UK Health Security Agency

English surveillance programme for antimicrobial utilisation and resistance (ESPAUR)

Report 2024 to 2025

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Contents

Content has been divided into chapters with sub-sections, to allow the reader to navigate to the most relevant topics.

This report is accompanied by an annexe, infographics, data appendices in the form of spreadsheets and downloadable slide decks of the graphs. These can be all accessed from the ESPAUR web page.

Foreword

Antimicrobial resistance (AMR) occurs when pathogens evade the action of the drugs that have been developed to counter them. AMR poses a significant global threat to human health and to the longevity of modern medicine. An estimated 4.71 million deaths were associated with bacterial AMR occurring globally in 2021 with this predicted to increase to 8.22 million by 2050 (1). As well as long-term consequences to population health, AMR also has immediate consequences at an individual level as, by increasing risk of treatment failure, AMR is associated with re-consultation, emergency department attendance, hospital admission, extended length-of-stay and increased morbidity and mortality. Several factors accelerate the development of AMR, including the misuse and overuse of antimicrobials. The World Health Organization published its Global Action Plan in 2015 which aims to tackle AMR through improved awareness and understanding, strengthened surveillance and research, improved infection prevention and control measures, optimised use of antimicrobials and sustained investment in treatment and diagnostics (2).

One of the pillars of the UK Health Security Agency's (UKHSA) mission is preparing and responding to threats posed by infectious diseases, including the emergence of AMR, in order to reduce their impact. The collection of data to monitor trends in resistant pathogens and associated infections, as well as in the consumption of antimicrobials is crucial to the UKHSA's goals. Having robust data enables informed decisions about where resources should be focused, and how interventions are best directed for those disproportionately affected by the burden of AMR.

To take effective action, it is crucial that data pertinent to AMR are accessible to all in a format that allows action to be taken – whether for policymakers or healthcare professionals who need them to inform their research or response, or for the public so that they can make decisions important to each one of them in their daily lives.

Publication of the annual ESPAUR report offers a comprehensive analysis of temporal trends in both the prevalence of infections caused by resistant pathogens and levels of antimicrobial prescribing in England. While the number of antibiotic-resistant infections has risen by 13.1% over the last 5 years, levels of antibiotic use have declined by 2% from pre-pandemic levels. However, the burden and impact of infectious disease are often not felt equally among society. The recently published Health Inequalities in Health Protection Report 2025 reported significant differences in hospital admission rates for infections, such as urinary tract infections (UTIs), an infection that is often caused by *Escherichia coli*, among populations with factors associated with health inequalities. This ESPAUR report shows that such inequalities are also linked to the total AMR burden for bloodstream infections. For example, the rate of resistant bacteraemia is 47% higher in the most compared to the least deprived Index of Multiple deprivation quintile, a gap that has widened by 18% since 2019.

Antimicrobial stewardship, professional education, training, and public engagement initiatives are also covered in this report. Activities aimed at improving antimicrobial use and management include the TARGET toolkit, the new UK-adapted AWaRe categories, World AMR Awareness Week, the Antibiotic Guardian campaign and e-Bug. The report also presents an overview of a broad range of new and ongoing research projects in healthcare-associated infections and AMR that were conducted by UKHSA with academic partners, many of whom contribute to key objectives set out in the 2024 to 29 UK National Action Plan for AMR. Finally, this report also contains information on actions being taken by ESPAUR's contributors and audience to combat the rise of AMR and improve antimicrobial prescribing. Our considerable thanks to all our contributing stakeholders whose broad breadth of work and activities not only make up this report but influence policy in the face of the global health threat we are facing in AMR.

Chapter 1. Introduction

The 2024 to 2025 ESPAUR report offers the latest comprehensive analysis of the national data on antimicrobial prescribing, resistance and stewardship and highlights the pertinent development and trends.

In 2024, the overall rates of bacteraemia of public health importance, surpassed pre-pandemic levels, and increased by 5.2% compared to 2023. The burden of antimicrobial resistance (AMR), calculated by determining the incidence rates of resistance in the population to antibiotics in organisms selected for their public health importance, increased by 9.3% from 2023 levels. This was largely due to changes in the incidence rates of *Escherichia coli* (the most frequently reported cause of resistant bacteraemia within AMR burden pathogens, contributing 70.5% to AMR burden in 2024). In total, 3 species of Enterobacterales (comprised of *E. coli, Klebsiella pneumoniae and Klebsiella oxytoca*) comprised 85.1% of the AMR burden, followed by Gram-positive organisms (comprised of *Enterococcus* spp., *Staphylococcus aureus* and *Streptococcus pneumoniae*) at 12.9%. The rise in the AMR burden followed an initial reduction at the beginning of the pandemic, with year-on-year increases in resistant bacteraemia reported since 2020 despite efforts to reduce AMR burden in England.

As in previous years, the AMR burden in bacteraemia in 2024 varied markedly across the regions of England, with the rate of resistant bacteraemia highest in London (44.3 per 100,000), compared to the South West (28.2 per 100,000). Variation in burden was also seen when patients were stratified by ethnicity and deprivation. The highest proportion of resistant bacteraemia by ethnicity was in the 'Asian or Asian British' ethnic group, who were more likely to have a bacteraemia caused by antibiotic resistant bacteria compared to those in the ‘White’ ethnic group; however, most episodes of infection were in the ‘White’ group (77.3%). The most deprived quintile had the highest rate of resistant bacteraemia (43.3 per 100,000), 47.2% higher than the least deprived quintile (29.4 per 100,000). Furthermore, the difference in rate between the highest and lowest deprivation quintile has widened from a 29% difference in 2019 to a 47% difference in 2024.

Between 2019 and 2024, trends in resistance to multiple antibiotic classes increased for both *E. coli* and *K. pneumoniae*. Resistance to third-generation cephalosporins, piperacillin-tazobactam and aminoglycosides rose in both species. Although carbapenem resistance remained relatively low in both organisms (<3%), statistically significant increases over this period raise concern given the critical role of carbapenems in treating multidrug-resistant infections.

In 2024, crude 30-day all-cause mortality was 15.4% for all Gram-negative bacteraemia; 17.2% for Gram-negative infections caused by resistant strains, and peaking at 24.1% when a carbapenemase-producing organism (CPO) was isolated from a sterile site. The greatest mortality for all Gram-negative bacteraemia was in adults aged ≥75 years (21.7%) and the lowest in children aged 1 to 14 years (2.8%). Crude mortality rates for bacteraemia cases did not vary significantly across deprivation levels as the higher number of bacteraemia cases in

more deprived populations resulted in a greater estimated number of deaths, highlighting a disproportionate health burden despite similar mortality rates.

Since 2020, the rates of reported CPO from all sample types have increased annually, rising from 4.7 to 12.9 per 100,000 population in 2021 to 2024 respectively. Although the proportion of screening, sterile site, and other sample types remained stable, the absolute number of CPOs rose by 123.9% in sterile sites and 201.5% in non-screening sites. Furthermore, carbapenem resistance among *E. coli* was 0.2%, a slight increase from 2019 (0.1%).

Rates of fungaemia have increased annually since 2020 with 3.9 fungal bloodstream infections per 100,000 population detected in 2024. *Candida albicans* comprised 40% of all fungal bloodstream infections. In 2024, resistance to fluconazole was detected in 1.9% of *C. albicans* and 14.5% of *Nakaseomyces glabratus* isolates.

In 2024, antibiotic consumption continued to be highest in general practice (70.4%), but this decreased by 1.9% from 2023 (2023: 1.44 vs 2024: 1.415 items per 1,000 inhabitants per day). In addition to the variation in AMR burden by deprivation quintile, antibiotic consumption in primary care[1] also varied by level of deprivation with antibiotic consumption 68.5% higher in the most compared to the least deprived quintile. From 2019 to 2024, antibiotic usage increased for every deprivation quintile, however the rate of increase was considerably larger in the 2 most deprived quintiles (5.5% in IMD 1 and 6.1% in IMD 2) compared to the 2 least deprived (4.3% in IMD 4 and 4.0% in IMD 5). Between 2023 and 2024, overall antibiotic use in secondary care declined by 1.4% (from 4,728 DDDs per 1,000 admissions). Outpatient prescribing decreased by 4.2% (from 1,588 to 1,521 DDDs per 1,000 admissions), with the 2024 rate remaining below that of 2019 (1,693 DDDs per 1,000 admissions). Inpatient prescribing remained stable with a marginal increase of 0.05% (from 3,140 to 3,142 DDDs per 1,000 admissions), however the rate in 2024 remained higher than that of 2019 (2,940 DDDs per 1,000 admissions).

Total antibiotic consumption in 2024 was 2% lower than the 2019 pre-pandemic level (2019: 17.9 vs. 2024: 17.5 Daily Defined Doses (DDD) per 1,000 inhabitants per day (DID), suggesting the stabilisation of prescribing patterns following the pandemic and the 2022 to 2023 group A *Streptococcus* (GAS) surge. In 2024, antibiotic use remained slightly lower than 2019 levels across most settings with the exception of ‘Other community’ settings where consumption increased by 43.8% (0.74 to 1.06 DID), hospital inpatients which saw a 2.7% increase (2.3 to 2.4 DID) and in independent sector settings where it more than doubled. The rise in ‘Other community’ consumption is largely attributed to the introduction of the Pharmacy First service in 2024 and now represents 34.5% of antibiotic use within the ‘Other community’ setting (0.061 items per 1,000 inhabitants per day), highlighting a significant change in how antibiotics are accessed in the community. In 2024, penicillins remained the most frequently used antibiotic group in both primary and secondary care. While consumption of most antibiotic groups remained below 2019 levels, increases were observed across several antibiotic groups

[1] Primary care includes data provided by general practice, dental practices, and other community settings (community pharmacy, out of hours and urgent care services, walk-in centres, community service and community hospitals)

including first- and second-generation cephalosporins (+0.028 DID, +11.9%), anti-*Clostridioides difficile* agents (+0.005 DID, +114.1%), sulfonamides and trimethoprim (+0.034 DID, +4.4%). A 54.1% rise was also seen in the use of the antibiotic sparing agent methenamine (+0.25 DID).

National primary and secondary care stewardship projects are ongoing with work currently being conducted to knowledge mobilise initiatives, such as the new UK-adapted AWaRe categories, as well as to evaluate their effectiveness (3).

The TARGET Cycle of AMS infographic has been developed to highlight the AMS is a continuous process as well as the key steps within that process, in response to feedback from primary care staff that a consistent, whole-practice approach to AMS is needed to improve prescribing behaviours. TARGET has also published additional evidence-based resources for the prevention and management of recurrent urinary tract infections.

Total antifungal consumption in 2024 was similar to that seen in 2019 (+2.0%). Antifungal usage decreased significantly in 2020 and has since increased to pre-pandemic levels, increasing by 30.7% from 2020 to 2024. An antifungal stewardship (AFS) survey was conducted across NHS trusts in 2024 and showed some improvements from the 2016 survey. For example, 87% of trusts with an AFS programme had access to fungal guidelines in 2024 compared to 76% in 2016. The use of fungal biomarkers to guide care of patients with invasive fungal disease reduced by 3% between 2016 and 2024, however the availability of fungal biomarkers had increased for all tests since 2016.

From April 2024 to March 2025, the number of Integrated Care Boards (ICBs) meeting the national target for total primary care prescribing of antibiotics ‘at or less than 0.871 items per STAR-PU’ was 17 out of 42 (40%), an improvement from 24% in the previous year. There were also 1,221,553 fewer GP prescriptions compared to the previous 12-months. An absolute increase of 12% was seen in the proportion of 5-day prescriptions for amoxicillin 500mg capsules between March 2024 and March 2025, and continued year-on-year increase to 69% at March 2025. The non-mandatory CQUIN ‘Prompt switching of intravenous (IV) to oral antibiotic’ was extended to paediatric patients. Overall, 33 of 135 (24%) NHS hospital trusts participated of which 6% were for paediatrics. Sixteen trusts met the 15% or lower threshold, although 18% of cases were receiving IV antibiotics past the point at which they meet switch criteria.

TARGET training has now reached over 1,000 primary care professionals and the TARGET and Royal College of General Practitioners (RCGP) collaborative webinar series continues to achieve high levels of engagement and positive feedback. A total of 190,648 pledges made on the main Antibiotic Guardian pledge page from the inception of the campaign in 2014 to the end of 2024. A health inequalities category was included in the 2024 to 2025 Antibiotic Guardian shared learning and awards event. Seventy-five projects and case studies were submitted across all 13 categories and with 48 entries being shortlisted. For World AMR Awareness Week (WAAW) in 2024, the webpage hosting the WAAW toolkit was visited 4,061 times between publication in September 2024 to the end of the year. A launch webinar was also run for the first time in 2024 which received 906 registrations.

A wide range of new and ongoing research projects are reported in the field of healthcare associated infection (HCAI) and AMR in the last year with over 100 peer-reviewed papers published across UKHSA, covering many of the major themes of the UK National Action Plan for AMR (NAP), including stronger laboratory capacity and surveillance in AMR, human infection prevention and control, and optimal use of antimicrobials. The 2 previous HCAI and AMR Health Protection Research Units (HPRU's; collaborations between the UKHSA and academia) funded by the National Institute for Health and Care Research ended their contacts in 2025 and a new NIHR AMR HPRU in Oxford started in April 2025 and will run till 2030

Infographics visualising the main findings from this report are available on the ESPAUR report web page.

This report details concerning trends, foreshadowing the considerable challenges ahead – with rising numbers of infections, increasing proportions of which are drug resistant, and widening variation associated with inequalities with key differences in burden shown by ethnicity and socio-economic class. Nevertheless, despite the challenging backdrop of increasing infections, improvements in prescribing have been seen. Improved understanding of trends and the factors which shape them, will assist the development and targeting of interventions to help redress these increases. This will be the focus of much of the 2024 to 2029 AMR NAP. Continued strengthening of our capabilities to monitor and mitigate AMR will be essential to this endeavour.

Chapter 2. Antimicrobial resistance (AMR)

Main messages

Bacteraemia: In 2024, the overall rates of bacteraemia due to bacteria of public health importance (*Escherichia coli, Klebsiella pneumoniae, Klebsiella oxytoca, Pseudomonas* spp., *Acinetobacter* spp., *Staphylococcus aureus, Enterococcus* spp. and *Streptococcus pneumoniae*) surpassed pre-pandemic levels, and increased by 5.2% since 2023. This was largely due to increased rates of *E. coli* (the most frequently reported cause of bacteraemia).

Fungaemia: Rates of fungaemia increased by 15.4% between 2020 and 2024, likely due to a combination of factors, including changing patient demographics, increasing numbers of at-risk patients, and improved detection and reporting. *Candida albicans* and *Nakaseomyces glabratus* (formerly *Candida glabrata*) comprised 40% and 27% of all fungaemia reports due to yeast from 2020 to 2024. However, rates of resistance to available antifungals remained low. Rates of *Candidozyma auris* fungaemia remained low in 2024 despite increased reports of colonisations in healthcare settings.

Antibiotic-resistant bacteraemia ('AMR burden'): The overall burden of resistance, estimated from cases of bacteraemia (as described above) resistant to one or more critically important antibiotics (see Table 2.1 for antibiotic list) rose by 13.1% from 2019 to 2024, reaching 20,484 episodes in 2024; an average of nearly 400 resistant cases per week. Most of this rise occurred since last year, with a 9.3% increase from 2023 to 2024.

