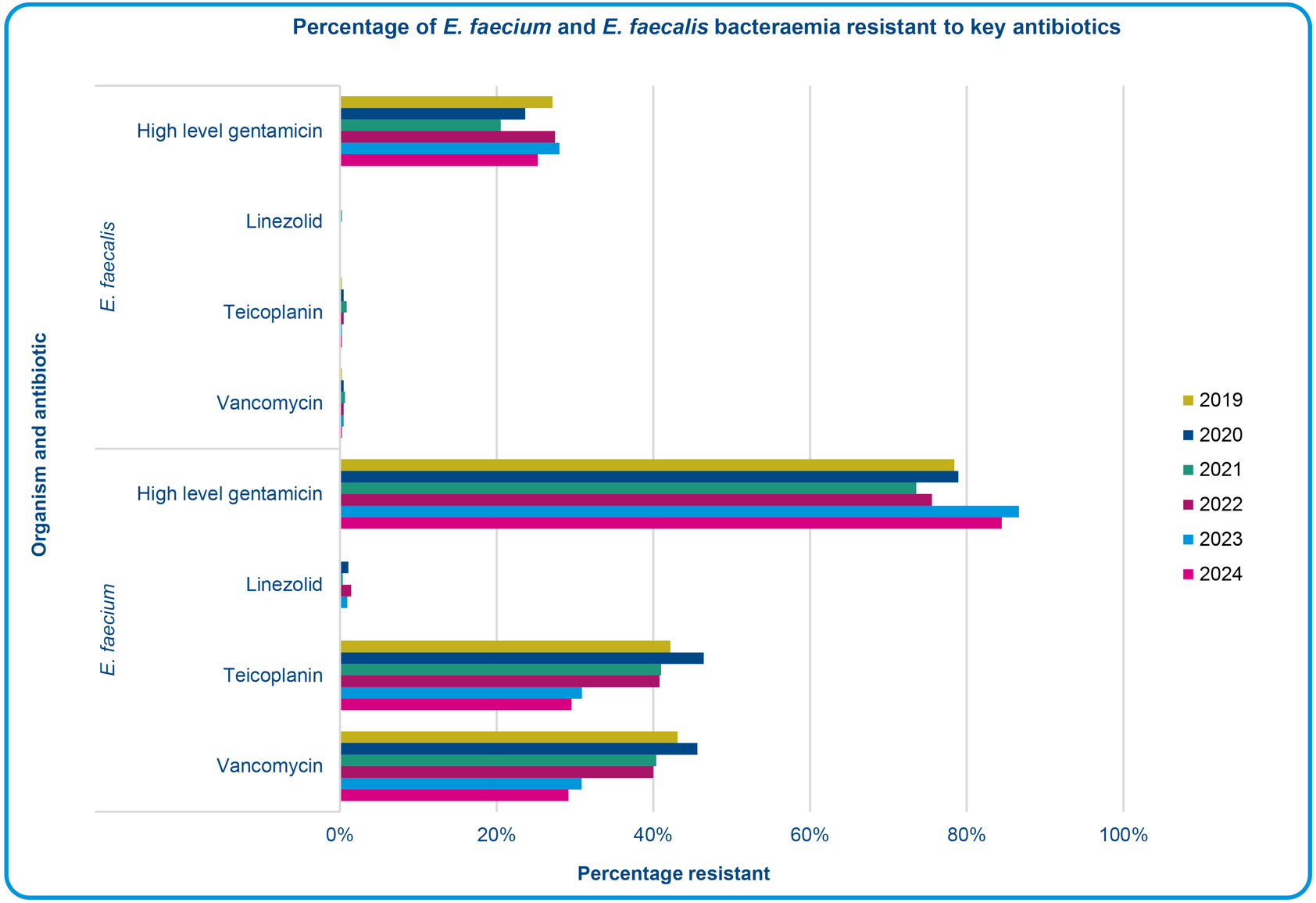
In **2024**, **vancomycin resistance** was reported in **29.1%** of ***E. faecium*** **blood isolates**.

In ***E. faecium*** **blood isolates** between **2023** and **2024**:

- **vancomycin, teicoplanin** and **high level gentamicin resistance** has **remained unchanged**.
- **resistance** to **linezolid** was not compared as **resistance** has **remained low.**

Comparing **2024** to **2019**:

- **vancomycin resistance** was **32.4% lower** compared to **2019**.
- **teicoplanin resistance** was **29.9% lower** compared to **2019**.
- **no change** to **high level gentamicin resistance** compared to **2019**.
- **resistance** to **linezolid** was not compared as **resistance** has **remained low.**

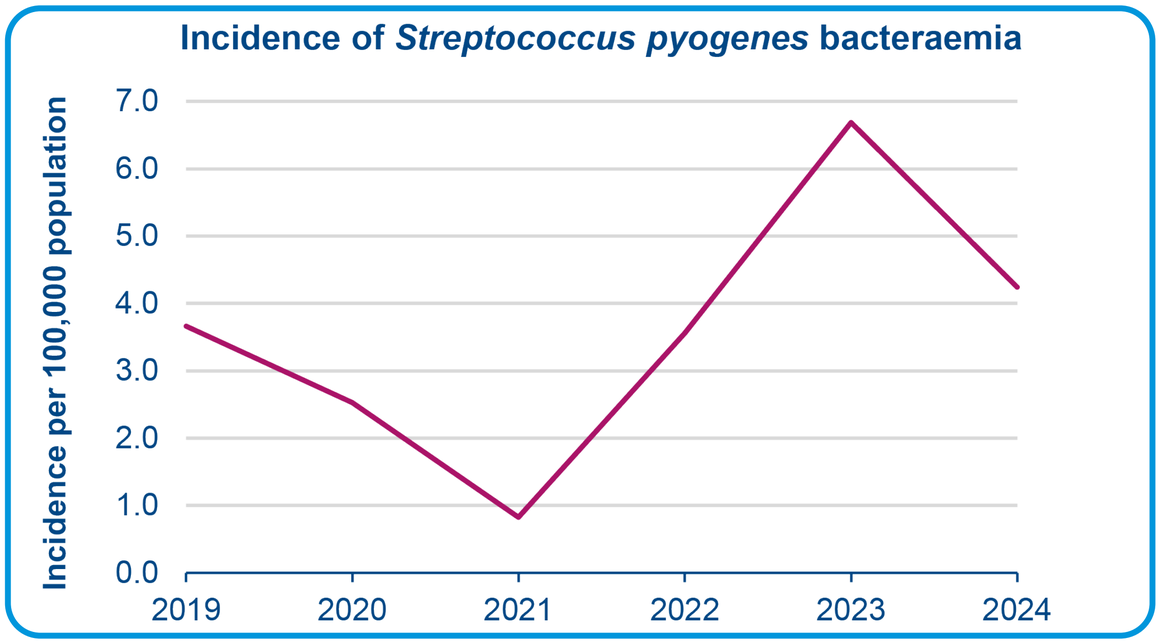


For further information on AMR in enterococcal bacteraemia see Supplementary Data. Data on AMR enterococcal bacteraemia are also shared via Discovery Dashboards.

Streptococcus pyogenes (Group A Streptococcus) bacteraemia

Streptococcus pyogenes (Group A Streptococcus) is a major pathogen, particularly for children. It causes diseases such as erysipelas, tonsillitis, scarlet fever, rheumatic fever, and glomerulonephritis. There was a UK-wide increase in reports of scarlet fever and invasive Group A Streptococcus (iGAS) in late 2022 into spring 2023.

In **2024**, the ***Streptococcus pyogenes* bacteraemia incidence** was **4.2 per 100,000 population**.
This was **36.3% lower** compared to **2023** and **14.8% higher** compared to **2019**.



AMR in *Streptococcus pyogenes* bacteraemia:

- **8.5% resistant** to **clindamycin** in **2024**.
- this has **remained unchanged** compared to **2023**.
- **no change** in **resistance** to **clindamycin** compared to **2019**.
- **no resistance** to **penicillin** has been reported between **2019** and **2024**.

For information on AMR in Gram-positive organisms see Supplementary Data. Data on AMR in Gram-positive organisms are also shared via Discovery Dashboards.

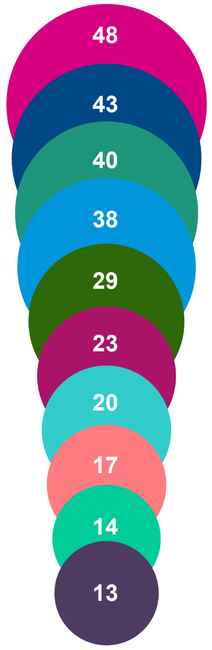
Unusual AMR phenotypes

ARHAI Scotland monitor unusual AMR phenotypes, in line with Appendix 13 of the National Infection Prevention and Control Manual, to enable a timely scientific and public health response to potential emerging AMR issues. This informs infection control practices and appropriate therapy and is critical to contain the development and spread of resistance. Additionally, ARHAI Scotland communicate any identified issues with other public health bodies as necessary.

Local monitoring ensures that microbiology clinicians, Infection Prevention and Control Teams (IPCT), Health Protection Teams (HPTs) and AMTs, as appropriate, are aware of each identified case in line with local protocols.