Enterobacterales (*E. coli*, *K. pneumoniae*, and *K. oxytoca*) dominated the burden of antibiotic-resistant bacteraemia, comprising 85.1% of the total number in 2024. The majority of the increase in resistant bacteraemia from 2019 to 2024 was due to increases in resistant Enterobacterales (52.6% of the increase due to *E. coli* and 33.8% due to *K. pneumoniae*), however rates of resistant *S. aureus* rose by 33.0% between 2019 and 2024 (the second largest rise after resistant *K. pneumoniae* [a 39.9% increase]).

There was substantial regional variation in both resistant bacteraemia and overall bacteraemia incidence; the highest AMR burden rate was in London and the lowest was in the North East. despite the lowest overall bacteraemia incidence, while the North East had the highest bacteraemia incidence and lowest resistance rate. Older adults bear the greatest burden of bacteraemia and resistant bacteraemia with the highest rates in those over 74 years old.

The highest burden of resistant bacteraemia was in the 'Asian or Asian British' ethnic group, followed by the 'Black, African, Caribbean or Black British' group, although most episodes were in the 'White' ethnicity (77.3%). The most deprived quintile had the highest rate of resistant bacteraemia, 47.2% higher than the least deprived quintile (55.9 vs. 29.4 per 100,000).

In 2024, crude 30-day all-cause mortality was 14.7% for Gram-negative bacteraemia caused by a susceptible strain, rising to 17.2% for infections caused by resistant strains (see Table 2.1),

peaking at 24.1% when a carbapenemase-producing organism (CPO) was isolated from a sterile site. Mortality was highest in adults aged ≥75 years (21.7%) and lowest in children aged 1 to 14 (2.8%). While mortality did not vary significantly by deprivation level, higher infection rates in more deprived populations resulted in a greater estimated number of deaths, highlighting a disproportionate health burden despite similar mortality rates.

Since the introduction of mandatory reporting in 2020, the rate of reported CPOs in England has increased annually, rising from 4.7 in 2021 to 12.9 per 100,000 population by 2024. Although the proportion of screening, sterile site, and other sample types remained stable, absolute numbers of CPOs rose by 123.9% in sterile sites and 201.5% in non-screening sites.

Between 2019 and 2024, reports of *E. coli* and *K. pneumoniae* resistant to multiple antibiotics increased, including third-generation cephalosporins, piperacillin-tazobactam and aminoglycosides. In the same period, resistance to second line agents in *S. aureus* increased, reducing options for adjunctive and step-down therapy in severe infections. In MRSA bacteraemia, resistance to tetracyclines more than doubled (from 13.4% to 30.3%), while resistance to macrolides (50%) and clindamycin (44.5%) remained high but stable.

UK 2024 to 2029 AMR National Action Plan (NAP): Target 1a of the UK's AMR NAP aims to prevent any increase in a specified set of drug-resistant infections in humans by 2029 from the financial year 2019 to 2020 baseline. In England, numbers rose by 22.7% between FYs 2019 to 2020 and 2024 to 2025, driven by *E. coli* and *K. pneumoniae* resistant to third-generation cephalosporins.

Urinary tract infections*:* In 2024, Enterobacterales comprised 80.6% of urinary isolates, with *E. coli* accounting for around 70% of all episodes. Most urinary isolates were from females, however, urinary *E. coli* resistance to all specified antibiotics was higher in males than females. Between 2019 and 2024, resistance in *E. coli* urinary isolates remained stable to nitrofurantoin, trimethoprim and fosfomycin (2.2%, 30.1% and 3.6% respectively).

Candidozyma auris: *C. auris* (formerly *Candida auris*) is a rapidly emerging, multidrug-resistant fungal pathogen. Case numbers in England have risen year-on-year since 2020, with several large hospital outbreaks concentrated in London and the South East, mostly representing colonisation (212 first patient detections in 2024). In response, UKHSA issued updated guidance for acute healthcare settings, and from April 2025 *C. auris* became a legally notifiable causative agent under the Health Protection (Notification) Regulations 2010.

***Plasmodium falciparum* malaria**: Treatment failure with ACT has now emerged in some East African countries in addition to regions in South East Asia, where it is widespread. Intravenous artesunate and oral ACT are still effective, but parasites with K13 and other resistance mutations have reduced sensitivity to ACT, so parasitaemia may reduce more slowly following treatment, and late treatment failure (recrudescence) is more likely. The Advisory Committee on Malaria Prevention (now UKMEAG) has published guidance on alternative ACT for use when treatment failure occurs, pending a full national guidance update (4).

Introduction to Chapter 2

This chapter presents findings from antimicrobial resistance (AMR) surveillance, predominately based on analysis of resistance in pathogens of public health importance causing bacteraemia and fungaemia, undertaken by the UK Health Security Agency (UKHSA). It reports bacteraemia resistance trends as recommended for surveillance by the Advisory Committee on Antimicrobial Prescribing, Resistance and Healthcare-Associated Infections (APRHAI) (5), and resistance related to *Mycobacterium tuberculosis, Neisseria gonorrhoeae,* and other common bacterial, fungal, viral, and parasitic infections. This chapter predominately focuses on organisms isolated from blood cultures (bacteraemia and fungaemia for bacteria and fungi respectively) due to the severity and impact of AMR on these clinical infections. However, evolving resistance in pathogens causing urinary tract infections (UTIs), blood-borne viral infections, gastrointestinal infections, as well as malaria are also covered, given their considerable clinical impact. All data pertaining to antimicrobial consumption in England is detailed in Chapter 3.

The estimated burden of bacteraemia with antibiotic resistance of public health importance ('AMR burden') in England was calculated using previously described methodology (6); briefly, this is calculated using estimates of the number of each selected pathogen resistant to one or more of a list of specified antibiotics; these organisms and defined antibiotic combinations are listed in Table 2.1, with further details provided in the accompanying Annexe. Monitoring and preventing any increase in the burden of AMR ('AMR burden') in humans is one of the UK Government's targets to confront AMR (more details on this are available in Box 2.1).

Table 2.1. Bacteria of public health importance due to association with antibiotic resistance, and selected resistance profiles used to estimate AMR burden

Pathogens	Antibiotic class resistance
Gram-negative bacteria	
Escherichia coli	carbapenems, third-generation cephalosporins, aminoglycosides, or fluoroquinolones
Klebsiella pneumoniae	carbapenems, third-generation cephalosporins, aminoglycosides, or fluoroquinolones
Klebsiella oxytoca	carbapenems, third-generation cephalosporins, aminoglycosides, or fluoroquinolones
Acinetobacter spp.	aminoglycosides and fluoroquinolones, or carbapenems
Pseudomonas spp.	3 or more antimicrobial groups, or carbapenems
Gram-positive bacteria	
Enterococcus spp.	glycopeptides
Staphylococcus aureus	methicillin
Streptococcus pneumoniae	penicillin and macrolides, or penicillin alone

Data on antimicrobial-resistant infections for the period 2019 to 2024 is presented as trends in either numbers of patient episodes (defined in the Annexe accompanying this report), percentage resistance or as a rate per 100,000 population. More detailed analysis of AMR burden pathogens, stratified by patient age group, biological sex, regional location within England, 30-day all-cause case fatality rate (2024 data only), deprivation index, and ethnicity, are presented within the chapter or its appendices. Statistical significance, defined where $p<0.05$, is presented throughout the report; details on how this is calculated can be found in the Annexe.

The primary data source used was the UKHSA's Second Generation Surveillance System (SGSS, described further in previous reports) (6, 7). Additional data sources, analytical methods, caveats, and additional resources are described in more detail in the Annexe accompanying this report. Data and figures are presented in the data spreadsheets and downloadable slidedecks, respectively.

Priority pathogens causing bacteraemia

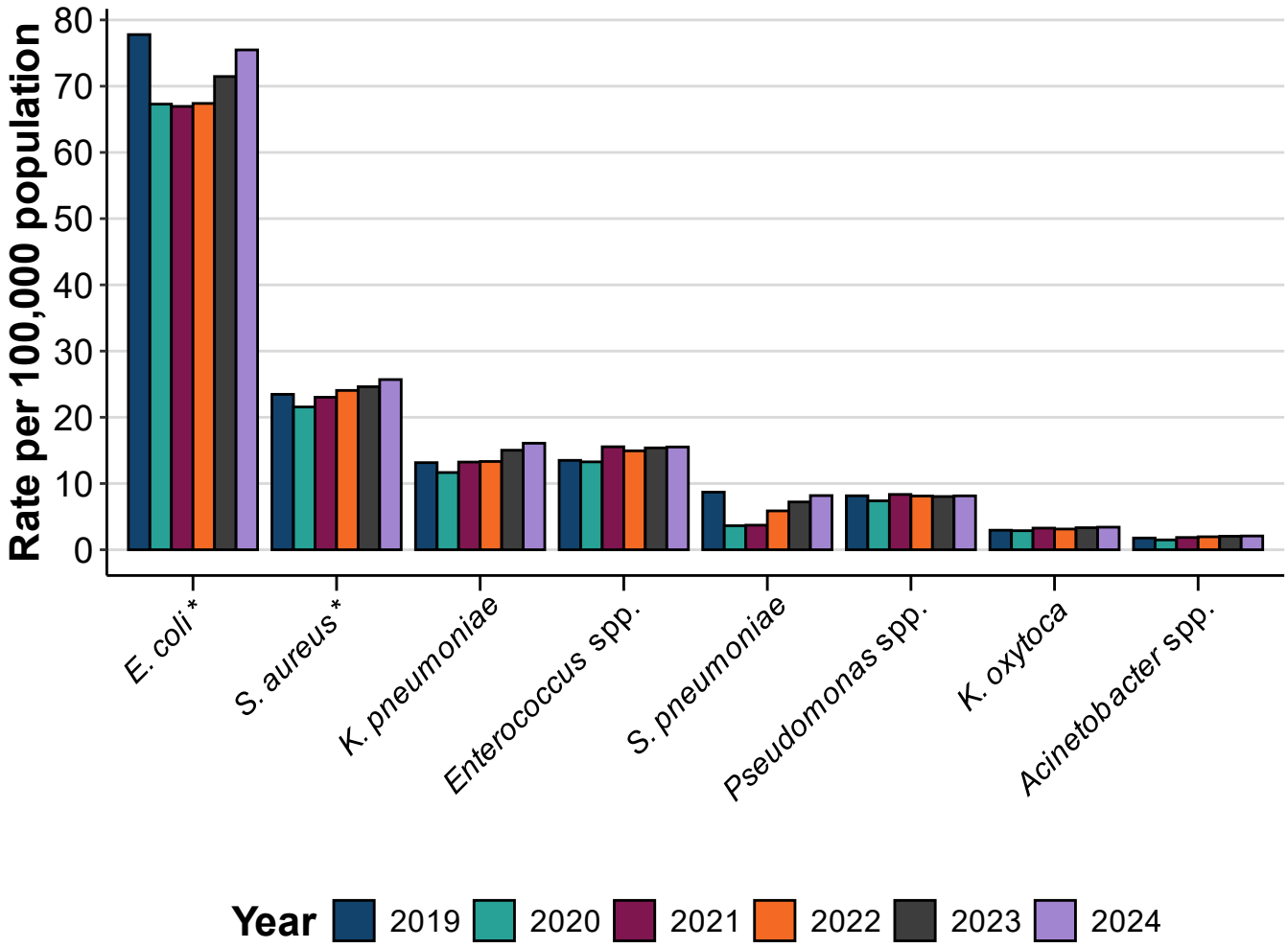
In 2024, there were 183,990 patient episodes of bacteria isolated from blood identified through reports received from laboratories in England (see accompanying data tables). This is a 5.7% increase compared to episodes reported in 2023 (*n* = 173,513), and a 20.8% increase since 2019 (*n* = 152,325). Nearly half of this increase between 2019 and 2024 can be explained by increases in coagulase-negative staphylococci (CoNS), with increases in other organisms contributing to <7% of the overall increase, the highest among those being *Micrococcus* sp., *K. pneumoniae*, and *S. aureus*. It is likely that a large proportion of the CoNS and *Micrococcus* sp. represent blood culture contaminants – though he factors surrounding the increased isolation of these organisms and their clinical significance (which cannot be ascertained from routine linked data) requires further consideration at both local and national levels.

In 2024, a reported 89.0% (*n* = 165,817) of episodes were monomicrobial (a single organism isolated from blood). Similar to previous reports (7, 8), the organisms most frequently isolated from monomicrobial bacteraemia were CoNS (28.6%), *E. coli* (21.0%) and *S. aureus* (7.1%). Among the 11.0% (n=20,495) of episodes that were polymicrobial (more than one bacterial or fungal species isolated from blood), the most frequently identified organisms were CoNS (16.4%), *E. coli* (12.9%), and *K. pneumoniae* (4.7%).

The bacteraemia burden (Table 2.1) in 2024 was higher than that reported in 2019, following a decline and subsequent increase during and after the COVID-19 pandemic. The AMR bacteraemia burden was similar in 2019 and 2023 (a <1% increase over the 5 years), and in the last year has subsequently risen by 5.2% in 2024. The incidence rate of bacteraemia due to *Acinetobacter* spp., *K. pneumoniae, K. oxytoca, Enterococcus* spp., and *S. aureus* increased between 2019 and 2024 (Figure 2.1). In contrast, in 2024, the incidence rate of *E. coli, S. pneumoniae* and *Pseudomonas* spp. bacteraemia remained below pre-pandemic levels, but have nonetheless risen since the declines seen during the COVID-19 pandemic.

More detail on the trends in incidence and mandatory national surveillance for *E. coli, S. aureus*, *K. pneumoniae and Pseudomonas aeruginosa* bacteraemia are available in the annual epidemiological commentary. In addition, incidence and resistance data for other Gram-negative organisms such as *Serratia* spp., *Enterobacter* spp., *Citrobacter* spp., *Proteus* spp., *Providencia* spp., *Morganella* spp. and *Stenotrophomonas* spp. are included in the accompanying data tables.

Figure 2.1. Annual incidence rate of selected pathogens [note1] of public health importance [note2] causing bacteraemia, per 100,000 population, England 2019 to 2024



[note 1] In this graph, the asterisk denotes that data for *E. coli* and *S. aureus* incidence is based on mandatory surveillance data, while reporting of the other pathogens was voluntary.
[note 2] See Table 2.1.

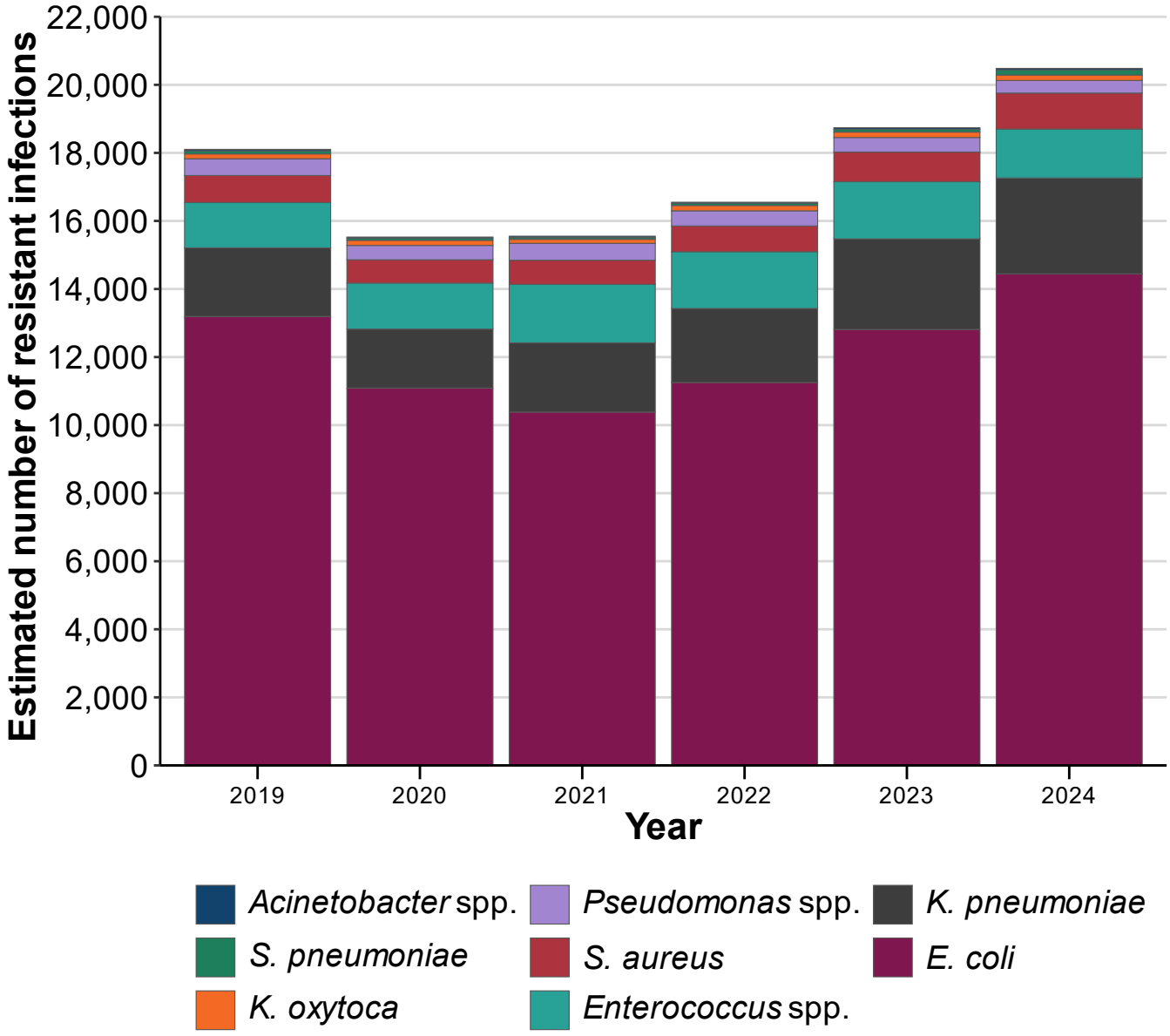
Antibacterial resistance

AMR burden

The burden of resistance, estimated by the total number of bacteraemia episodes due to bacteria of public health importance resistant to one or more defined antibiotics (Table 2.1),

increased by 13.1% between 2019 (n = 18,103) and 2024 (n = 20,484; Figure 2.2), representing an average of nearly 400 new patient episodes of resistant bacteraemia each week. The majority of the increase since 2019 occurred in the last 2 years; with a 9.3% rise from 2023 (*n* = 18,740) to 2024. Of all bacteraemia episodes for AMR burden pathogens, 22% were resistant to key antibiotics (see Table 2.1).

Figure 2.2. Annual estimated total of the burden of antibiotic-resistant bacteraemia episodes, England 2019 to 2024



Enterobacterales (*E. coli*, *K. pneumoniae*, and *K. oxytoca*) dominated the burden of antibiotic-resistant bacteraemia, comprising 85.1% of the total number in 2024. *E. coli* was responsible for 65% of antibiotic-resistant bacteraemia over the past 6 years, peaking in 2019 at 72.9% and comprising 70.5% in 2024. The relative contribution of *K. pneumoniae* increased from 11.1% in 2019 to 13.8% in 2024. *E. coli* and *K. pneumoniae,* are responsible for most of the 13.1% increase in resistant bacteraemia seen from 2019 to 2024 (comprising 52.6% and 33.8% of the

overall rise, respectively). *K. pneumoniae* was the organism with the fastest rate of increase from 2019 to 2024, increasing by 39.9%.

The proportion of antibiotic-resistant bacteraemia due to common Gram-positive pathogens remained relatively stable, with Gram-positive organisms accounting for 12.9% of the overall AMR burden in 2024 (*Enterococcus* spp. (7%), *S. aureus* (5.2%), *S. pneumoniae* (0.7%). Between 2019 and 2024, there was a 33.0% rise in resistant *S. aureus.*

Further detail is available in the data tables accompanying this report.

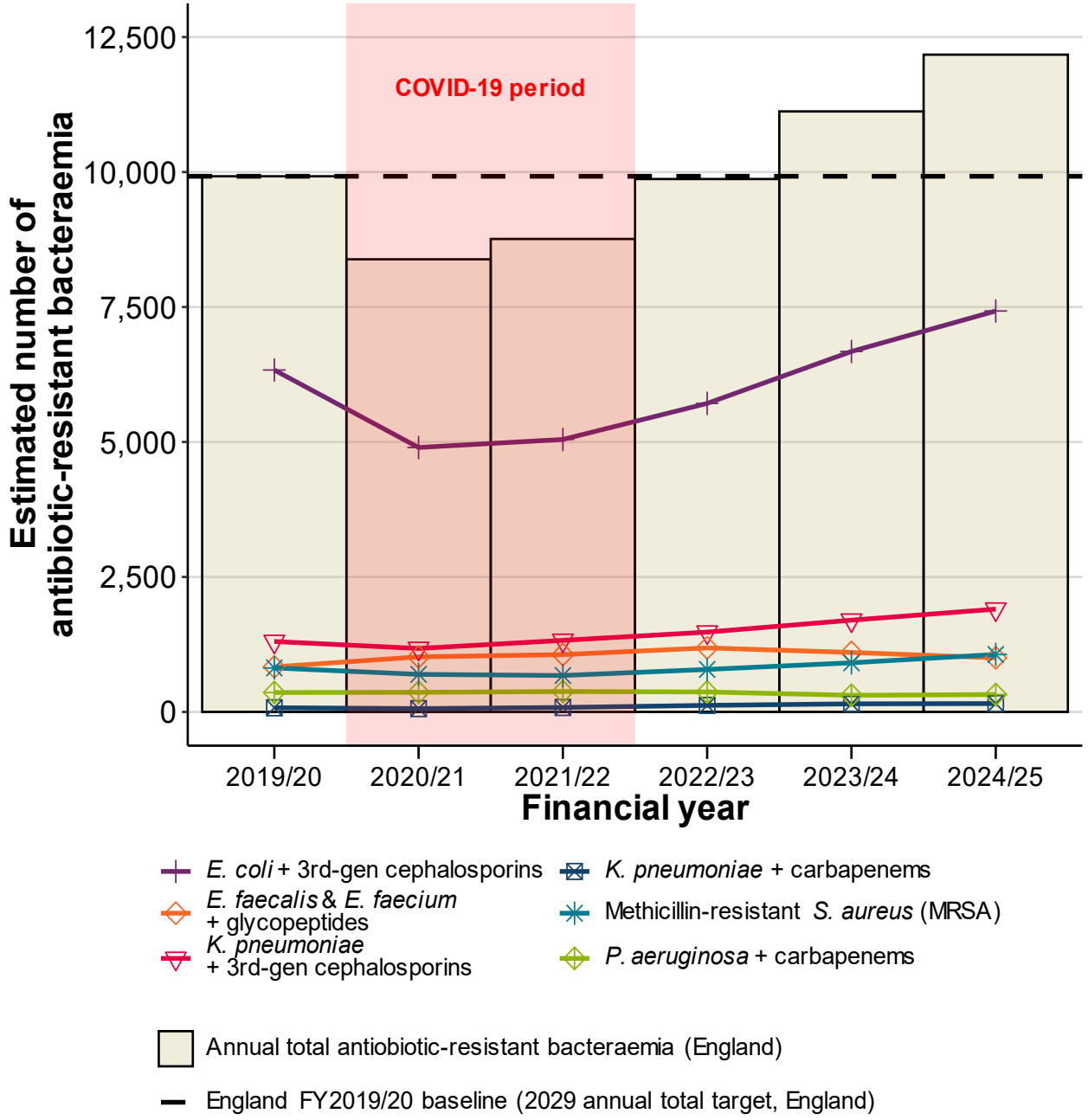
Box 2.1. Progress against the UK 2024 to 2029 AMR National Action Plan's human health targets: England data

The UK government's 2024 to 2029 AMR National Action Plan (NAP), Confronting antimicrobial resistance 2024 to 2029 includes 5 human health targets.

Target 1a states that by 2029, the UK aims to prevent any increase in a specified set of drug-resistant infections in humans from the 2019 to 2020 financial year (FY). These infections are a subset of those included in the ESPAUR bacteraemia AMR burden estimates (those listed in Table 2.1). Further information on included pathogen-antibiotic combinations included are in the Annexe.

In England, a 22.7% increase in the specified set of drug-resistant infections was recorded between FY 2019 to 2020 and FY 2024 to 2025 (from 9,922 to 12,175; Box Figure 2.1.1), therefore, preventing an increase in these infections from the 2019 baseline is an ambitious target in England. The increase is predominately driven by *E. coli* and *K. pneumoniae* resistant to third-generation cephalosporins (61.0% and 15.6% of antibiotic-resistant bacteraemia, respectively, in FY 2024 to 2025) (9).

Box Figure 2.1.1. Estimated number of antibiotic-resistant bacteraemia by financial year (FY) in England, FY 2019 to 2020 to FY 2024 to 2025 [note1] [note2]



[note1] The following combinations are not shown individually due to small numbers (please refer to the data tables accompanying this report for further detail): *E. coli* resistant to carbapenems, *P. aeruginosa* resistant to 3 or more antibiotic classes (excluding carbapenems), *Acinetobacter* spp resistant to carbapenems, *Acinetobacter* spp. resistant to aminoglycosides and ciprofloxacin, *S. pneumoniae* resistant to penicillin, and *S. pneumoniae* resistant to penicillin and macrolides.

[note2] The UK's 2024 to 2029 AMR NAP is UK-wide; this figure depicts a calculation of the target based on data from England only and only includes estimates for England.

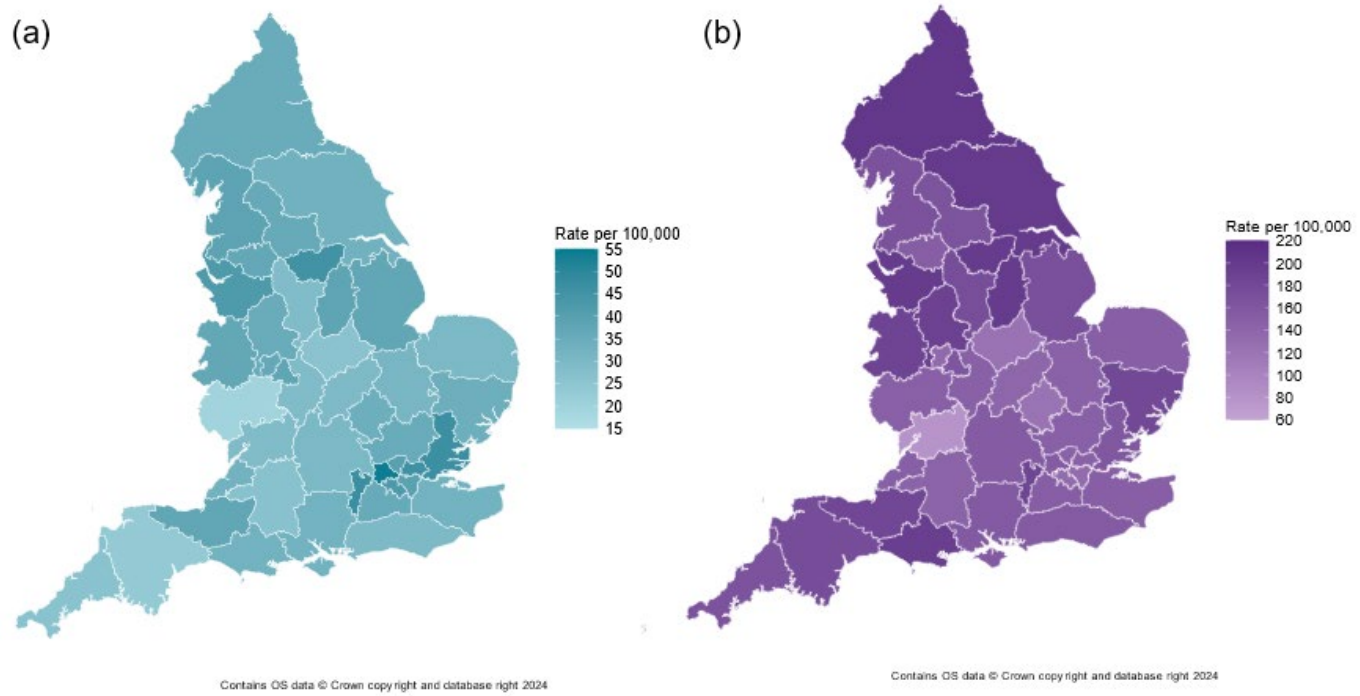
Geographical distribution

The geographical distribution in the burden of AMR bacteraemia and the incidence of bacteraemia caused by resistant AMR burden pathogens is shown in Figure 2.3 and can be found in the accompanying data tables.

The London region reported the highest AMR burden rate (44.3 per 100,000 population), while the South West had the lowest (28.2 per 100,000 population). The North East recorded the highest overall bacteraemia incidence (200 per 100,000 population), but the resistant bacteraemia rate (35.6 per 100,000 population) was lower than that seen in many other regions. Conversely, London had the lowest overall bacteraemia incidence (140.6 per 100,000 population) despite its high AMR burden rate.

The variation in rate of resistance across geographical areas is greater at the Integrated Care Board (ICB) level than at the regional level. The NHS North West London ICB reported the highest AMR burden rate (54.0 per 100,000 population), followed by NHS Frimley ICB and NHS Mid and South Essex ICB (47.1 and 46.6 per 100,000 population, respectively). The lowest AMR burden rate was reported in NHS Herefordshire and Worcestershire ICB (19.7 per 100,000 population). The NHS North East and North Cumbria ICB had the highest incidence of bacteraemia (203.8 per 100,000), whilst NHS Gloucestershire ICB had the lowest (78.9 per 100,000 population).