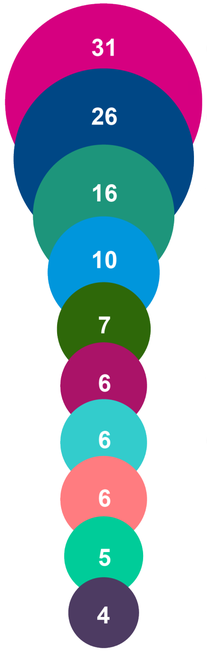
In **2024**, **529** instances of **unusual AMR phenotypes** were reported through the **AMR Early Warning System**. The **ten most frequently reported unusual AMR phenotypes** in Gram-negative and Gram-positive bacteria were:

Gram-negative bacteria



- meropenem/Imipenem/ceftazidime/piperacillin-tazobactam resistant *Pseudomonas aeruginosa*
- ceftazidime-avibactam resistant *Escherichia coli*
- meropenem resistant *Escherichia coli*
- meropenem resistant *Klebsiella pneumoniae*
- ceftolozane-tazobactam resistant *Pseudomonas aeruginosa*
- ceftazidime-avibactam resistant *Klebsiella pneumoniae*
- ceftriaxone resistant *Haemophilus influenzae*
- cefotaxime resistant *Haemophilus influenzae*
- meropenem/ceftazidime/piperacillin-tazobactam resistant *Pseudomonas aeruginosa*
- colistin resistant *Enterobacter cloacae*

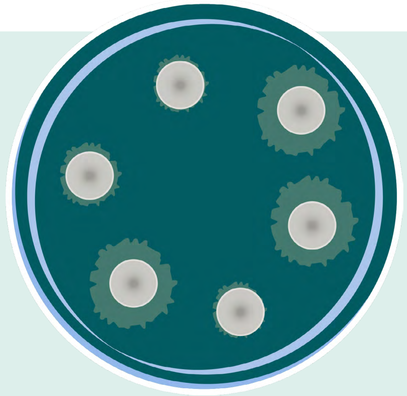
Gram-positive bacteria



- cefotaxime sensitive at increased dose *Streptococcus pneumoniae* (MIC >0.5 mg/L)
- ceftriaxone sensitive at increased dose *Streptococcus pneumoniae* (MIC >0.5 mg/L)
- tigecycline resistant *Streptococcus dysgalactiae*
- penicillin resistant *Streptococcus pneumoniae* (MIC > 2 mg/L)
- tigecycline resistant Streptococcus species group G
- tigecycline resistant *Enterococcus faecium*
- daptomycin resistant *Enterococcus faecium* (MIC >4 mg/L)
- linezolid resistant *Enterococcus faecalis*
- linezolid resistant *Enterococcus faecium*
- teicoplanin resistant *Staphylococcus aureus*

ARHAI Scotland also monitor unusual AMR phenotypes in fungal organisms.

In August 2023, ARHAI Scotland issued a briefing note following a small number of *Candidozyma auris* cases in Scottish hospitals, providing key guidance on detection and management in acute care.



Since the briefing note was issued, cases of *C. auris* continue to be detected sporadically in Scotland. ARHAI Scotland are collaborating with Public Health Scotland (PHS) on national guidance for *C. auris*, including advice on screening.

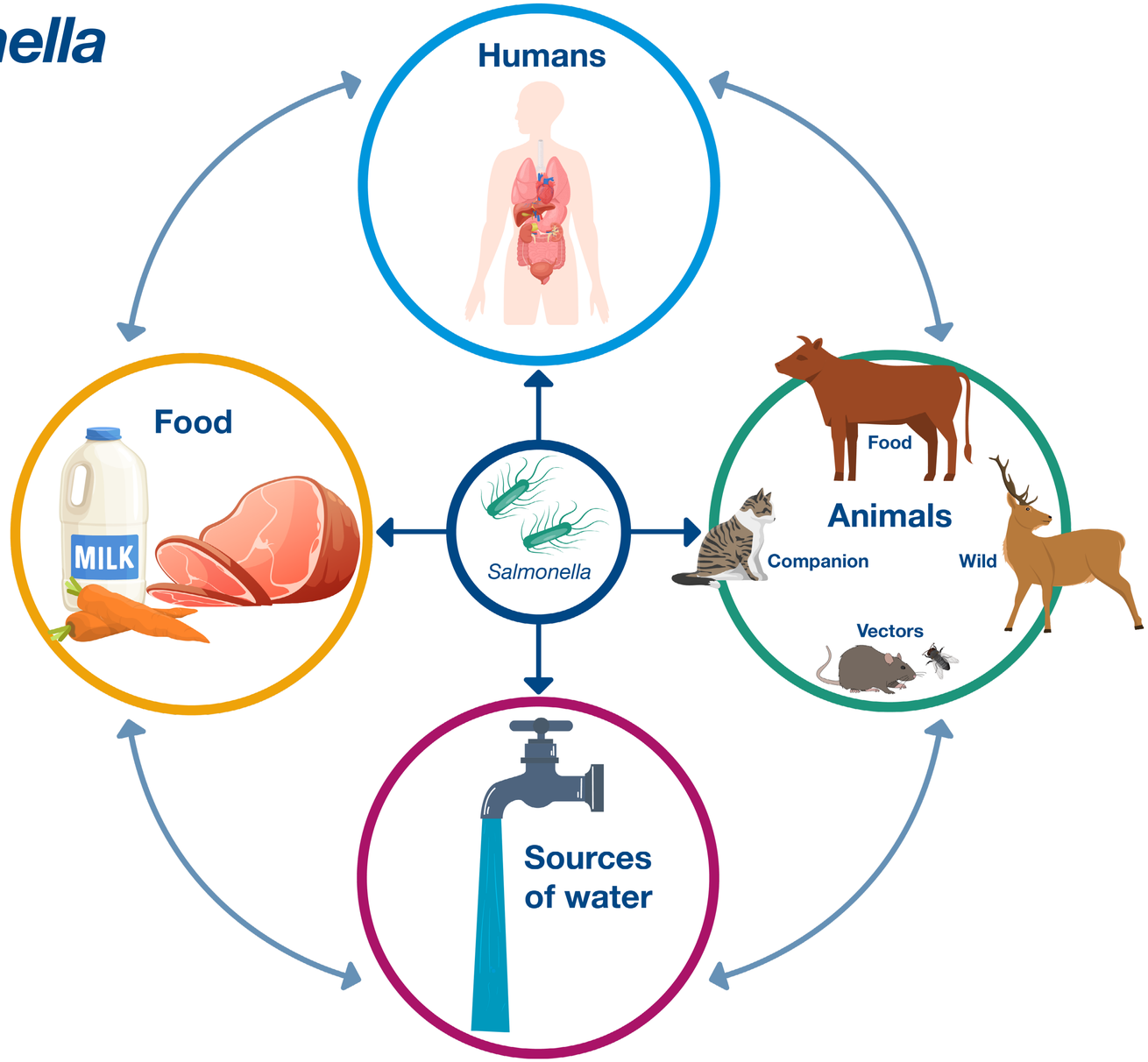
ARHAI Scotland will continue to monitor intelligence relating to unusual AMR phenotypes epidemiology in Scotland.

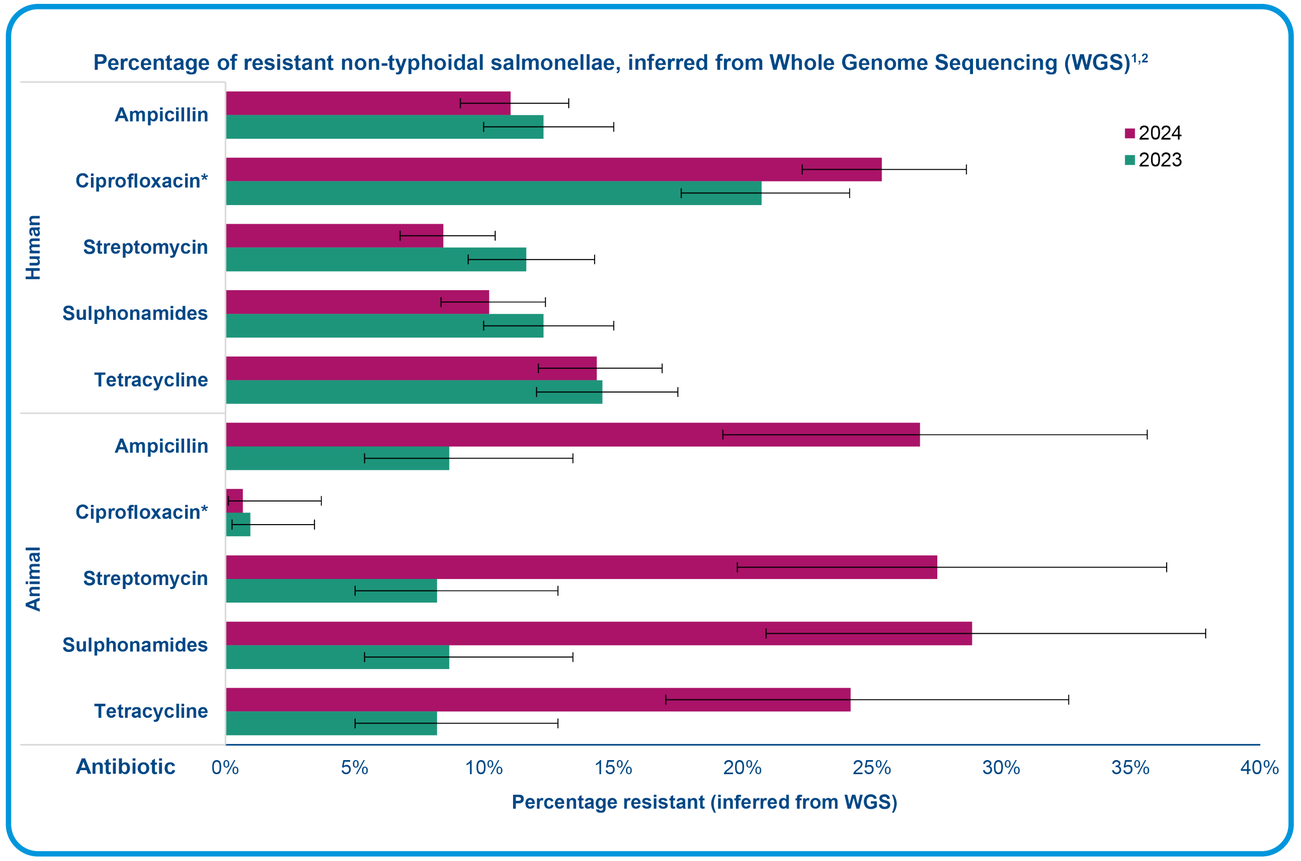
For further information on unusual phenotypes, including those that are less frequently reported, see Supplementary Data.