Figure 2.3. Geographical distribution in rate per 100,000 population of the (a) estimated burden of AMR and (b) estimated rate of bacteraemia by Integrated Care Board (n = 42), in England 2024



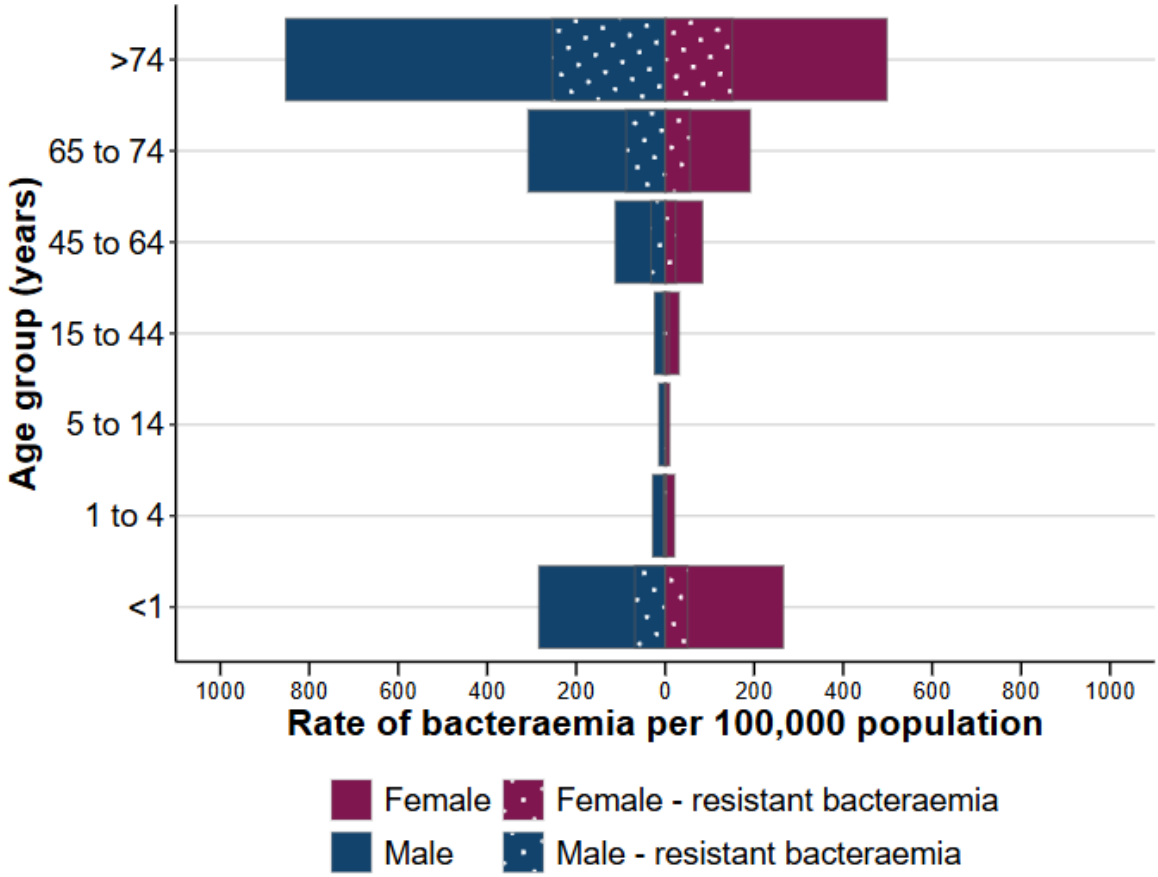
Age and sex distribution

The burden from all bacteraemia and resistant bacteraemia differed according to age group and sex in 2024 (Figure 2.4). Data behind the figure is available in the chapter 2 data table accompanying this report. The highest number and incidence rates of both bacteraemia and

resistant bacteraemia were observed in individuals aged over 74 years old (males and females, with 22.9% and 23.3% of episodes respectively being resistant). This age group had the greatest burden of resistance across all ages.

Adults aged 45 and over accounted for the majority of cases of bacteraemia and resistant bacteraemia, comprising 87.7% and 89.5% respectively. Individuals over 74 accounted for nearly half of all reported cases in both categories, with 45,068 bacteraemia (49.0%) and 10,400 (50.8%) resistant bacteraemia episodes. No sex differences in percentage of resistant episodes were seen, except in the 15 to 44 age group ($p<0.05$) where resistance was higher in women (21.4%, rate 8.5 per 100,000 population) than in men (18.9%; rate 5.5 per 100,000 population).

Figure 2.4. The rate of AMR burden bacteraemia and resistant bacteraemia by age group and sex in England in 2024 [note 1]



[note 1] Forty-nine bacteraemia (of which 8 are resistant bacteraemia) episodes had a missing age group or sex information.

Ethnicity and deprivation

Health equity data has been included in UKHSA's AMR surveillance and published in ESPAUR reports since 2021. In 2024, UKHSA conducted a review of its routine national surveillance outputs to access the completeness and validity of health equity data (see Box 2.2). The

recommendations from the review have been incorporated into in this 2024 to 2025 ESPAUR report.

Box 2.2. Outcomes of health equity review for infection surveillance: ESPAUR 2022 to 2023 report

Including health equity data in infection surveillance helps identify populations at highest risk, enabling targeted public health interventions to reduce infection-related health inequities. An internal review undertaken in 2024 of UKHSA routine national surveillance outputs, including the ESPAUR 2022 to 2023 report, evaluated the completeness and validity of health equity data in bacteraemia surveillance, with a view to identifying opportunities for improving bacteraemia surveillance and to identify learning that can more broadly implemented across UKHSA infection surveillance.

Reviewing the ESPAUR 2022 to 2023 report, the Health Equity review concluded:

- ethnicity and deprivation data were consistently captured across key surveillance measures, with high completeness factors associated with missing ethnicity or IMD data (from multivariable analysis):
  - younger age (under 18 years)
  - male sex
  - sampled from 2020 onwards (vs 2018 to 2019)
  - infection with *Streptococcus* spp. (vs other organisms)
  - data on inclusion health groups (for example asylum seekers, prisoners, people experiencing homelessness) were limited

The review made specific recommendations relevant to the ESPAUR report where relevant implementation of recommendations has been indicated:

- disaggregate data by ethnicity and deprivation, where feasible, to support detailed analysis of health inequalities: Implemented data disaggregated by organism-antimicrobial combination
- report outcome measures (for example case fatality rates) by ethnicity and deprivation to enable equity-focused analysis: Implemented in 2023 to 2024 ESPAUR report onwards
- identify and report cases with missing deprivation data due to use of ‘ZZ’ postcodes, indicating no fixed abode (for example likely homelessness) – implemented in this report
- age-standardise or age-stratify rates by ethnicity and deprivation to account for variation in age distribution – implemented in this report
- expand geographic reporting to include rural vs urban classifications and smaller geographies such as Integrated Care Boards (ICBs) – implemented ICB-level AMR burden data reporting in this report

Of individuals with a reported ethnicity (95.6%, *n* = 88,073), the highest number and rate of bacteraemia episodes (per 100,000 population) were recorded in people from the White ethnic group, who accounted for 85.1% of bacteraemia episodes (*n* = 77,606), and 77.3% of all resistant episodes (*n* = 15,888). The second highest number of resistant bacteraemia were in the Asian and Asian British population (12.1% of all resistant bacteraemia, *n* = 2,478), followed by the Black, African, Caribbean or Black British population (4.4%, *n* = 898), Mixed or Multiple ethnic groups (0.9%, *n* = 177) and Any other ethnic group (0.9%, *n* = 178).

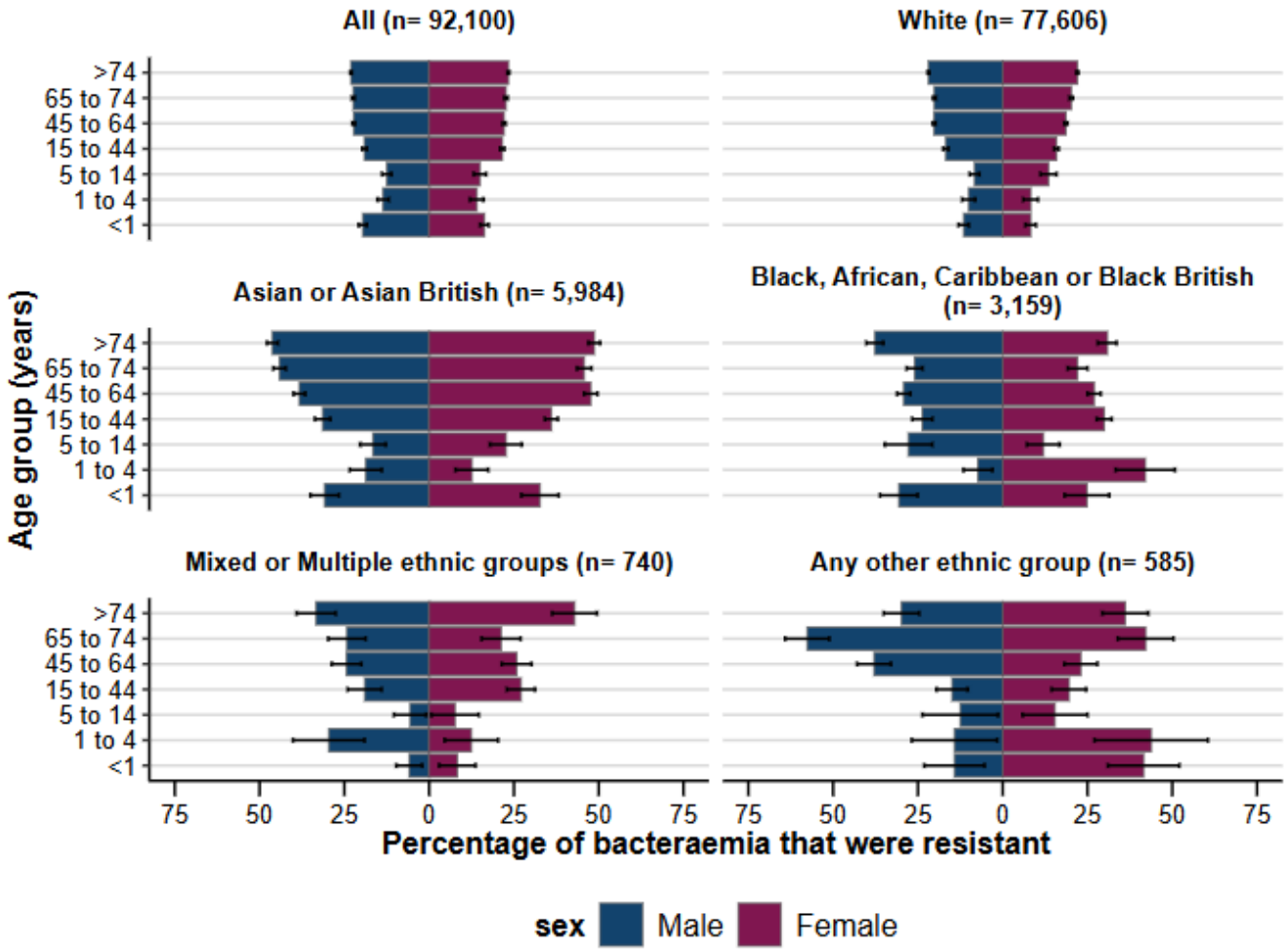
The population with the highest proportion of resistance within bacteraemia was the Asian or Asian British ethnic group, with 41.4% of bacteraemia episodes resistant, followed by Any other ethnic group (30.4%), Black, African, Caribbean or Black British ethnic group (28.4%) and Mixed or multiple ethnic groups (23.9%), with the White ethnic group having the lowest percentage of bacteraemia resistant (20.5%).

Further detail on bacteraemia rates by ethnic group is available in the Chapter 2 data tables accompanying this report.

There are known differences in the age and sex profile of the population within different ethnic groups in England, and with older age and male sex are both associated with higher rates of both bacteraemia and resistant bacteraemia (Figure 2.4). To enable fairer comparisons of rates between ethnic groups that take into account these demographic differences, we have presented the percent of resistant bacteraemia per age group and sex by ethnicity is presented below, to better show disparities in resistance by ethnic group (Figure 2.5) (10).

The percent of bacteraemia that were resistant in the ‘Asian or Asian British’ population was higher than in the White population across age and sex groups, with a maximum of 48.7% resistance (in over 74 year old females), compared to 22.0% resistance in the same age-sex group in the White population. All ethnic groups demonstrated higher bacteraemia resistance in the older age groups, however the white population consistently had lower resistance rates than other ethnic groups across age bands. The resistance rates of the whole population were similar to the pattern seen in the White population (which comprises 85.1% of bacteraemia episodes), highlighting the importance of presenting resistance rates by ethnicity and age-sex to ensure differing population structures are not masking disparities between ethnic groups.

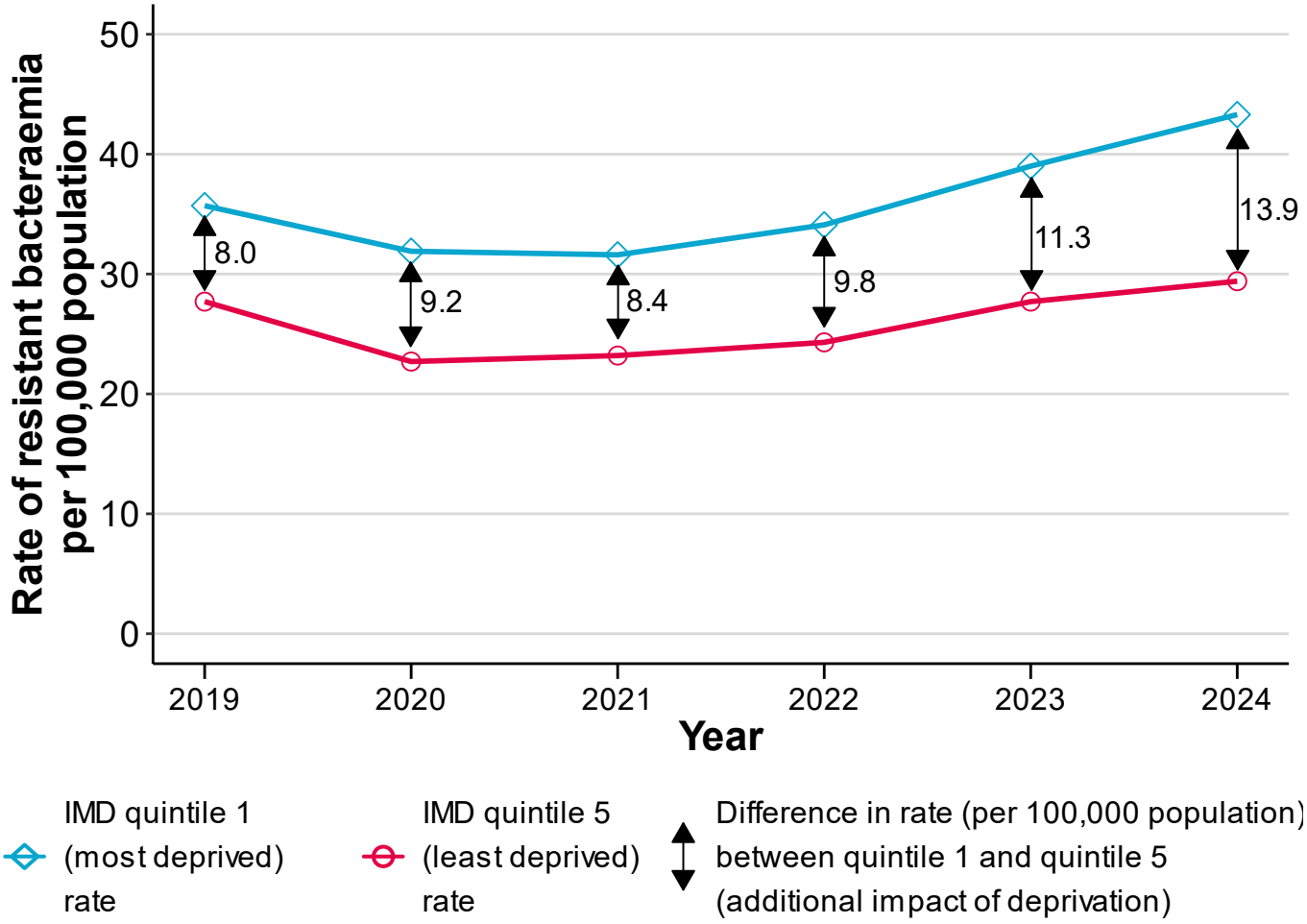
Figure 2.5. The percentage of bacteraemia that were resistant by age group, sex and ethnic group in England in 2024



In 2024, AMR burden differed according to indices of multiple deprivation (IMD), measured by quintile (where the first quintile represents the population in the most deprived 20% of areas in England and the fifth quintile represents the least deprived 20% of areas) (Figure 2.6). There are complex interactions between ethnicity and deprivation, which are not currently adjusted for in these analyses.

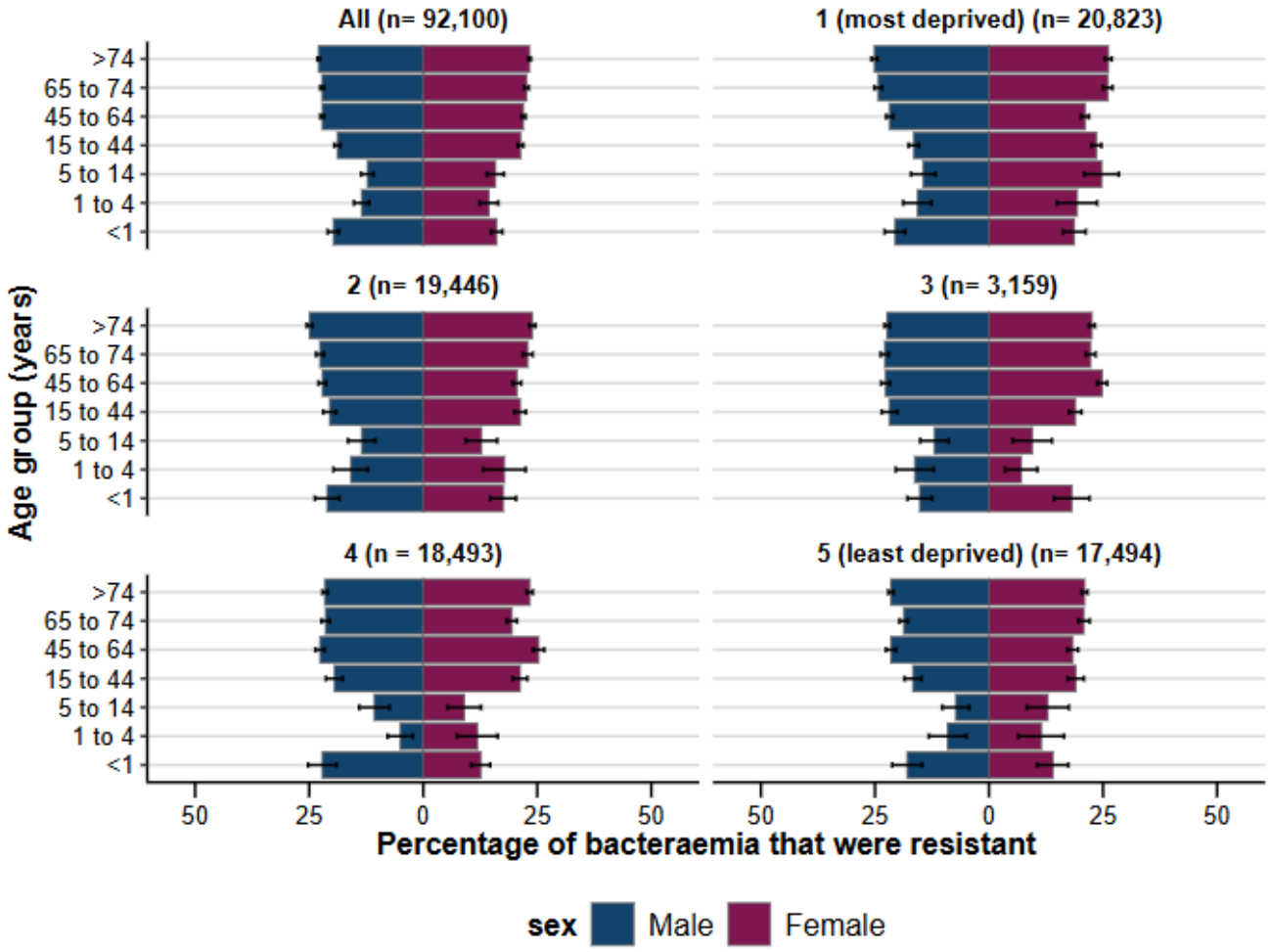
Of those individuals with a reported IMD quintile (99.99%; *n* = 92,089) in 2024, the highest number and rate of bacteraemia as well as resistant bacteraemia were recorded in people in the most deprived quintile (23.5% of bacteraemia episodes; *n* = 20,823, rate = 43.3 per 100,000 population). This represents a 47.2% higher rate of resistant bacteraemia when compared to the least deprived quintile (43.3 vs 29.4 per 100,000 population; $p < 0.05$); this gap between the most and least deprived has grown since 2019 when the rate of resistant bacteraemia was 29.0% higher in the most deprived quintile compared to the least deprived. Per 100,000 population, in 2019 there were an additional 8 episodes of resistant bacteraemia in the most deprived quintile compared to the least deprived quintile; this rose to nearly 14 additional episodes in 2024, highlighting the additional impact deprivation has on the most deprived 20% of the country (Figure 2.6). Data on bacteraemia rates by IMD quintile is available in the chapter 2 data table accompanying this report.

Figure 2.6. Rate of resistant bacteraemia per 100,000 population of most and least deprived IMD quintiles and gap between most and least deprived quintiles, 2019 to 2024



The percent of bacteraemia that are resistant per age group and sex category by IMD quintile are displayed in Figure 2.7. In 2024, resistance rates did not differ substantially across age and sex groups across the quintiles, however resistance was consistently higher per age and sex group in the most deprived compared to the least deprived quintile.

Figure 2.7. The percentage of resistance bacteraemia by age group, sex and IMD quintile in England in 2024



Gram-negative bacterial infections

Data presented in this section focuses on the most commonly isolated Gram-negative bacteria and their phenotypic profiles. More extensive pathogen and antibiotic combination analysis can be found in the data and figure appendices accompanying this report. Data on acquired carbapenemase-producing Gram-negative organisms (CPO) is presented later in the chapter.

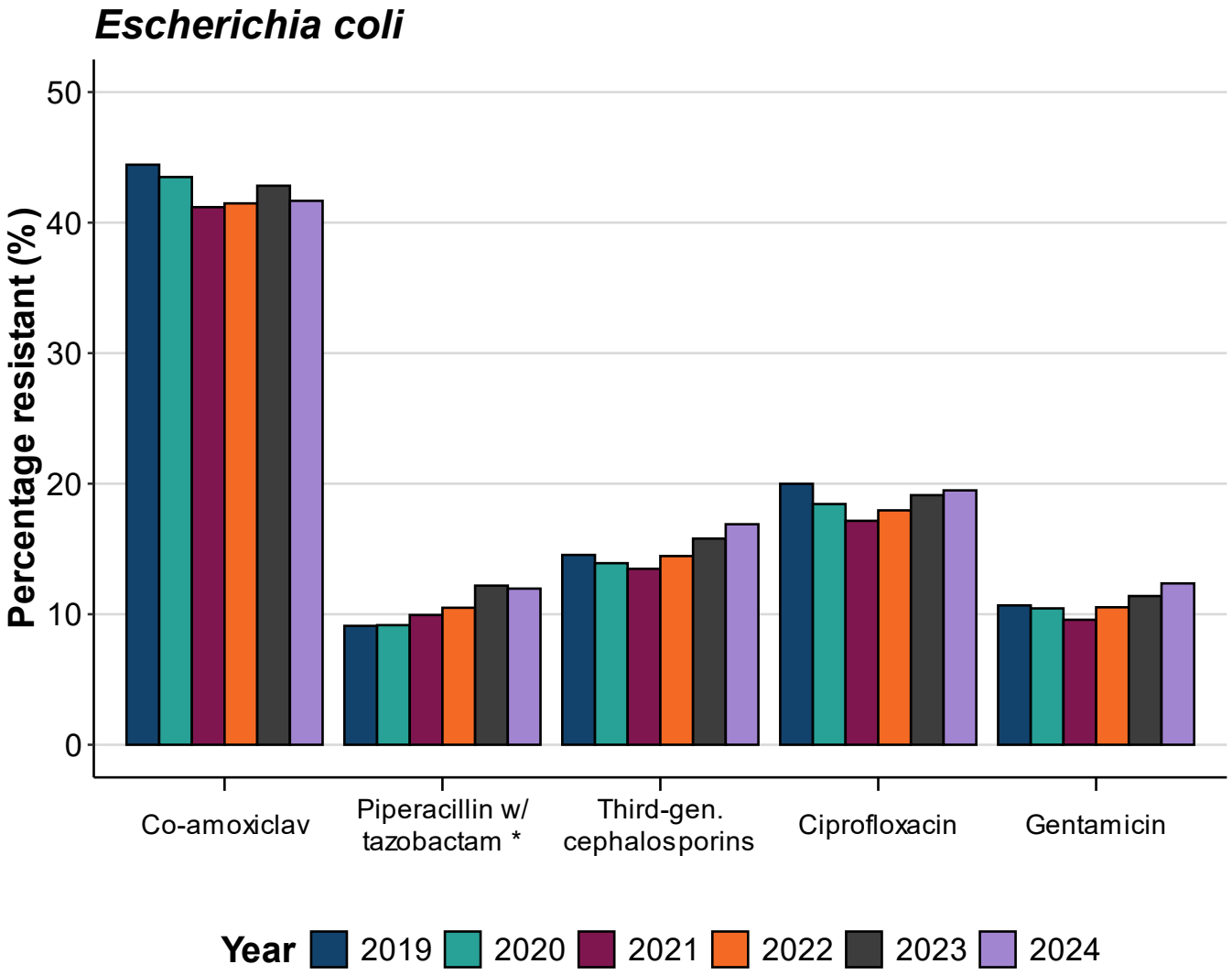
Resistance trends in bacteraemia

Reports of *E. coli* resistant to multiple antibiotics increased between 2019 and 2024 (Figure 2.8a). Resistance rose to gentamicin (from 10.7% to 12.4%), amikacin (from 0.9% to 3.1%), and third-generation cephalosporins (14.5% to 16.9%). There have been year-on-year rises of one percentage point in third-generation cephalosporin resistance from 2021 to 2024 (13.5% in 2021, 14.5% in 2022, 15.8% in 2023 and 16.9% in 2024). In 2024, *E. coli* resistance to co-amoxiclav was 41.7% and resistance to ciprofloxacin was 19.5%. Please see Box 3.2 in Chapter 3 for further information concerning the national guidance on the impact of fluoroquinolone use (11). Carbapenem resistance was 0.2%, a slight increase from 2019 (0.1%).

Antibiotic resistance increased across most major antibiotic classes in *K. pneumoniae* between 2019 and 2024. (Figure 2.8b). Rises were reported for resistance to third-generation cephalosporins (from 16.3% to 19.2%), piperacillin with tazobactam (from 15.1% to 23.1%), gentamicin (from 9.0% to 11.9%), amikacin (from 1.1% to 2.7%), ciprofloxacin (from 15.5% to 18.5%), and carbapenems (from 1.0% to 1.5%).

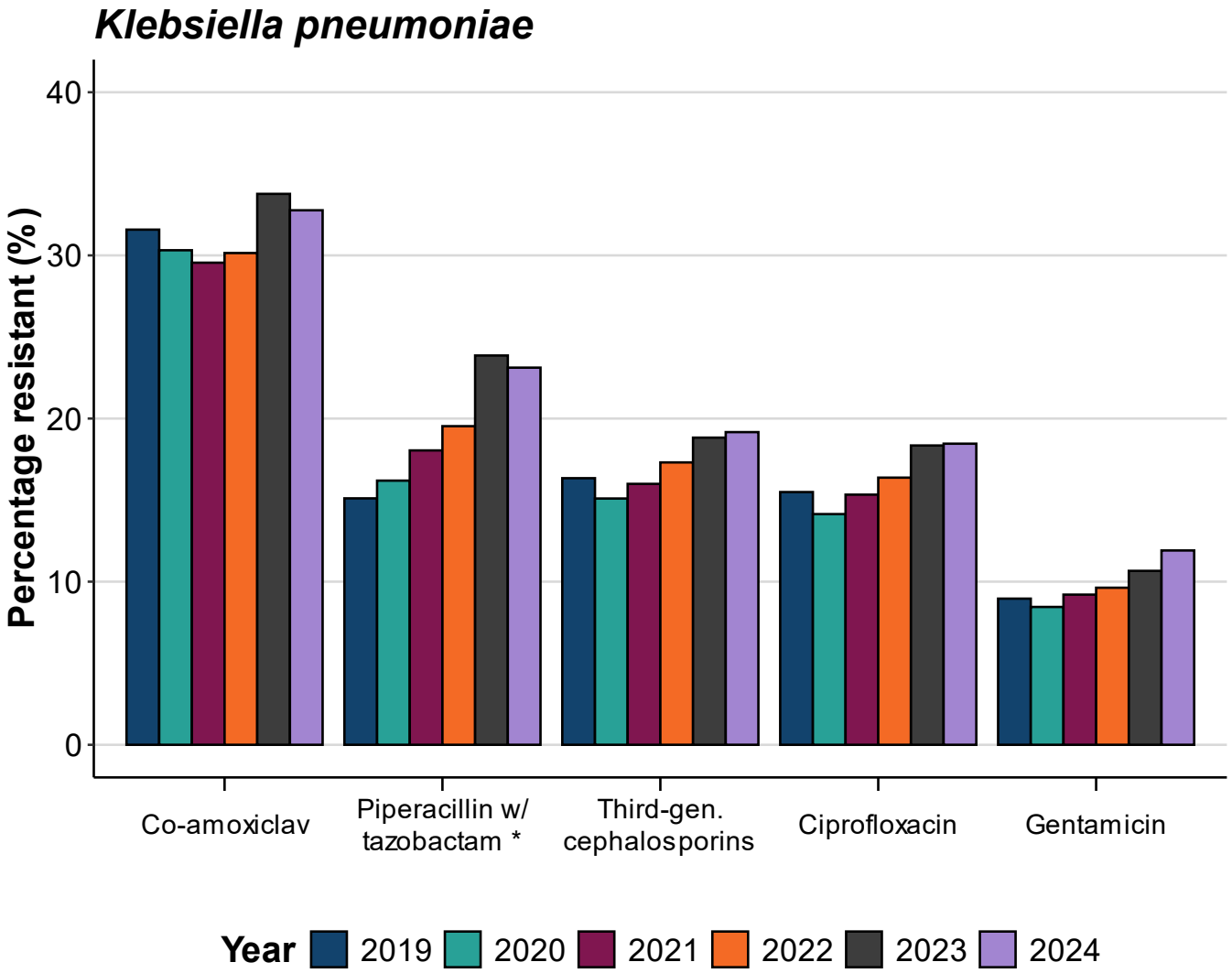
In 2021, the European Committee on Antimicrobial Susceptibility Testing (EUCAST) revised piperacillin with tazobactam breakpoints for Enterobacterales, affecting the interpretation of resistance trends over time. This change and its implications are explored further in Box 2.3 ESPAUR 2023 to 2024 report

Figure 2.8a. Trends in resistance to specified antibiotics in *Escherichia coli* bacteraemia, between 2019 and 2024, England



Amikacin and carbapenem are not displayed, as the percentage resistance remained below 4.0% and 0.3%, respectively, between 2019 and 2024 (see accompanying data tables).