Antimicrobial resistance in *Salmonella*

Salmonella is a Gram-negative bacterium, ubiquitous in nature and a common cause of gastrointestinal illness in humans. *Salmonella* is usually a self-limiting infection and treatment with antibiotics is not routinely recommended. However, in some individuals, antimicrobial therapy may be required, particularly for severe or extraintestinal infections.

Salmonella is a zoonosis - a wide range of domestic and wild animals can act as a reservoir, including cattle, sheep, pigs, poultry, reptiles and household pets. Infected animals are often asymptomatic. *Salmonella* is notifiable in humans and a reportable animal pathogen in the UK.





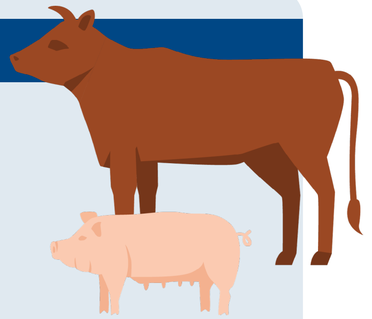
[1] For ciprofloxacin* this includes mutations and acquired genes associated with reduced susceptibility above the Salmonella specific breakpoint of greater than 0.06mg/L as recommended by EUCAST, Jan 2024.

[2] For animal data, this includes isolates from different animal species, as well as different *Salmonella* serotypes, therefore year to year comparisons should be treated with caution.

Comparing 2024 to 2023, in humans

Resistance to key antibiotics **remained unchanged** between **2023** and **2024**.

Comparing 2024 to 2023, in animals



Resistance to **ampicillin**, **streptomycin**, **sulphonamides** and **tetracycline** **increased** between **2023** and **2024**.

Resistance to **ciprofloxacin** **remained unchanged**.

For information on antimicrobial resistance in *Salmonella* from humans and animals see Appendix 2 and Supplementary Data.

Antimicrobial resistance in animals

Antimicrobial resistance in veterinary clinical isolates from livestock

For 2024, detailed information on antimicrobial resistance (AMR) in veterinary clinical isolates from livestock species are presented in Supplementary Data. These data are derived from clinical specimens submitted to the farm animal diagnostic services offered by Scotland's Rural College (SRUC) Veterinary Services. These samples are tested on a 'charged for' basis to inform private veterinary treatment of diseased animals. There is a cost to the animal keeper that affects the submission of samples to these services.

The primary purpose of screening for AMR is to inform veterinary treatment, and isolates from animals are tested against a panel of antimicrobials relevant for that purpose at, where they exist, species-relevant clinical breakpoints.

The microorganisms included, such as *Staphylococcus* species, *Streptococcus* species, *Pasteurellaceae* and *E. coli* are selected based both on their prevalence among all submissions, i.e. their importance as causes of animal morbidity, as well as, in some cases, their similarity to microorganisms that cause morbidity in humans.

Antimicrobial resistance in *E. coli* isolates from healthy livestock

In addition to diagnostic isolates, *E. coli* collected from enteric samples of healthy animals are tested as a measure of the background resistance in livestock entering the food chain. This is undertaken in collaboration with Food Standards Scotland monitoring AMR in *E. coli* from cattle, sheep, pigs and poultry presenting at abattoirs in Scotland for slaughter for human consumption. The antibiotics tested for resistance were selected for their relevance for human treatment, rather than veterinary practice.

Among high priority critically important antimicrobials (HP-CIAs*):

- **resistance** to **co-amoxiclav** in **poultry** isolates **decreased** from **17.1%** (71 of 415 tested) in **2023**, to **8.2%** (39 of 474 tested) in **2024**.
- **resistance** to **ciprofloxacin** was **not detected** in isolates from **pigs**, **cattle** or **sheep** in **2024**.
- in **2024**, **resistance** to **third generation cephalosporins (cefotaxime, ceftazidime)** was detected in **four** isolates from **poultry** (0.8% of 475 tested) and a **single** isolate from **pigs** (0.2% of 418 tested).

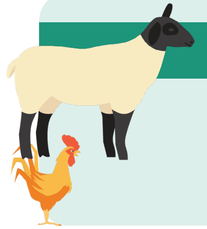
Among non-HP-CIAs:

- **gentamicin resistance** in **poultry** isolates **increased** to **10.5%** (50 of 475 tested) in **2024** from **5.1%** (21 of 415 tested) in **2023**.

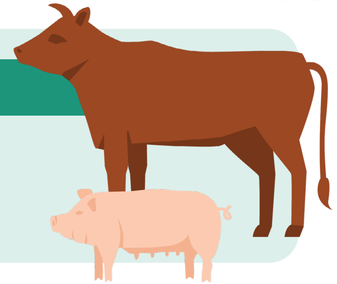
Proportions of antimicrobial resistance to key antibiotics in *E. coli* isolates from pigs, poultry, sheep and cattle over the last six years are presented in the Supplementary Data.

*High priority critically important antimicrobials (HP-CIAs) are: carbapenems, cefovecin, cephalosporins (3rd and later generations), ciprofloxacin, enrofloxacin, marbofloxacin, ofloxacin, orbifloxacin and pradofloxacin

Multi-drug resistance in *E. coli* isolates from healthy livestock

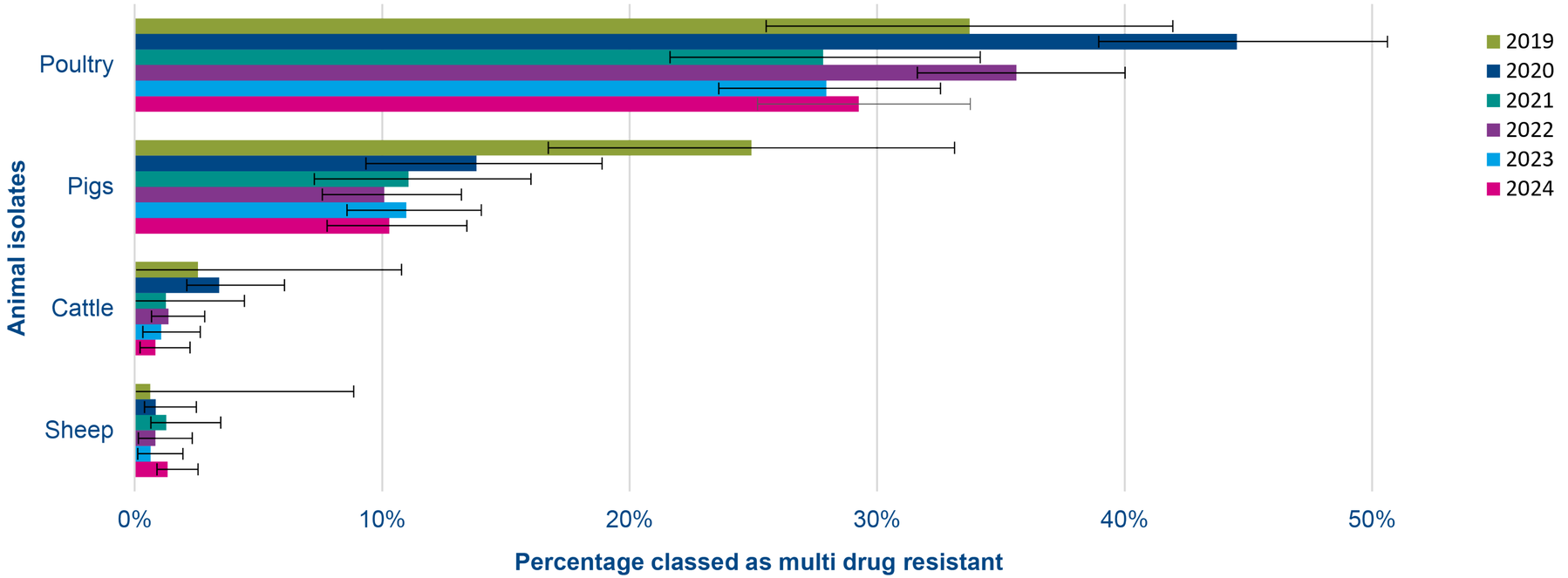


percentage of multi-drug resistant (MDR) *E. coli*



The percentage of **multi-drug resistant (MDR) *E. coli*** isolates reported in **2024** has **remained unchanged** ⟷ compared to **2023** and remained **higher** in **poultry** and **pigs** than in **cattle** and **sheep**, where MDR **remained low**.

Percentage of *E. coli* isolates classed as multi-drug resistant



For information on AMR in *E. coli* from healthy animals see Supplementary Data.

Antimicrobial resistance in the environment

Minimising the spread of antimicrobial resistance (AMR) through the environment remains a UK priority and the UK's five-year National Action Plan (NAP) sets out the ambitions in this area. The environment has long been recognised as a dispersal route and reservoir of resistant pathogens, and as an arena for the evolution of resistance.

Additionally, environmental AMR monitoring can serve as an early warning system for the presence of AMR pathogenic bacteria of public health importance. The Scottish Environment Protection Agency (SEPA) gathers intelligence to support the environmental AMR ambition in the NAP.

SEPA analyses water samples for the presence and abundance of *E. coli* and intestinal *enterococci* at Scotland's designated bathing water sites during the bathing season (June to mid-September). Since 2018, SEPA has also been testing and reporting on the levels of cefotaxime resistant *E. coli* in bathing water samples (SEPA AMR Surveillance Portal).

SEPA has provided some cefotaxime resistant *E. coli* isolates from bathing waters to third party researchers for more in-depth molecular analysis.

Pharmaceutical pollution is a major global One Health problem with significant impacts on ecosystems, wildlife, people and the economy and it exacerbates the spread of AMR in the environment. SEPA, as a member of the One Health Breakthrough Partnership, is using a One Health approach to address pharmaceutical pollution through innovative upstream interventions (such as social and eco-directed prescribing) and to help reduce the input and impacts of human and animal pharmaceuticals on Scotland's water environment.

List of abbreviations and acronyms

Acronym	Definition
AMR	Antimicrobial Resistance
AMS	Antimicrobial Stewardship
AMT	Antimicrobial Management Team
AMU	Antimicrobial Use
ARHAI Scotland	Antimicrobial Resistance and Healthcare Associated Infection Scotland
ASAP	Association of Scottish Antimicrobial Pharmacists
AST	Antimicrobial Susceptibility Testing
AWaRe	Access, Watch, Reserve, classification of antibiotics
BNF	British National Formulary
BSAC	British Society for Antimicrobial Chemotherapy
C. auris	*Candidozyma auris*
CAESAR	Central Asian and European Surveillance of Antimicrobial Resistance
CI	Confidence Interval
CHI	Community Health Index
CLSI	Clinical and Laboratory Standards Institute
COVID-19	Coronavirus disease 2019
CPE	Carbapenemase-producing Enterobacterales
CPO	Carbapenemase-producing Organism
DCVP	Data Capture Validation and Pricing
DDDs	Defined Daily Doses
E. coli	*Escherichia coli*
E. faecalis	*Enterococcus faecalis*
E. faecium	*Enterococcus faecium*
EDRIP	ECOSS Roll-out Implementation Programme
ECDC	European Centre for Disease Prevention and Control
ECOSS	Electronic Communication of Surveillance in Scotland
ESPAUR	English Surveillance Programme for Antimicrobial Utilisation and Resistance
EUCAST	European Committee on Antimicrobial Susceptibility Testing
FSS	Food Standards Scotland
GGC	Greater Glasgow and Clyde
GLASS	Global Antimicrobial Resistance and Use Surveillance System
GP	General Practitioner
HCAI	Healthcare associated infection
HMUD	Hospital Medicines Utilisation Database
HP-CIA	High Priority Critically Important Antibiotics

Acronym	Definition
HPT	Health Protection Team
iGAS	Invasive Group A Streptococcus
ISO	International Organization for Standardization
IMP	Imipenemase
IPCT	Infection Prevention and Control Team
IV	Intravenous
K. oxytoca	*Klebsiella oxytoca*
K. pneumoniae	*Klebsiella pneumoniae*
KPC	Klebsiella pneumoniae Carbapenemase
LIMS	Laboratory Information Management System
MDR	Multi Drug Resistant
MIC	Minimum Inhibitory Concentration
NAP	National Action Plan
NDM	New Delhi Metallo-beta-lactamases
NICE	National Institute for Health and Care Excellence
NHS	National Health Service
NRS	National Records of Scotland
NSS	NHS National Services Scotland
OBD	Occupied Bed Days
OXA	Oxacillinase
P. aeruginosa	*Pseudomonas aeruginosa*
PHS	Public Health Scotland
PIS	Prescribing Information System
S. aureus	*Staphylococcus aureus*
S. pneumoniae	*Streptococcus pneumoniae*
SAPG	Scottish Antimicrobial Prescribing Group
SANG	Scottish Antimicrobial Nurses Group
SEPA	Scottish Environmental Protection Agency
SAMRS SMiRL	Scottish Antimicrobial Resistance Service, Scottish Microbiology Reference Laboratories
SONAAR	Scottish One Health Antimicrobial Use and Antimicrobial Resistance
SRUC	Scotland's Rural College
UK	United Kingdom
UKHSA	United Kingdom Health Security Agency
UKAS	United Kingdom Accreditation Service
UTI	Urinary Tract Infection
VIM	Verona integron-encoded metallo-beta-lactamase
VRE	Vancomycin resistant enterococci
WGS	Whole Genome Sequencing
WHO	World Health Organization

Appendix 1 – Background information

Revisions to the surveillance

Revisions to surveillance are summarised below. See Appendix 2 for further information on revisions.

Description of Revision	First report revision applied	Report section(s) revision applies to	Rational for revision
Implementation of new Biomerieux® VITEK antimicrobial susceptibility testing (AST) cards within laboratories	2020	Antimicrobial resistance in humans	Implementation of new Biomerieux® VITEK AST cards in late 2018 that test amoxicillin in combination with a fixed clavulanic acid concentration of 2 mg/L as per the EUCAST recommendations. Roll out across National Health Service (NHS) boards was variable due to laboratories depleting existing stock of older cards. This change was associated with an increase in co-amoxiclav non-susceptibility in 2019.
Temocillin breakpoints (Enterobacterales)	2020	Antimicrobial resistance in humans	No EUCAST breakpoint available. Initially all Biomerieux® VITEKs used the British Society for Antimicrobial Chemotherapy (BSAC) legacy urinary tract infection breakpoint of 16. NHS Greater Glasgow and Clyde (GGC) moved to systemic breakpoint of 8 in ~2015. Other NHS boards moved variably up until end 2017. NHS GGC and some others retained an 'I' category (minimum inhibitory concentration 16) up until October 2019 when all moved to S<8 and R>8.
Implementation of v_12.0 EUCAST breakpoints	2022	Antimicrobial resistance in humans and antimicrobial resistance in *Escherichia coli* isolates from healthy livestock	Changes can be accessed here. Breakpoints were generally lower in the EUCAST breakpoint table V12.0 compared to V9.0. Exceptions to this are trimethoprim for both Enterobacterales and *Staphylococcus aureus* and azithromycin for *S. aureus* only, where the breakpoint increased.

Description of Revision	First report revision applied	Report section(s) revision applies to	Rational for revision
Fosfomycin results	2022	Antimicrobial resistance in humans	EUCAST have noted that testing for fosfomycin susceptibility in *E. coli* urinary isolates using VITEK 2 may lead to errors, and recommend that this method of testing is not used (see here for further details). The majority of laboratories in NHS Scotland use VITEK 2 and therefore AST results for fosfomycin may be unreliable. Consequently, fosfomycin resistance is not included in this report.
UK-adapted WHO Access, Watch and Reserve list update	2024	Antimicrobial use in humans	The UK AWaRe (Access, Watch and Reserve) lists were updated following review. For further information see Appendix 2.
SAPG methodology update for identifying duration of courses of antibiotics	2024	Antimicrobial use in humans	The Scottish Antimicrobial Prescribing Group (SAPG) agreed upon new methodology for identifying five-day courses of amoxicillin, and three-day courses of trimethoprim. For further information, see Appendix 2.
New UK National Action Plan 2024-2029 Targets progress update for Scotland	2024	Antimicrobial use in humans and Antimicrobial resistance in humans	New human health target data for the UK NAP 2024-2029 'Confronting antimicrobial resistance 2024 to 2029' are presented in this report.
Data on antimicrobial use in animals	2024	Antimicrobial use in animals	Data on antimicrobial use in companion animals have not been included in this report. The data from the Small Animal Veterinary Surveillance Network (SAVSNET) were not available at the time of reporting. Inclusion of these data will be reviewed again in future reports.

Appendix 2 – Metadata

Publication title

Scottish One Health Antimicrobial Use and Antimicrobial Resistance in 2024 (SONAAR report, 2024)

Description

This annual report provides data relating to antimicrobial use (AMU) and antimicrobial resistance (AMR) in Scotland during 2024.

Theme

Health and Care (ARHAI Scotland, NHS National Services Scotland and Public Health Scotland (PHS)).

Topic

Antimicrobial use and resistance in humans and animals.

Format

Online resource (PDF).

Data source(s)

Antimicrobial use in humans

Antibiotic use in primary care: Prescribing Information System (PIS), PHS and NHS National Services Scotland (NSS).

Population denominator data: Mid-year population projections for Scotland, National Records of Scotland (NRS) population estimates.

Antibiotic use in secondary care: Hospital Medicines Utilisation Database (HMUD), PHS and NSS.

Healthcare associated denominator: Total occupied bed days (OBDs), Sum of OBDs for all hospitals in numerator: PHS ISD(S)1.

Antimicrobial resistance in humans

Bacteraemia:
Case data: ECOSS.

Population denominator data: National Records of Scotland (NRS) mid-year population estimates.

UK NAP Target estimated AMR bacteraemia: Electronic Communication of Surveillance in Scotland (ECOSS) and ECOSS Enhanced Surveillance Web Tool.

Urinary tract infections caused by *Escherichia coli*: ECOSS.

Carbapenemase-producing organisms:

Case data: ECOSS and the Scottish Antimicrobial Resistance Service, Scottish Microbiology Reference Laboratories (SAMRS SMiRL, Glasgow).

Population denominator data: National Records of Scotland (NRS) mid-year population estimates.

Unusual AMR phenotypes: ECOSS.

Antimicrobial resistance in *Salmonella*: SAMRS SmiRL via PHS.

Antimicrobial resistance in animals: Scotland's Rural College (SRUC) Veterinary Services.