Figure 2.8b. Trends in resistance to specified antibiotics in *Klebsiella pneumoniae* bacteraemia, between 2019 and 2024, England [note1]



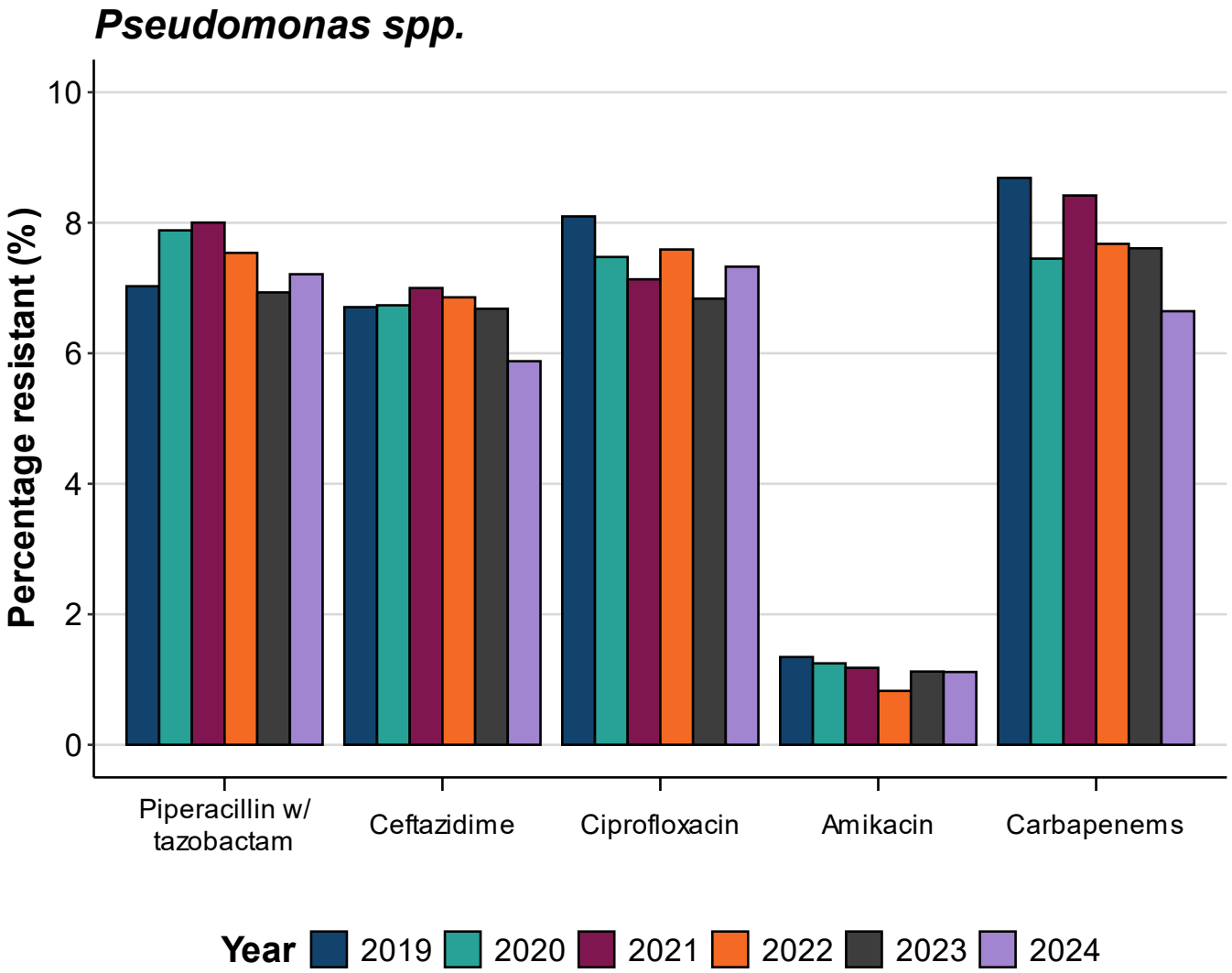
[note 1] EUCAST piperacillin with tazobactam breakpoints for Enterobacterales changed in 2021 (12); see Box 2.3 in ESPAUR 2023 to 2024 report for more details.

Further detail on antibiotic class groupings can be found in the Annexe (Table 2.1) accompanying this report.

Pseudomonas spp. bacteraemia resistance remained largely stable, with <8% resistance across major antibiotic classes in 2024 (Figure 2.9). Resistance to gentamicin is not presented due to the removal of the EUCAST breakpoint in 2020 and a subsequent decrease in reported susceptibility testing by laboratories (96.5% in 2019 to 48.0% in 2024).

In 2024, 17.3% of *Acinetobacter* spp. were *A. baumaunii.* Of 1,200 tested *Acinetobacter* sp. isolates, 26 (2.3%) were carbapenem-resistant, of which 15 (7.7%) were *Acinetobacter baumannii*. Further details of antibiotic resistance trends in *Acinetobacter* spp. can be found in the accompanying data tables.

Figure 2.9. Trends in resistance to specified antibiotics in *Pseudomonas* spp. bacteraemia, between 2019 and 2024, England [note1] [note2]



[note 1]: 84.8% of *Pseudomonas* sp. episodes were *P. aeruginosa*.
[note 2]: In this figure, 'carbapenems' refers only to meropenem or imipenem, as described in the Annexe (Table 2.1) accompanying this report.

Laboratories are reminded to send isolates with 'exceptional' antibiotic resistant phenotypes to the AMRHAI Reference Unit for confirmation; see the Bacteriology Reference Department user manual for referral criteria.

All-cause mortality in Gram-negative bacteraemia

The overall rate for 30-day all-cause mortality in patients with selected Gram-negative bacteraemia (*E. coli*, *K. pneumoniae*, *Pseudomonas* spp., *Acinetobacter* spp.) was 15.4% in 2024 (estimated number of deaths [est.] = 8,394); mortality was lowest in children aged one to 14 years (2.8%, est. = 17) and highest in adults aged 85 years and over (21.7%, est.= 2,532). The 30-day all-cause mortality in infants <1 year old in 2024 was 11.8% (est. = 106).

Male patients had a higher crude mortality rate (16.8%, est. = 4,838) than female patients (13.8%, est. = 3,551). Patients infected with a strain resistant to one or more antibiotics defining AMR burden (Table 2.1) had a higher crude mortality rate (17.2%, est. = 2,379) compared to those with a susceptible strain (14.7%, est. = 5,952). These findings were significant at a 5% level of statistical confidence.

The mortality rate varied by organism in 2024, where patients infected with *Pseudomonas* spp. had the highest crude mortality rate (21.2%, est. = 973) followed by *K. pneumoniae* (17.6%, est. = 1,591), and *E. coli* (14.3%, est. = 5,687). Patients infected with an *E. coli* or *K. pneumoniae* strain resistant to one or more AMR burden-defined antibiotics had a statistically significant ($p < 0.05$) higher crude mortality rate (15.9%, est. = 1,783; 22.3%, est. = 499 respectively) compared to those with a susceptible strain (13.7%, est. = 3,879; 16.1%, est. = 1,086 respectively).

In those for whom ethnicity was reported, the crude 30-day all-cause mortality rate was highest in the white ethnic group (15.8%, est. = 7,263) and lowest in the mixed or multiple ethnic group (9.5%, est. = 38).The mortality rates for the Asian or Asian British population and the Black, African, Caribbean or Black British population were 11.8% (est. = 454) and 10.3% (est. = 188) respectively. As mortality is higher in older populations and the age-sex distribution in different ethnicity populations differs, crude 30-day all-cause mortality rate was calculated for males and females over 75 years by ethnic group. Of those with recorded ethnicity information and greater than 20 fatalities, case fatality was highest in the White and Asian or Asian British populations (20% and 19% for males, and 17% and 17% for females, respectively, est. = 2711 and est. = 120 for males; est. = 1976 and est. = 101 for females, respectively). Fatality rates for the Black, African, Caribbean or Black British population was 16% for males (est. = 39) and 14% for females (est. = 14%). The similarity in fatality in the White and Asian or Asian British populations for those aged over 75 years, compared to the lower fatality rate for the Asian or Asian British population for all age groups, indicates that the younger age profile of non-White ethnic groups obscures non-age stratified crude mortality rates.

Crude mortality rates for bacteraemia cases in the most deprived IMD quintile was the lowest (14.5% crude), however there was no statistical evidence of a difference in mortality rate across quintiles. Despite no statistical difference in the case fatality rate across IMD quintiles, the estimated number of deaths was 19.1% higher in the most deprived quintile (est. = 1,754) than in the least deprived quintile (est. = 1,472), due to the higher number of bacteraemia cases in the more deprived population. Further work is underway looking at mortality across different ethnic groups and deprivation together.

Box 2.3. Modelling excess mortality from resistant bacteraemia

Understanding the mortality burden associated with AMR is critical to assessing its true public health impact. While crude mortality rates provide important insights, they do not distinguish between deaths caused by the infection itself and those that may be directly attributable to resistance. To address this, a modelling approach was used to estimate the number of deaths due to antibiotic-resistant bacteraemia (defined below), across 4 key pathogens – *E. coli, Klebsiella* spp., *Pseudomonas* spp. and *S. aureus,* that could have been averted under 2 counterfactual scenarios.

Two hypothetical scenarios (counterfactuals) were modelled to estimate the number of deaths that could have been averted under different assumptions about the role of antimicrobial resistance. They were:

- effect of resistance on outcome (treatment failure) – estimates the number of deaths that could have been avoided if infections caused by resistant organisms had instead been susceptible to standard antibiotics and effectively treated
- burden of resistant infections (occurrence) – estimates the number of deaths that could have been avoided if resistant infections had not occurred at all

For financial year 2023 to 2024, reported bloodstream infections from UKHSA's SGSS were linked with English hospital admissions from the NHS's Hospital Episode Statistics and the Office for National Statistics' mortality data, using patient NHS numbers. All-cause mortality within 30 days of infection was calculated. Models were adjusted for sex, age, comorbidity, whether emergency admission (or not), previous hospital stay with 12 months and ethnicity. In addition, for hospital-onset cases the models account for the time from admission to onset. Cases where linkage to deaths or hospital records was not possible, due to missing administrative information were excluded (n = 833). Resistance was defined as non-susceptibility to at least one of the following antibiotics:

- third-generation cephalosporins
- gentamicin
- amikacin
- ciprofloxacin
- piperacillin with tazobactam
- co-amoxiclav
- carbapenems

Approximately one in 10 deaths in patients occurring within 30 days of the onset a resistant bacteraemia were estimated to be directly attributable to the antimicrobial resistance itself: that is, these deaths might have been avoided if the bacteria responsible for the infection had been susceptible (Box Figure 2.3.1). In contrast, around 80% of deaths were estimated to be excess deaths due to the occurrence of the resistant bacteraemia, meaning they might have

been prevented if the resistant infection had not occurred at all – and if that infection was due to failure of prophylaxis, then resistance could have been a significant factor.

The true impact of these resistant infections is likely to lie somewhere between these estimates, as preventing resistance would not only improve treatment outcomes but may also reduce the occurrence of resistant infections altogether.

Box Table 2.3.1. Deaths within 30 days of the onset of infection and estimated excess deaths by pathogen in England, financial year 2023 to 2024

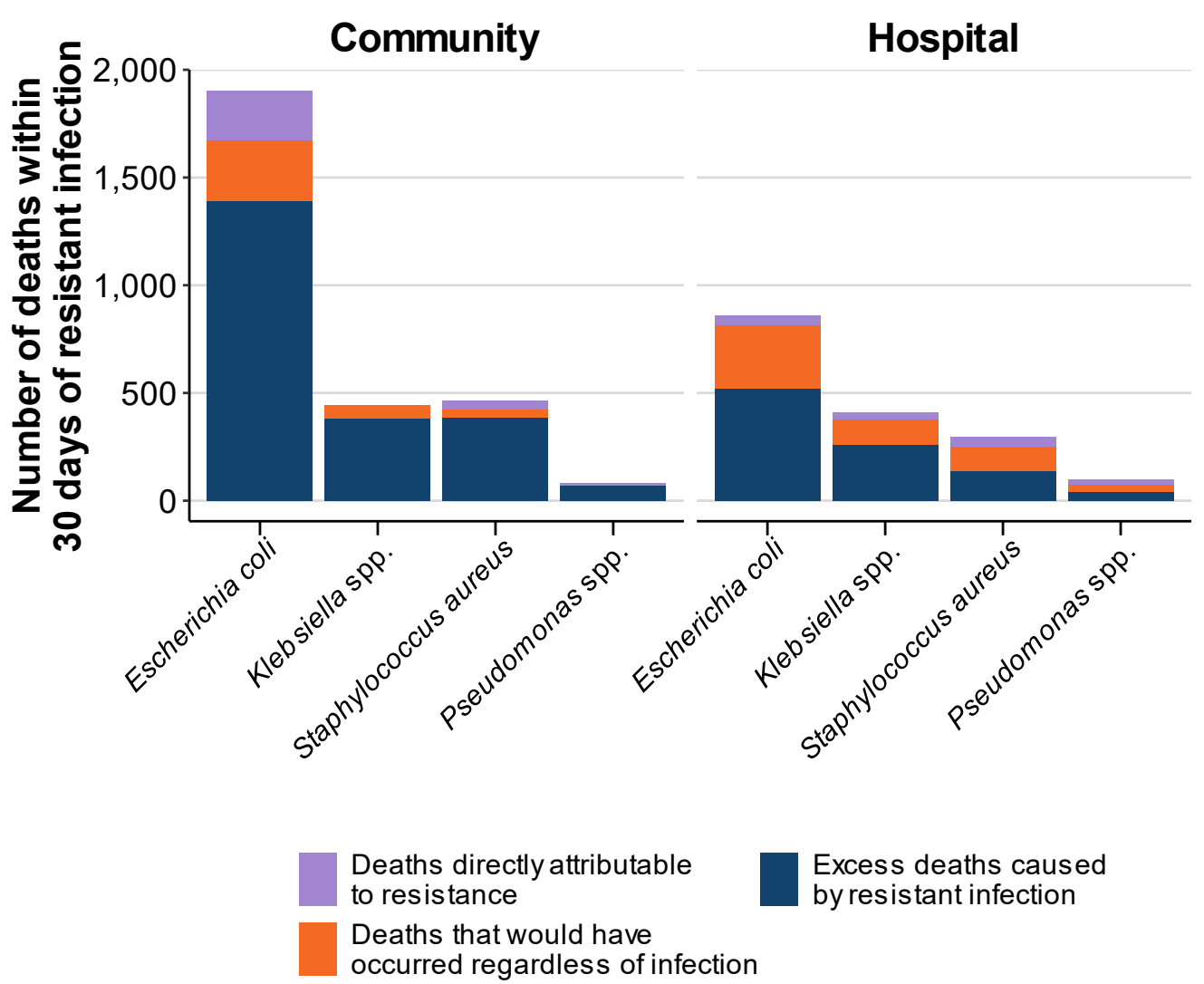
Pathogen	Cases	Deaths n (%)	Excess due to resistance n (%)	Excess due to infection itself n (%)
E. coli	17,612	2,764 (15.7%)	275 (1.6%)	2,186 (12.4%)
Klebsiella spp.	4,114	853 (20.7%)	30 (0.7%)	668 (16.2%)
Pseudomonas spp.	653	181 (27.7%)	34 (5.2%)	147 (22.5%)
S. aureus	3,523	759 (21.5%)	82 (2.3%)	603 (17.1%)

Thirty-day mortality following resistant bloodstream infections varied considerably by pathogen, with the highest rates observed in resistant *Pseudomonas spp.* (27.7%), followed by *Klebsiella spp.* (20.7%), *S. aureus* (21.5%), and *E. coli* (15.7%). While a smaller proportion of deaths in each group were directly attributable to resistance, ranging from 0.7% in *Klebsiella spp.* to 5.2% in *Pseudomonas spp.,* a larger proportion was linked to the occurrence of the resistant infection itself (Box Table 2.3.1). These findings highlight both the impact of resistance on treatment outcomes and the broader burden of resistant infections on patient survival.