Antimicrobial resistance in the environment: N/A

Date that data are acquired

Antimicrobial use in humans

Antibiotic use in primary care:
Patient-based analysis: 02/09/2025
Urinary tract infections analysis: 03/07/2025
Primary care trend data: 24/06/2025
Primary care duration of course analysis: 24/06/2025
Primary care antifungal analysis: 10/09/2025
Population denominator data: Mid-year population estimates for Scotland, NRS population estimates: 07/03/2025

Antibiotic use in secondary care:
Secondary care trend analysis: 24/06/2025
Secondary care antifungal analysis: 09/10/2025
Healthcare denominator data: Total occupied bed days (OBDs), sum of OBDs for all hospitals in numerator: 07/03/2025

Antimicrobial resistance in humans

Bacteraemia:
Gram-negative case data: 09/06/2025
Gram-positive case data: 25/06/2025

Population denominator data: Mid-year population projections for Scotland: 07/03/2025

Urinary tract infections caused by *Escherichia coli*:
Case data between 2019 and 2022: 02/04/2024
Case data between 2023 and 2024: 03/06/2025

Carbapenemase-producing organisms:
Case data: 02/07/2025
Population denominator data: Mid-year population projections for Scotland: 07/03/2025

Unusual AMR phenotypes: 27/06/2025

Antimicrobial resistance in *Salmonella*: 26/06/2025

Antimicrobial resistance in animals

Antimicrobial resistance in veterinary clinical isolates from livestock: 14/08/2025

Antimicrobial resistance in *Escherichia coli* isolates from healthy livestock: 17/07/2025

Antimicrobial resistance in the environment: N/A

Release date

18 November 2025

Frequency

Annual

Timeframe of data and timeliness

The latest iteration of data are to 31 December 2024, therefore the data are 11 months in arrears.

Continuity of data

Antimicrobial use in humans:
A new digital pharmacy system was rolled out in NHSScotland in 2023. The new Data Capture Validation and Pricing (DVCP) system for producing payment schedules for pharmacies, dispensing doctors, and appliance suppliers on behalf of NHS boards was replaced May 2023.

Following the implementation of the new Data Capture Validation and Pricing (DCVP) system in 2023, differences across how medicines are mapped to the British National Formulary (BNF) were identified. This may affect a small number of relevant drugs and presentations intended for systemic use for data from 2023 onwards.

Changes in healthcare activity during the COVID-19 pandemic may have affected antimicrobial use and comparison of results should be interpreted with caution. The six years from 2019 to 2024 are presented in this report, with the years 2019 and 2023 being compared directly with 2024.

Antimicrobial resistance in humans:

New Biomerieux® VITEK AST cards were implemented in late 2018 that test amoxicillin in combination with a fixed clavulanic acid concentration of 2 mg/L as per the EUCAST recommendations. Roll out across National Health Service (NHS) boards was variable due to laboratories depleting existing stock of older cards. This change was associated with an increase in co-amoxiclav non-susceptibility in 2019.

Temocillin breakpoints (Enterobacterales): No EUCAST breakpoint available. Initially all Biomerieux® VITEKs used the British Society for Antimicrobial Chemotherapy (BSAC) legacy urinary tract infection breakpoint of 16 (MIC). NHS Greater Glasgow and Clyde (GGC) moved to systemic breakpoint of 8 in ~2015. Other NHS boards moved variably up until end 2017. NHS GGC and some others retained an 'I' category (minimum inhibitory concentration 16) up until October 2019 when all moved to S<8 and R>8.

Throughout 2022, the majority of Scottish National Health Service (NHS) diagnostic laboratories, on a phased basis, changed from version 9.0 of the European Committee on Antimicrobial Susceptibility Testing (EUCAST) breakpoint table to version 12.0. NHS boards have continued with a phased approach to implementing more recent versions of EUCAST yearly updated breakpoint tables. Breakpoints are generally lower in the more recent EUCAST breakpoint table versions 12.0 (2022) to 14.0 (2024) compared to version 9.0 (2019). Exceptions to this were trimethoprim for both Enterobacterales and *Staphylococcus aureus* (*S. aureus*) and azithromycin for *S. aureus*, where the breakpoint increased in version 12.0. A reduction in a breakpoint will result in an increase in the number of isolates falling into the resistant category. Conversely, an increased breakpoint will result in a reduction in the numbers in the resistant category. Furthermore, later EUCAST versions also include revisions to, or the introduction of, multiple clinical breakpoints for certain species. This must be considered when interpreting results for this report.

EUCAST have noted that testing for fosfomycin susceptibility in *E. coli* urinary isolates using VITEK 2 may lead to errors, and recommend that this method of testing is not used (see here for further details). The majority of laboratories in NHS Scotland use VITEK 2 and therefore AST results for fosfomycin may be unreliable.

Consequently, fosfomycin resistance is not included in this report.

A number of NHS laboratories have undergone changes to their Laboratory Information Management Systems (LIMS) with further roll-out planned. Any changes to LIMS may affect how results have been reported to ECOSS.

Changes in healthcare activity and patient populations during the COVID-19 pandemic may have affected the epidemiology of infections included in this report and comparison of results should be interpreted with caution.

Antimicrobial resistance in *Salmonella*:

Changes in healthcare activity, patient populations and contact between animals and their vets during the COVID-19 pandemic may have affected the epidemiology of *Salmonella* and comparison of results between 2020 and 2022 should be interpreted with caution.

Antimicrobial resistance in animals:

The COVID-19 pandemic may have affected the level of contact between animals and their vets between 2020 and 2022. Comparison of results should be interpreted with caution.

Antimicrobial resistance in the environment: N/A

Revisions statement

These data are not subject to planned major revisions. However, ARHAI Scotland aims to continually improve the interpretation of the data and therefore analysis methods are regularly reviewed and may be updated in the future.

Revisions relevant to this publication

National Records of Scotland (NRS) mid-year population estimates

Population denominators have been retrospectively updated from mid-2019 to mid-2022 to reflect revisions by National Records for Scotland (NRS), following Scotland's Census 2022. Population estimates for mid-2023 were revised following publication of the NRS mid-year population estimate for 2023.

Antimicrobial use in humans:

In 2024 the UK AWaRe (Access, Watch and Reserve) lists were updated. First-generation cephalosporins (e.g. cefalexin, cefadroxil, cefalotin, cefazolin, cefradine) were moved from the Watch to the Access category. Fusidic acid was moved from the Access category to Watch while tinidazole was moved to the Access category from Other.

Demeclocycline and Pristinamycin were moved from Watch to Other. This change was applied retrospectively to prescribing data included in this report. The following Supplementary Data tables have been also revised.

- Supplementary Tables 3.1, 3.2 and 3.3,
- Supplementary Tables 10.1, 10.2, 10.3,
- Supplementary Table 12.2,
- Supplementary Table 13.2,
- Supplementary Tables 19.1, 19.2, 19.3, and 19.4,

See SONAAR report 2023 for data using the previous methodology.

Methenamine hippurate, a urinary antiseptic used for the prevention of recurrent urinary tract infections, is currently classified in the UK AWaRe 'Other' category. As it is not an antibiotic, its inclusion in the denominator for the 70% Access target has prompted review of its appropriateness within antibiotic stewardship metrics. Discussions are ongoing to clarify its role in the calculation of these targets.

In the 2024, prescribing data by prescriber type have been excluded from the main SONAAR report to minimise the risk of misinterpretation. Prescriber classification is derived from prescription form type; however, this approach has limitations. Specifically, within GP practices, non-GP prescribers may utilise GP prescription forms for electronic prescribing, which compromises the reliability of distinguishing between GP and non-GP prescribers. This limitation is acknowledged; however, to support transparency, the relevant data remain available in the Supplementary Data tables, where prescriber type is clearly defined according to prescription form type.
The revisions apply to the following tables:

- Supplementary Table 1.2,
- Supplementary Tables 2.2 and 2.3,
- Supplementary Tables 12.1 and 12.2,
- Supplementary Tables 13.1, 13.2 and 13.3,
- Supplementary Tables 19.1, 19.2, 19.3 and 19.4,
- Supplementary Tables 16.1.1, 16.1.2, 16.2.1, 16.2.2

See SONAAR report 2023 for previous terminology.

To better reflect local prescribing practices across Scotland, the Scottish Antimicrobial Prescribing Group (SAPG) updated its methodology in 2025 for estimating antibiotic course durations. Course duration is not recorded in Prescribing Information System (PIS) and so this must be estimated through quantity of tablets / capsules prescribed. Prescribers use different pack sizes and dosing instructions, so broadening the definitions helps ensure antimicrobial use is measured more accurately and consistently.

A five-day course of amoxicillin is now defined as a prescription of less than 15, 15, or 30 capsules of 500mg, replacing the previous definition of 15 capsules. Similarly, the definition of a three-day course of trimethoprim was expanded to include 12 tablets of 100mg, in addition to the previous standard of 6 tablets of 200mg. These definition changes have been applied retrospectively. The following tables in the Supplementary Data tables have been revised to reflect this change.

- Supplementary Table 14.1
- Supplementary Table 15.1
- Supplementary Tables 16.1.2 and 16.2.2

See the SONAAR report 2023 for data using the previous methodology.

New human health target data for the UK NAP 2024-2029 'Confronting antimicrobial resistance 2024 to 2029' are presented in this report. This includes reporting on Scotland's progress against target 4a, that by 2029, we aim to reduce total antibiotic use in human populations by 5% from the 2019 to 2020 financial year baseline and target 4b, that by 2029, we aim to achieve 70% of total use of antibiotics from the Access category (new UK category) across the human healthcare system.

Antimicrobial use in animals:

Antimicrobial use in companion animals is not included in this report. The data from the Small Animal Veterinary Surveillance Network (SAVSNET) not available at the time of reporting.

Antimicrobial resistance in humans:

Bacteraemia: None.

UK NAP Target estimated AMR bacteraemia: New human health target data for the UK NAP 2024-2029 'Confronting antimicrobial resistance 2024 to 2029' are presented in this report. This includes reporting of Scotland's progress against the human health NAP target 1b. that by 2029, we aim to prevent any increase in a specified set of drug resistant infections in humans from the 2019 to 2020 financial year baseline. This report includes the estimated number of resistant bacteraemia between financial year 2019 and 2024.

Urinary tract infections caused by *Escherichia coli*: EUCAST have noted that testing for fosfomycin susceptibility in *E. coli* urinary isolates using VITEK 2 may lead to errors, and recommend that this method of testing is not used (see here for further details). The majority of laboratories in NHS Scotland use VITEK 2 and therefore AST results for fosfomycin may be unreliable. Consequently, fosfomycin resistance is not included in this report

Carbapenemase-producing organisms: None.

Antimicrobial resistance in *Salmonella*:

None.

Antimicrobial resistance in animals:

Retrospective amendments were made to data processing to improve the capture and identification of isolate Antimicrobial Susceptibility Testing (AST) results.

Antimicrobial resistance in the environment: N/A

Concepts and definitions

Statistical significance: Please note where an increase or decrease is stated in this report this refers to a statistical change. Statistical significance has been determined by a p-value of less than (<) 0.05. Due to the number of tests being done at the same time a Bonferroni correction has been applied and the p-values adjusted to reflect the number of tests undertaken for each organism. In order to keep the amount of multiple testing to a minimum, only organism and drug combinations with enough cases each year have been tested.

Confidence Intervals: Confidence intervals (95% CI) for proportions were calculated to indicate robustness of the proportions presented. Where a 95% CI has been quoted or displayed in a figure as an error bar around a percentage, the method used is the Wilson Score.

Rounding: Please note that due to rounding to 1 decimal place, values may not add up to 100%.

Year to Year Comparisons: The current calendar year 2024 was compared to the previous calendar year 2023, as well as calendar year 2019. Rates and proportions were compared using Poisson regression and binomial regression respectively. This is performed to determine the presence of a significant change to the rate or proportion between two different years. A resulting p-value of less than 0.05 (or Bonferroni-adjusted threshold) was deemed statistically significant to determine an increase or decrease relative to the previous years.

For antimicrobial susceptibility testing results where revisions were made to the EUCAST clinical breakpoints during the time period covered within this report, year to year comparisons have not been reported.

Comparisons of antimicrobial susceptibility testing results for *E. coli* urine isolates were not reported for 2024 compared to 2019, due to historic differences in reporting of urine isolates into ECOSS across NHS boards.

Year to year comparisons of antimicrobial susceptibility testing results where the average number of isolates tested each year is less than 25 were not reported.

Antimicrobial use in humans

Prescribing data: details available from PHS overview of prescribing data.

Population estimates: details available from the National Records of Scotland Mid-Year Population Estimates.

Occupied bed days: details available in PHS ISD(S)1 data manual.

Defined Daily Doses (DDDs), World Health Organization (WHO): details available from the ATC/DDD Index.

Guidance: UK Access, Watch, Reserve, and Other classification for antibiotics (UK-AWaRe antibiotic classification), UKHSA. Available from UKHSA.

Unless otherwise stated Primary Care figures exclude Dental (GP14) Prescription Forms.

Primary care prescribing information sourced from PIS is linked to patient Community Health Index (CHI) numbers. Using patient CHI numbers, it is possible to analyse demographic information on patients prescribed antibiotics such as age and gender. Patients resident in Scotland have a unique CHI number meaning it is also possible to count numbers of distinct patients receiving a particular treatment or investigate prescribing patterns for particular individuals over time. From 2009 onwards, the majority of prescriptions can be linked to a valid CHI number, however CHI capture rates can vary by drug, geographical area or prescriber type, with GPs having better capture rates than other prescriber types. When interpreting trends in patient counts over time, the underlying CHI capture rate must also be considered. In the supplementary data for this report, where patient level data is used, the relevant CHI capture rates are also presented. It is difficult to identify with certainty how much impact increasing CHI completeness has on the number of patients identified, but the evidence available suggests that the impact is small when considering the scale of change in CHI completeness presented in this report and this should not generally be significantly affecting trends in patient counts.
Parenteral antibiotic DDDs are used to monitor use of intravenous antibiotics.

UK National Action Plan Targets for antimicrobial use:

The UK AMR National Action Plan (NAP) 2024-2029 contains outcomes and commitments that will make progress towards the 20-year vision, which is for AMR to be contained, controlled and mitigated. The targets are to:

- Reduce total antibiotic use in human populations by 5% from the 2019 to 2020 financial year baseline by 2029.
- Achieve 70% of total use of antibiotics from the Access category (new UK category) across the human healthcare system by 2029.

Further information available in the UK 5-year action plan for antimicrobial resistance 2024 to 2029.

Antimicrobial resistance in humans

Case definitions:

Total numbers, incidence rates and antimicrobial susceptibility testing (AST) results for bacteraemia and bacteriuria were calculated using the following case definitions:

A new case of bacteraemia is a patient from whom an organism has been isolated from the patient's blood, and who has not previously had the same organism isolated from blood within a 14-day period (i.e. 14 days from date last positive sample obtained). The most complete then most resistant AST result during each episode is reported for each case.

A new case of *Escherichia coli* bacteriuria (referred to in this report as 'episodes of *E. coli* isolated from urine') is a patient from whom *E. coli* has been isolated from the patient's urine, and who has not previously had the same organism isolated from urine within a 30-day period (i.e. 30 days from date last positive sample obtained). The most complete then most resistant AST result during each episode is reported for each case.

Isolate(s) refers to the organism isolated from each case of bacteraemia or bacteriuria.

With the exception of *Escherichia coli* bacteraemia and *Staphylococcus aureus* bacteraemia, all human bacteraemia data are based only on positive blood results extracted from ECOSS and are not validated cases. *Escherichia coli* bacteraemia and *Staphylococcus aureus* bacteraemia data use validated data collected as part of mandatory surveillance programme as detailed in the Protocol for National Enhanced Surveillance of Bacteraemia.

Please note that bacteriuria (bacteria present in urine) is used as a proxy for urinary tract infection (UTI) and not all cases reported will be validated cases of UTI. As part of the NHS Pharmacy First Scotland service, community pharmacists have the ability to supply via patient group direction trimethoprim or nitrofurantoin for uncomplicated UTIs in non-pregnant females aged 16-65 until August 2022, after which the eligible age range extended to 16 years and over). This service has been available in all community pharmacies since August 2020 and is likely to have had an impact on the number of urine samples being referred to laboratories since females with uncomplicated UTIs can be treated by pharmacists without attending their General Practitioner.

A new case of CPO is a patient from whom an organism-carbapenemase enzyme gene combination has been identified from a clinical or screening specimen, and who has not previously had the same organism- carbapenemase enzyme gene combination identified within the same calendar year.

Incidence rates were calculated as follows:

Bacteraemia or bacteriuria episode rate per 100,000 population = (Number of cases per year / mid- year Scottish population) x 100,000

Population estimates: details available from the National Records of Scotland Mid-Year Population Estimates.

Percentage resistance:

Resistance is defined as isolates reported as resistant (R).

Percentage resistant = resistant isolates divided by the total number of isolates tested multiplied by 100.

Antimicrobial resistance burden:

The burden of antimicrobial resistant bacteraemia is estimated for select priority organisms of public health importance including: *Escherichia coli*, *Klebsiella pneumoniae*, *Klebsiella oxytoca*, *Acinetobacter* species, *Pseudomonas aeruginosa*, *Enterococcus faecium*, *Enterococcus faecalis*, *Staphylococcus aureus* and *Streptococcus pneumoniae* bacteraemia. The percentage of organisms resistant (R) to at least one key antibiotic is reported (see Table 1: Key organism and antibiotic combinations for burden of antimicrobial resistant bacteraemia). Antimicrobial susceptibility results are not available for all bacteraemia cases, therefore the percentage resistance from available results is applied to the total number of bacteraemia cases to provide the estimated number of antimicrobial resistant bacteraemias.

Table 1: Key organism and antibiotic combinations for burden of antimicrobial resistant bacteraemia.

Organism(s)	Key antibiotic(s)
Escherichia coli, *Klebsiella pneumoniae* and *Klebsiella oxytoca*	Carbapenems (imipenem, meropenem or ertapenem) Third generation cephalosporins (ceftazidime, cefotaxime or ceftriaxone), and not resistant to carbapenems Gentamicin, and not resistant to carbapenems or third generation cephalosporins Ciprofloxacin, and not resistant to carbapenems or third generation cephalosporins or gentamicin
Acinetobacter species	Carbapenems (imipenem or meropenem) Aminoglycosides (amikacin or gentamicin), and ciprofloxacin, but not resistant carbapenems
Pseudomonas aeruginosa	Carbapenems (imipenem or meropenem) Three or more antimicrobial groups: aminoglycosides (amikacin, gentamicin); piperacillin-tazobactam (Tazocin); ciprofloxacin, ceftazidime), but NOT resistant to carbapenems.
Enterococcus faecium and *Enterococcus faecalis*	Vancomycin
Staphylococcus aureus	Meticillin
Streptococcus pneumoniae	Penicillin and macrolides (erythromycin, azithromycin, clarithromycin) Penicillin, but not resistant to macrolides

UK National Action Plan Target for antimicrobial resistance:

The UK National Action Plan (NAP) 'Confronting Antimicrobial Resistance 2024 to 2029' includes human health target 1a which aims by 2029, to prevent any increase in a specified set of drug resistant infections in humans from the 2019 to 2020 financial year baseline. This target uses a specified list of organism-antibiotic combinations, which is a subset of the list used to estimate AMR burden in Scotland. The target uses an adapted methodology developed by Cassini and others (see Attributable deaths and disability-adjusted life-years caused by infections with antibiotic-resistant bacteria in the EU and the European Economic Area in 2015: a population-level modelling analysis. The Lancet Infectious Diseases, 19, 1, pages 56 to 66 (2018)) for a UK specific measure of AMR burden.