Box Figure 2.3.1 illustrates deaths within 30 days of a resistant bacteraemia, split by community and hospital onset, and by pathogen. Each bar is divided into:

- orange (residual infection) – deaths that would have occurred regardless of infection
- navy blue (infection itself) – excess deaths caused by the resistant infection (but not due to resistance)
- purple (resistance of infection) – deaths directly attributable to the resistance (that is that could have been avoided if the infection had been susceptible)

Box Figure 2.3.1. Deaths within 30 days of the onset of bacteraemia and estimated excess deaths by onset (community or hospital) and pathogen



Community-onset resistant *E. coli* bacteraemia were associated with the highest number of deaths overall, and the greatest number of excess deaths (purple + orange), reflecting its high incidence. *Pseudomonas* spp., especially in hospital-onset infections, had a greater proportion of deaths attributed to resistance (purple) relative to their total, highlighting its high mortality impact per case. The residual component (orange) was smaller in proportion for *Pseudomonas* spp. and *S. aureus*, suggesting that more deaths in these cases were directly linked to the infection. *Klebsiella* spp. showed substantial burden (number of cases and deaths attributable to resistant infection) in both settings, particularly hospital-onset cases. Deaths within 30 days of a resistant infection varied by pathogen and setting, with community-onset *E. coli* contributing the largest number of deaths, while a higher proportion of deaths were directly attributable to resistance in hospital-onset *Pseudomonas* spp. and *S. aureus* infections.

AMR continues to contribute substantially to mortality associated with bacteraemia in England. However, its impact is not uniform across pathogens or settings. Analysis of national surveillance data shows that while *E. coli* bacteraemia remains the leading cause of deaths due to its high incidence, resistant infections caused by *Pseudomonas* spp., *Klebsiella* spp., and *S. aureus* are associated with significantly higher mortality per case, particularly in hospital-onset episodes.

Understanding the mortality associated with resistant infections is critical to informing and prioritising action against AMR. Quantifying deaths attributable to resistance itself, separate from those due to infection, enables a more accurate understanding of AMR's true impact and helps identify where interventions, such as targeted surveillance, empirical treatment guidance, robust infection prevention and control, strengthened antimicrobial stewardship, and investment in diagnostics and therapeutics, may be most effective. This evidence also supports preparedness and response planning for AMR-related outbreaks.

Acquired carbapenemase-producing Gram-negative organisms (CPO)

Notification data

From 1 October 2020, diagnostic laboratories in England have had a statutory duty to report acquired CPOs isolated from human samples (13). Since then, notifications of CPO have been published weekly and quarterly at national and regional levels, with the recent addition of ICB breakdown to the quarterly report. Details on notification definition, de-duplication and sample type categorisation are available in Chapter 2 of the Annexe accompanying this report.

In 2024, there were 7,438 notifications (from 5,743 persons) of CPO in England from all specimen types. The rates of reported CPO per 100,000 population have increased annually since 2021, the first full year of mandatory CPO reporting; 4.7 per 100,000 in 2021 to 12.9 per 100,000 in 2024.

Whilst the proportion of episodes for screening (71.4% from 2021 to 2024), sterile site (4.2%) and other samples types (24.4%) has remained stable over the past 4 years, absolute numbers of reports across all categories are increasing, with a 123.9% and 201.5% increase in the number of CPOs isolated from sterile or non-screening sites respectively between 2021 and 2024 (Table 2.2).

Table 2.2. Number and annual rate of CPO episodes by specimen type and year in England, 2021 to 2024

Specimen type	Percentage of CPO episodes in 2021 (n)	Rate of CPO in 2021 per 100,000 population	Percentage of CPO episodes in 2022 (n)	Rate of CPO in 2022 per 100,000 population	Percentage of CPO episodes in 2023 (n)	Rate of CPO in 2023 per 100,000 population	Percentage of CPO episodes in 2024 (n)	Rate of CPO in 2024 per 100,000 population
Sterile site isolates	5.2% (138)	0.2	4.1% (163)	0.3	4.6% (263)	0.5	4.2% (309)	0.5
Screening samples	72.2% (1,923)	3.4	72.3% (2,902)	5.1	71.3% (4,111)	7.1	71.4% (5,314)	9.2
Other samples	22.6% (602)	1.1	23.6% (947)	1.7	24.2% (1,395)	2.4	24.4% (1,815)	3.1
Total	(2,663)	4.7	(4,012)	7.0	(5,769)	10.0	7,438	12.9

In 2024, New Delhi metallo-beta-lactamase (NDM) followed by Oxacillinase-48-like (OXA-48-like) were the predominant CPO mechanisms detected in England (NDM: 2,671 out of 7,438, 35.9%; OXA-48: 2,560 out of 7,438, 34.4%; *K. pneumoniae* carbapenemase [KPC]: 1,459 out of 7,438, 19.6%). When indicated, this has implications for treatment, as NDM-producing organisms are some of the most resistant and challenging organisms to treat, with extremely limited treatment options. Rates of reported Verona Integron-Mediated Metallo-beta-lactamase (VIM) and Imipenemase Metallo-beta-lactamase (IMP) remained rare (<10% of reported CPOs; VIM: 207 out of 7,438, 2.8%; IMP: 518 out of 7,438, 7.0 %). The proportion of reports of episodes with more than one mechanism has increased year-on-year, from 3.7% in 2021 to 7.0% in 2024. Of CPOs isolated from sterile site samples in 2024, 24 (7.8%) episodes had more than one mechanism, 20 of which were OXA-48-like and NDM in *K. pneumoniae*. This is an increase from 7 (5.1%) episodes in 2021, 2 of which were OXA-48-like and NDM in *K. pneumoniae*.

In 2024, the North West and London continued to report the highest number of CPOs, a trend observed since national reporting began. However, there was marked regional variation in both the frequency and type of carbapenemases recorded (Figure 2.10 and Figure 2.11).

Differences in local or regional screening policies and the presence of regional foci, potentially related to prolonged outbreaks, are likely to influence these patterns.

Figure 2.10. Notifications per 100,000 population of acquired carbapenemase-producing Gram-negative bacteria by (a) region and (b) integrated care board, England, 2024

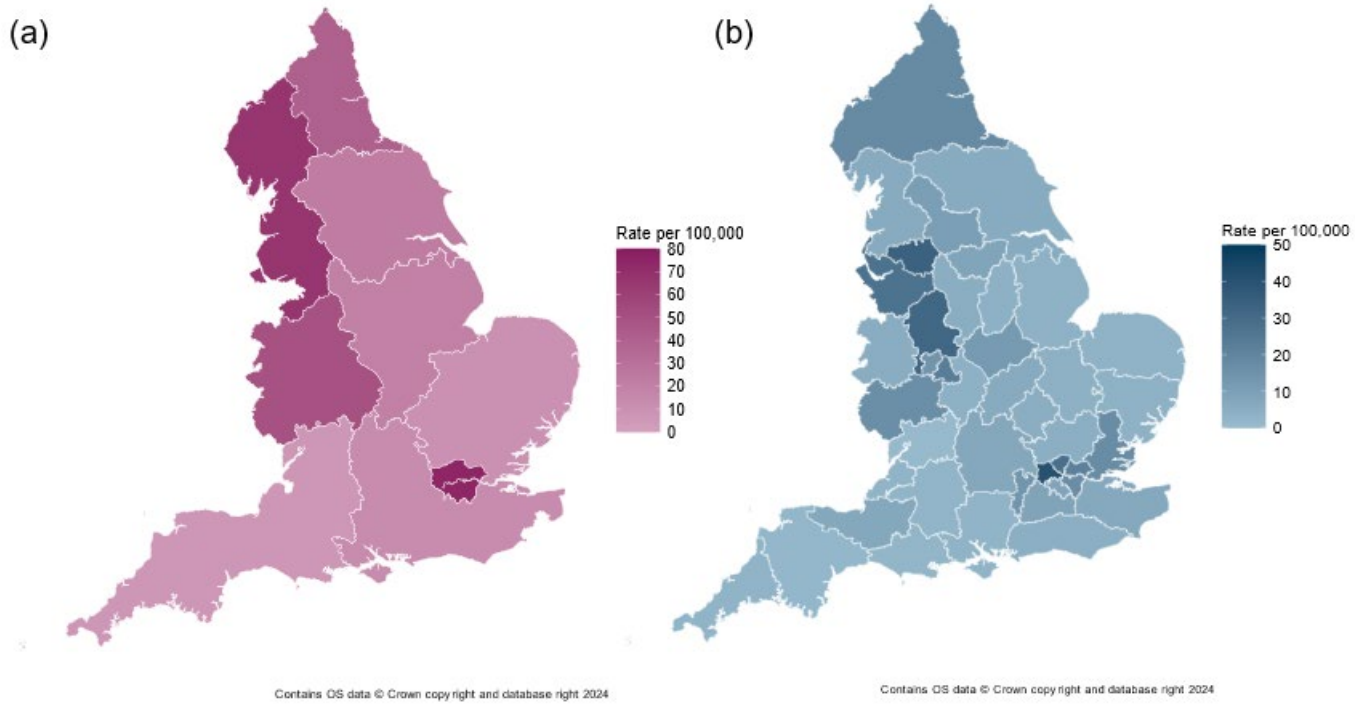
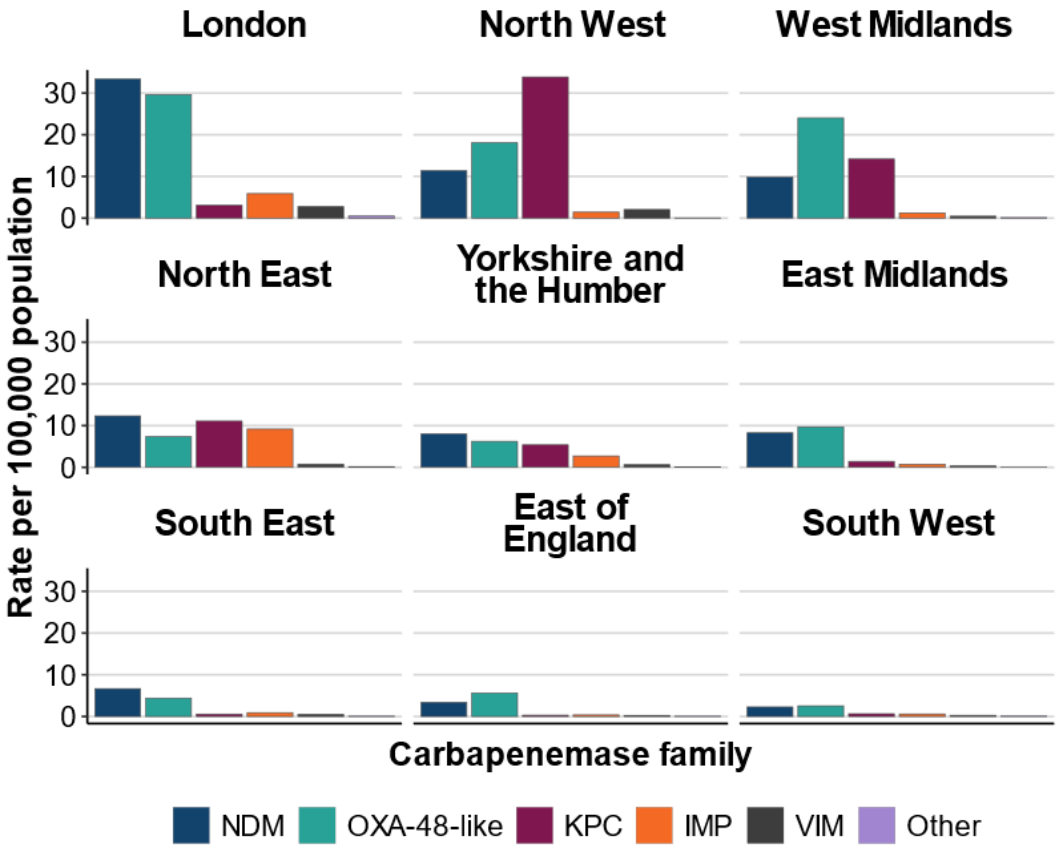


Figure 2.11. Regional notifications per 100,000 population of acquired carbapenemase-producing Gram-negative bacteria by carbapenemase family in England, 2024