To report on Scotland's progress against this NAP target, the estimated number of antimicrobial resistant bacteraemia in Scotland is calculated. This is calculated using the percentage resistance per organism-antibiotic combination (number of antimicrobial resistant blood isolates in Scotland, out of all blood isolates tested per organism) applied to the total incidence of bacteraemia per organism, for each calendar year. This was summed (for calendar year) across the organism-antibiotic combinations listed in Table 2 below.

Table 2: Key organisms and antibiotics for burden of antimicrobial resistant infections as measured in the 2024-2029 UK AMR NAP.

Organism(s)	Key antibiotic(s)
Escherichia coli and *Klebsiella pneumoniae*	Carbapenems (imipenem, meropenem or ertapenem). Third generation cephalosporins (ceftazidime, cefotaxime or ceftriaxone), and not resistant to carbapenems.
Acinetobacter species	Carbapenems (imipenem or meropenem). Aminoglycosides (amikacin or gentamicin) and ciprofloxacin, but not resistant carbapenems.
Pseudomonas aeruginosa	Carbapenems (imipenem or meropenem). Three or more antimicrobial groups: aminoglycosides (amikacin, gentamicin); piperacillin-tazobactam (Tazocin); ciprofloxacin, ceftazidime), but not resistant to carbapenems.
Enterococcus faecium and *Enterococcus faecalis*	Vancomycin
Staphylococcus aureus	Meticillin
Streptococcus pneumoniae	Penicillin and macrolides (erythromycin, azithromycin, clarithromycin). Penicillin, but not resistant to macrolides.

Carbapenemase-producing organisms:

The term carbapenemase-producing organisms (CPO) encompasses all acquired carbapenemase-producing Gram-negative bacteria and is not limited to carbapenemase-producing Enterobacterales.

Further detail on case definitions can be accessed from the Toolkit for the early detection, management and control of carbapenemase-producing Enterobacteriaceae in Scottish acute settings.

Unusual AMR phenotypes:

In 2018, the SONAAR team at ARHAI Scotland introduced an electronic process to run a twice weekly interrogation of ECOSS to identify unusual AMR phenotypes and contact the submitting laboratory requesting confirmation of reported resistance. All alerts are assessed by ARHAI Scotland and if of potential public health concern are drawn to the attention of the wider public health community for appropriate action.

Definitions of an unusual AMR phenotype can be accessed from EUCAST.

Appendix 13 of the National Infection Prevention & Control Manual contains a mandatory alert microorganism/ condition list. Local monitoring ensures that microbiology clinicians, infection prevention and control teams, health protection teams and antimicrobial management teams, as appropriate, are aware of each identified case as per local protocols.

The identification of an alert is dependent on laboratories actively performing AST and submitting results to ECOSS. This may result in underreporting, or no reporting, of a particular organism-antibiotic combination if there is limited or no testing performed.

An instance of an unusual AMR phenotype was considered as the first isolate of one specific organism per patient per calendar year. Where more than one organism was present in a sample, deduplication was carried out separately for each organism.

Antimicrobial resistance in *Salmonella*

Salmonella is notifiable in humans and a reportable animal pathogen in the UK. All medical diagnostic laboratories are required to forward suspect isolates from humans to the SAMRS SMiRL which is responsible for testing antimicrobial susceptibility in *Salmonella*. All veterinary diagnostic laboratories isolating *Salmonella* from livestock species and dogs are also required to send suspect isolates for confirmation and typing to the SAMRS SMiRL.

For animal data, most of the isolates received by the reference laboratory have been collected by passive surveillance as the result of clinical suspicion in the animals sampled. The submission of animal samples is affected by the willingness of an animal keeper to pay the costs of laboratory testing to inform treatment, in addition to the clinical presentation in the affected animal(s). There is, therefore, likely to be year-on-year variation in the relative proportions of different animal species from which clinical samples are submitted and, also, variation in the proportions of different serotypes identified.

Interpretation of *Salmonella* resistance to individual antibiotics is further complicated by the fact that in some subtypes there are well-recognised genetic elements encoding resistance to multiple agents. Thus, the occurrence of resistance to individual antibiotics is not always independent and the apparent prevalence of resistances to different agents can be strongly influenced by the abundance of *Salmonella* sub-types in the sample set for each reporting period. Therefore, caution is required, within the scope presented in this report, when considering year-on-year comparison on proportions resistant in all *Salmonella* isolates from animals.

Whole genome sequencing (WGS) was introduced into routine use in the SAMRS SMiRL in late 2017 for the identification and characterisation of *Salmonella* isolates.

Following a review of published reports and an extensive validation confirming the high degree of correlation observed between the two approaches, the *in silico* prediction of AMR phenotype from WGS was introduced in January 2020. The predictive tools in use allow the identification of many individual AMR genes. The availability of data from isolates from different source populations (humans and animals) which have undergone the same processing by the same laboratory offers an opportunity to monitor the trends in resistance and identify epidemiological links in these populations.

Antimicrobial resistance in animals

Staphylococcus species are common commensal organisms that can act as important opportunist pathogens of humans and other animals.

Streptococcus species can be important pathogens or opportunist colonisers of livestock species, with the potential to cause severe disease of the skin, respiratory tract, body cavities, wounds and urinary tract. Some species, including *Streptococcus agalactiae*, *Streptococcus dysgalactiae*, and *Streptococcus suis*, are also recognised in human infections.

Pasteurellaceae are important causes of potentially severe respiratory and soft tissue infections in livestock animals. In livestock animals, high levels of morbidity and mortality can result with consequential significant economic losses.

E. coli are a major constituent of the normal faecal flora of humans and warm-blooded animals. However, some strains can cause intestinal and extraintestinal disease.

Antimicrobial resistance in veterinary clinical isolates from livestock:

Data presented here represent the percentage of resistant isolates over all tested isolates. These data represent a non-random sample of veterinary practices and veterinary isolates, based on voluntary submission of data to SRUC. The data from veterinary clinical isolates are subject to a number of important biases. Unlike the clinical samples in humans in Scotland, the samples are tested on a ‘charged for’ basis to inform private veterinary treatment of diseased animals. There is a cost to the animal keeper that affects the submission of samples to these services. In addition, the primary purpose of screening for AMR is to inform veterinary treatment and they are tested against a panel of antimicrobials relevant for that purpose at, where they exist, species-relevant clinical breakpoints, based on British Society for Antimicrobial Chemotherapy (BSAC) breakpoints. Interpretation of these data in terms of their relevance to public health is challenging beyond the notion of evidence of impact of a selection pressure existing in another compartment of the ecosystem that humans share closely with animals.

Antimicrobial resistance in *Escherichia coli* isolates from healthy livestock:

Data presented here represent the percentage of resistant isolates over all tested isolates. These isolates are from healthy livestock animals and are tested against a panel of antimicrobials, and at breakpoints, relevant to human clinical isolates. The percentage of multi drug resistant isolates, defined as isolates resistant to three or more antimicrobial classes, is also presented.

Breakpoints for AST in *E. coli* isolates from healthy livestock are provided by SRUC and are aligned with EUCAST breakpoints, except tetracycline which uses the Clinical and Laboratory Standards Institute (CLSI) breakpoint value. EUCAST breakpoints are applied to healthy livestock isolates to enable relevant comparisons of resistance with isolates from humans, to human relevant antibiotics. Changes to breakpoints over time have been applied retrospectively to healthy livestock isolates to allow year-on-year comparisons.

Antimicrobial resistance in the environment: N/A

Relevance and key uses of the statistics

Making information publicly available. The report is intended to support planning, prioritisation and evaluation of initiatives to optimise antimicrobial use and to minimise antimicrobial resistance.

Accuracy

Antimicrobial use in humans

Antibiotic use in primary care: A subset of these data are routinely validated by Practitioner Services on a monthly basis.

Healthcare associated denominator, total occupied bed days: Sum of OBDs for all hospitals in numerator, standardised methodology used.

Antimicrobial resistance in humans

Bacteraemia: Data supplied by United Kingdom Accreditation Service (UKAS) accredited laboratories using standardised testing methodologies.

UK NAP Target estimated AMR bacteraemia: The calculation of estimated antimicrobial resistant bacteraemia uses data supplied by United Kingdom Accreditation Service (UKAS) accredited laboratories using standardised testing methodologies. The number of antimicrobial resistant blood isolates in Scotland, out of all blood isolates tested per organism, is then applied as a percentage of total incidence of bacteraemia per organism. This was summed across the specified list of organism-antibiotic combinations listed in the NAP.

Urinary tract infections caused by *Escherichia coli*: Data supplied by UKAS accredited laboratories using standardised testing methodologies. However, it should be noted that PHS are undertaking an ECOSS quality improvement project (ECOSS Roll-out Implementation Programme (EDRIP)) which has highlighted some inconsistent mapping and reporting of urine sample results in ECOSS. EDRIP is currently paused due to the roll out of a new laboratory information management system. Due to these data inconsistencies, it is not currently possible to report and compare incidence over time, however we do not expect this to impact the national antimicrobial resistance.

Carbapenemase-producing organisms: Data supplied by UKAS accredited laboratories using standardised testing methodologies.

Unusual AMR phenotypes: Data supplied by UKAS accredited laboratories using standardised testing methodologies. Unusual AMR phenotypes are confirmed with the sending laboratory.

Antimicrobial resistance in *Salmonella*: Data supplied by UKAS accredited laboratories using standardised testing methodologies via SAMRS SMiRL.

Antimicrobial resistance in animals: Data supplied by UKAS accredited laboratories using standardised testing methodologies. SRUC (ISO:17025), SAMRS SMiRL, Glasgow (ISO:15189).

Antimicrobial resistance in the environment: N/A

Completeness

Antimicrobial use in humans:
The AMU primary care queries use the BNF classification to identify and extract relevant drugs and presentations intended for systemic use. The vast majority of presentations are mapped to a BNF classification, but a small number may not be. In addition, preparations of medicines which do not have a classification in the BNF may subsequently be assigned one. This means that there may be small differences in the data extracted over time.

Secondary Care data are complete for all NHS health boards, apart from the Golden Jubilee University Hospital which is complete to August 2024 and partially complete for September 2024.

Antimicrobial resistance in humans

Bacteraemia: All data for the reporting period have been included in the analysis as reported to ECOSS.

UK NAP Target estimated AMR bacteraemia: All data for the reporting period have been included in the analysis.

Urinary tract infections caused by *Escherichia coli*: All available data within ECOSS have been included in the analysis. In 2022, it was identified that urine isolates from one NHS board had not been reported in ECOSS. Following investigation, isolates were reported from September 2022 onwards. Due to inconsistencies in data collection over time it has not been possible to report and compare incidence and AMR trends in urine isolates.

Carbapenemase-producing organisms: There were some carbapenemase-producing organism isolates where full antibiotic susceptibility testing was not carried out in 2023.

Unusual phenotypes: All laboratory confirmed isolates have been included in the analysis.

Antimicrobial resistance in *Salmonella*: All laboratory confirmed isolates have been included in the analysis.

Antimicrobial resistance in animals

Antimicrobial resistance in veterinary clinical isolates from livestock: These data represent a non-random sample of veterinary practices and veterinary isolates, based on voluntary submission of data to SRUC. Isolates are derived from samples and animal carcases submitted throughout the year to Disease Surveillance Centres operated by SRUC across Scotland.

Antimicrobial resistance in *Escherichia coli* isolates from healthy livestock: Samples are collected on a monthly basis from a convenience sample of livestock animals of four species (cattle, sheep, pigs and poultry) presenting at abattoirs in Scotland and submitted to SRUC.

Antimicrobial resistance in the environment: N/A

Comparability

Antimicrobial use in humans

The numerator for antibiotic use includes the number of WHO DDDs and is comparable to other antibiotic use surveillance programmes using this method. These data are extracted from live databases (PIS and HMUD) where historic data may be subject to slight variation.

Occupied bed days (OBDs), is derived using a standardised methodology allowing comparability across years.

ARHAI Scotland are a member of the Central Asian and European Surveillance of Antimicrobial Resistance (CAESAR) network and contribute AMU data to WHO Global Antimicrobial Resistance and Use Surveillance System (GLASS).

Antimicrobial resistance in humans

Bacteraemia:

Further details on bacteraemia in Scotland are available in the ARHAI Scotland Annual Report.

Further details on reports on AMR surveillance across the UK (UKHSA, PHW) are reported below, as well as from the ECDC (EARS-Net). ARHAI Scotland submit data annually to the UK AMR NAP ambitions (UKHSA), and to the WHO Global Antimicrobial Resistance and Use Surveillance System (GLASS) initiative, and ARHAI Scotland are part of the Central Asian and European Surveillance of Antimicrobial Resistance (CAESAR) Network. The comparability of data across these reports should be interpreted with caution, due to differences in inclusion criteria, data definitions and availability.

UKHSA annual English surveillance programme for antimicrobial utilisation and resistance (ESPAUR) report. https://www.gov.uk/

government/publications/english-surveillance-programme-antimicrobial-utilisation-and-resistance-espaur-report.

Public Health Wales annual Antimicrobial resistance in blood cultures in Wales report.

European Centre for Disease Prevention and Control (ECDC) report on Antimicrobial resistance surveillance in Europe.

AMR and prescribing data from ARHAI Scotland and UKHSA are included in the WHO Global Antimicrobial Resistance and Use Surveillance System (GLASS) dashboard.

Escherichia coli and *Staphylococcus aureus* bacteraemia epidemiological data are published quarterly by ARHAI Scotland.

ARHAI Scotland Annual report: https://www.nss.nhs.scot/publications/ arhai-scotland-2023-annual-report/

Urinary tract infections caused by *Escherichia coli*:

UKHSA annual English surveillance programme for antimicrobial utilisation and resistance (ESPAUR) report.

Carbapenemase-producing organisms:

UKHSA collection on carbapenem resistance.

ECDC Surveillance Atlas of Infectious Diseases.

Unusual AMR phenotypes: N/A

Antimicrobial resistance in *Salmonella*: N/A

Antimicrobial resistance in animals

Antimicrobial resistance in veterinary clinical isolates from livestock: The primary purpose of screening for AMR is to inform veterinary treatment and isolates from animals are tested against a panel of antimicrobials relevant for that purpose at, where they exist, species-relevant clinical breakpoints.

Antimicrobial resistance in *Escherichia coli* isolates from healthy livestock: Breakpoints for AST in *E. coli* isolates from healthy livestock are provided by SRUC and are aligned with EUCAST breakpoints, except tetracycline which uses the CLSI breakpoint value. EUCAST breakpoints are applied to healthy livestock isolates to enable relevant comparisons of resistance with isolates from humans, to human relevant antibiotics.

Changes to breakpoints over time have been applied retrospectively to healthy livestock isolates to allow year-on-year comparisons.

Antimicrobial resistance in the environment: N/A

Accessibility

It is the policy of NHS National Services Scotland (NSS) to make its web sites and products accessible according to published guidelines.

Coherence and clarity

Tables are accessible via the Supplementary Data on our website.

Value type and unit of measurement

Antimicrobial use in humans:

DDDs per 1,000 population per day (DDDs/1,000/day).

Percentage of the Scottish population receiving at least one course of antibiotics (%) = count of individuals receiving at least one course of antibiotics / total population.

Percentage of antibiotics use belonging to Access group (%) = count of antibiotic items belonging to Access group / total count of antibiotic items.

Count of items and number of items per 1,000 population per day (items/1,000/day).

Percentage of antibiotic courses of three-day duration (%) = count of antibiotic items of three-day duration / total count of antibiotic items.

Percentage of antibiotic courses of five-day duration (%) = count of antibiotic items of five-day duration / total count of antibiotic items.

Percentage of primary care items by prescriber form type (%) = count of antibiotic items by prescriber form type in primary / total count of antibiotic items in primary care.

DDDs per 1,000 occupied bed days (DDDs/1,000 occupied bed days).

Rate of antibiotics given intravenously = count of DDDs for IV antibiotics per 1,000 population per day (IV antibiotic DDDs /1,000 occupied bed days).

DDDs per 1,000 population (DDDs/1,000).

Antimicrobial resistance in humans

Bacteraemia:

Count of cases and incidence rates (per 100,000 population).

Percentage of resistant blood isolates (%) = count of blood isolates resistant for organism-antibiotic combination / total count of blood isolates tested for organism-antibiotic combination.

UK NAP Target estimated AMR bacteraemia:

Estimated count of antimicrobial resistant bacteraemia are calculated based on the percentage of resistant bacteraemia (%) (count of blood isolates resistant for organism-antibiotic combination / total count of blood isolates tested for organism-antibiotic combination), which is then applied to the total incidence of bacteraemia per organism. This was summed across the specified list of organism-antibiotic combinations listed in the UK NAP.

Urinary tract infections caused by *Escherichia coli*:

Count of cases.

Percentage of resistant urine isolates (%) = count of urine isolates resistant for organism-antibiotic combination / total count of urine isolates tested for organism-antibiotic combination.

Carbapenemase-producing organisms:

Count of cases and incidence rate (per 100,000 population). Count of cases by enzyme type and organism.

Percentage of cases by organism (%) = count of cases by organism / total count of cases.

Unusual AMR phenotypes:

Count of confirmed AMR unusual phenotype instances, and count of confirmed unusual AMR phenotype instances per organism-antibiotic combination.

Antimicrobial resistance in *Salmonella*:

Percentage of inferred phenotypic resistance from WGS by antimicrobial (%) = count of isolates with inferred phenotypic resistance / total count of tested isolates.

Antimicrobial resistance in animals

Antimicrobial resistance in veterinary clinical isolates from livestock:

Count of resistant isolates and count of all isolates tested.

Percentage of resistant isolates (%) = count of resistant isolates / total count of all isolates tested.

Antimicrobial resistance in *Escherichia coli* isolates from healthy livestock:

Count of resistant isolates and count of all isolates tested.

Percentage of resistant isolates (%) = count of resistant isolates / total count of all isolates tested.

Antimicrobial resistance in the environment: N/A

Disclosure

The PHS protocol on Statistical Disclosure Protocol is followed.

Official Statistics designation

Not Assessed

UK Statistics Authority Assessment

Not Assessed

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Appendix 2 – Early access details

Pre-Release Access

Under terms of the ‘Pre-Release Access to Official Statistics (Scotland) Order 2008’, NSS is obliged to publish information on those receiving Pre-Release Access (‘Pre-Release Access’ refers to statistics in their final form prior to publication). The standard maximum Pre-Release Access is five working days. Shown below are details of those receiving standard Pre-Release Access.

Standard Pre-Release Access

- Scottish Government Health Department
- NHS Board Chief Executives
- NHS Board Communication leads

Appendix 3 – NSS and official statistics

Official Statistics

Our statistics comply with the Code of Practice for Statistics in terms of trustworthiness, high quality and public value. This also means that we keep data secure at all stages, through collection, processing, analysis and output production, and adhere to the 'five safes'.

Designed by the NHS National Services Scotland Creative Services team.