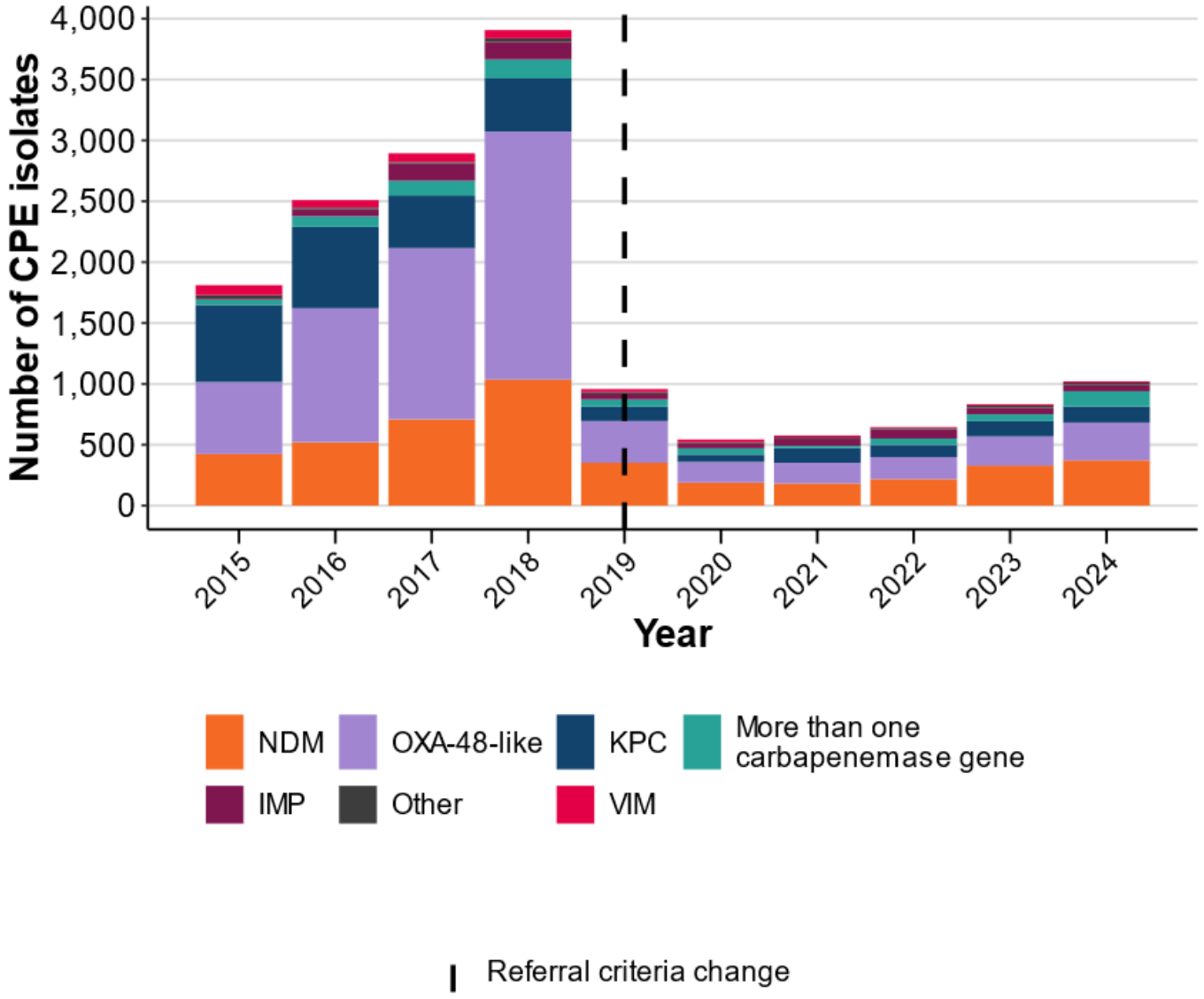
In 2024, the overall rate for 30-day all-cause mortality in patients with a CPO isolated from a sterile site specimen was 24.1% (estimated number of deaths = 68), compared to the 15.4% in 2024 (est. = 8,370) observed in selected Gram-negative AMR burden pathogens (*E. coli*, *K. pneumoniae*, *Pseudomonas* spp., *Acinetobacter* spp.) isolated from blood mentioned in the previous section.

National AMR reference laboratory

The Antimicrobial Resistance and Healthcare-Associated Infections (AMRHAI) Reference Unit screens all Enterobacterales sent for investigation of carbapenem resistance with a multiplex PCR targeting all carbapenemase gene families that have been identified amongst submissions. In 2024, 1136 Enterobacterales isolates (115 of which were isolated from blood cultures) referred to the AMRHAI Reference Unit were confirmed as positive for at least one carbapenemase. The ‘big 5’ carbapenemase families (KPC, OXA-48-like, NDM, VIM and IMP) and combinations thereof, continue to dominate and account for >98% of carbapenemase-producing Enterobacterales (CPE) in England. Of the referred carbapenemase-positive isolates in 2024, 12.5% harboured more than one carbapenemase gene, an increase from 7% in 2023, with NDM + OXA-48-like the most common combination detected (Figure 2.12a). Two isolates were referred that harboured 3 carbapenemase genes: IMP + NDM + OXA-48-like in an *E. coli* from a rectal swab and KPC + NDM + OXA-48-like in a *K. pneumoniae* from sputum. In 2024 the proportion of CPE submissions originating from blood dropped compared with 2023 (10.1% in 2024 compared with 12.9% in 2023) (Figure 2.12b). Data represented in the graph is available in the Chapter 2 data table accompanying this report.

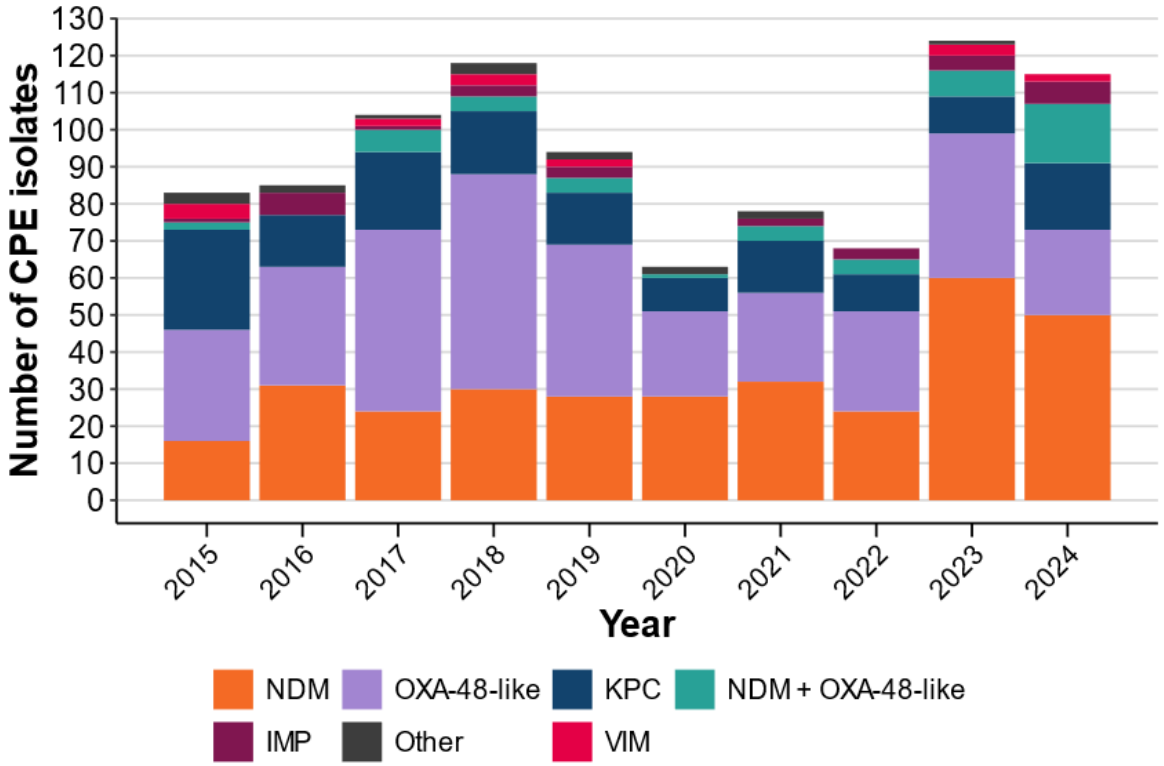
In 2024, OXA-23 was detected in a further 4 *Proteus mirabilis* and 2 *E. coli* isolates referred to AMRHAI. Other non-‘big 5’ carbapenemase genes detected included GES (*n* = 2) and IMI (*n* = 12), highlighting the need to refer suspected carbapenemase-producing isolates negative for the ‘big 5’ families to AMRHAI for screening for rarer carbapenemase families.

Figure 2.12a. Number of confirmed CPE isolates referred to the UKHSA's AMRHAI Reference Unit (excluding blood cultures), 2015 to 2024 [note1] [note2]



[note 1] Other includes: FRI, GES, GIM, IMI, OXA-23 (in Enterobacterales) and SME.
[note 2] Following a change to the referral criteria in 2019, submission of confirmed CPE isolates representing colonisation to the AMRHAI Reference Unit was no longer encouraged.

Figure 2.12b Number of confirmed CPE blood culture isolates referred to the UKHSA's AMRHAI Reference Unit, 2015 to 2024 [note1]



[note 1] Other includes: GES, IMI, IMP + OXA-48, KPC + NDM, KPC + OXA-48 and SME.

For *Pseudomonas* spp., the metallo-carbapenemase enzymes VIM and NDM continue to dominate but other metallo-carbapenemase enzymes (IMP and DIM) as well as non-metallo carbapenemase families (GES and OXA-48-like) and isolates with 2 carbapenemase families have been identified (Table 2.3). Please review the referral criteria for when to suspect an acquired carbapenemase in a *Pseudomonas* spp. isolate.

Table 2.3. Distribution of carbapenemase gene families amongst Pseudomonas spp. referred to the UKHSA's AMRHAI Reference Unit from all sources, England, 2017 to 2024

Year	Carbapenemase gene family				
	VIM	IMP	NDM	GES	Other (number)
2017	111	22	19	8	DIM (1); OXA-48-like (2)
2018	99	17	41	9	DIM (2); KPC (3); OXA-48-like (2)
2019	86	11	27	11	DIM (1); KPC (1); OXA-48-like (1); SIM (1)
2020	33	10	19	8	DIM (2); KPC (1)
2021	33	4	13	9	-
2022	21	19	18	8	GIM (1), OXA-48-like (1)
2023	35	5	25	5	DIM (1); GIM (5); KPC (1)
2024	24	5	31	8	IMP + NDM (1); KPC + NDM (1); KPC + VIM (1); DIM (5); OXA-48-like (1)

Gram-positive bacterial infections

Resistance trends in bacteraemia

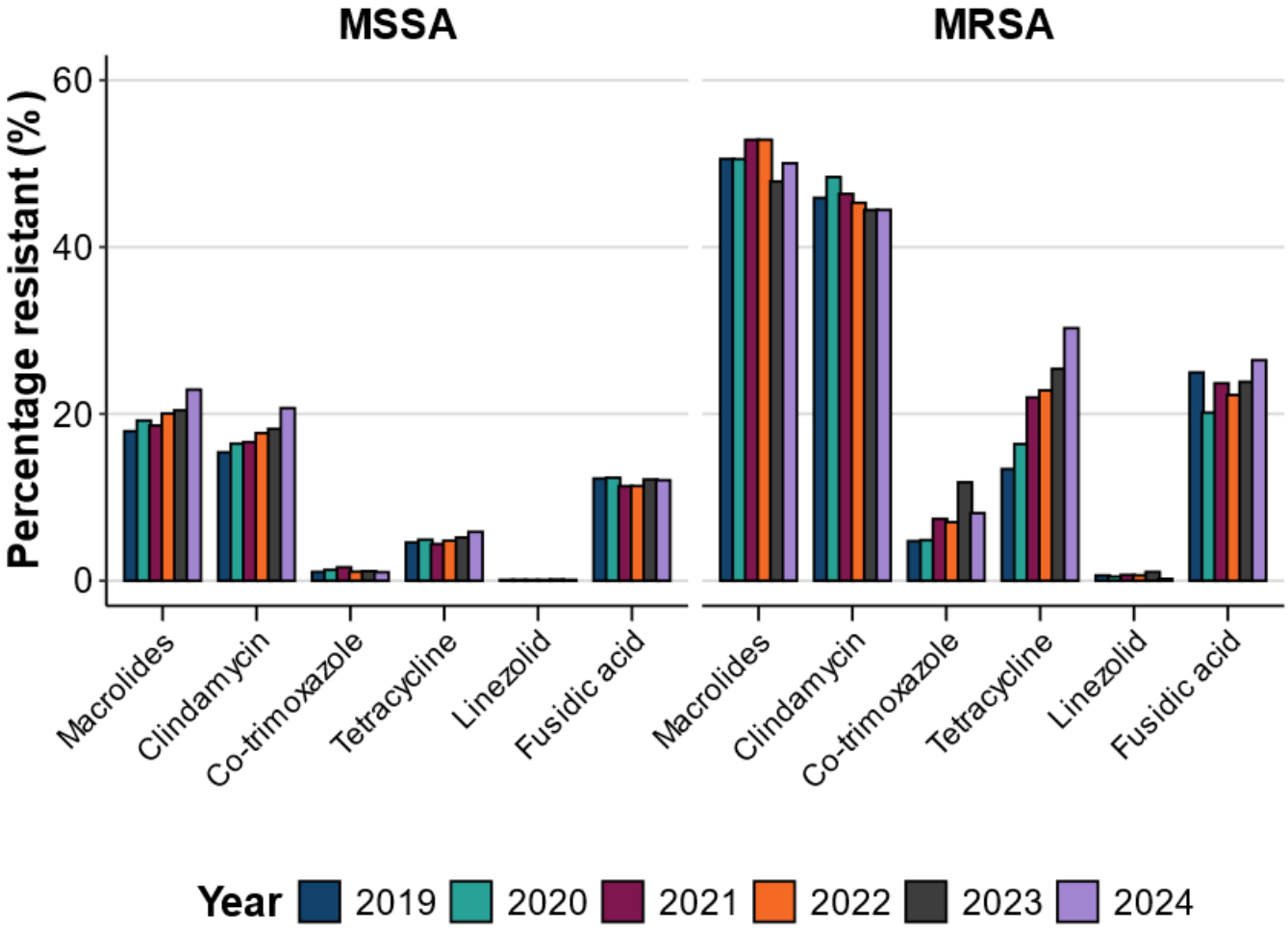
In 2024, methicillin-resistant *S. aureus* (MRSA) comprised 7.1% of the total *S. aureus* isolates from blood. As shown in Figure 2.13, resistance to a range of antibiotics was higher in MRSA compared with methicillin-susceptible *S. aureus* (MSSA).

Resistance to second line antibiotics continued to increase in bacteraemia caused by MSSA. Between 2019 and 2024, there was increased resistance to macrolides (17.9% to 22.9%), clindamycin (15.4% to 20.7%) and tetracycline (4.6% to 5.9%) (Figure 2.13a). In MRSA bacteraemia (Figure 2.13a), resistance to tetracycline more than doubled between 2019 and 2024 from 13.4% to 30.3%, whereas resistance to macrolides (50% resistance in 2024), and clindamycin (44.5%) remained high but stable.

Data on the susceptibility of *S. pneumoniae* bacteraemia is shown in Figure 2.14. The percentage of isolates resistant to penicillin, tetracycline and macrolides increased between 2019 and 2024, from 1.6% to 2.7%, 6.8% to 9.5%, and 5.7% to 8.2%, respectively. Full 6-year trend tables are available in the Chapter 2 data tables accompanying this report. Unpublished UKSHA data from 2024 indicates higher resistance among *S. pneumoniae* isolates from the lower respiratory tract, with resistance to penicillin, tetracycline and macrolides reported at 3%, 17% and 19% respectively (Figure 2.14). Antimicrobial resistance may vary by site of infection, reinforcing the importance of using local, site-specific susceptibility data to guide empirical treatment.

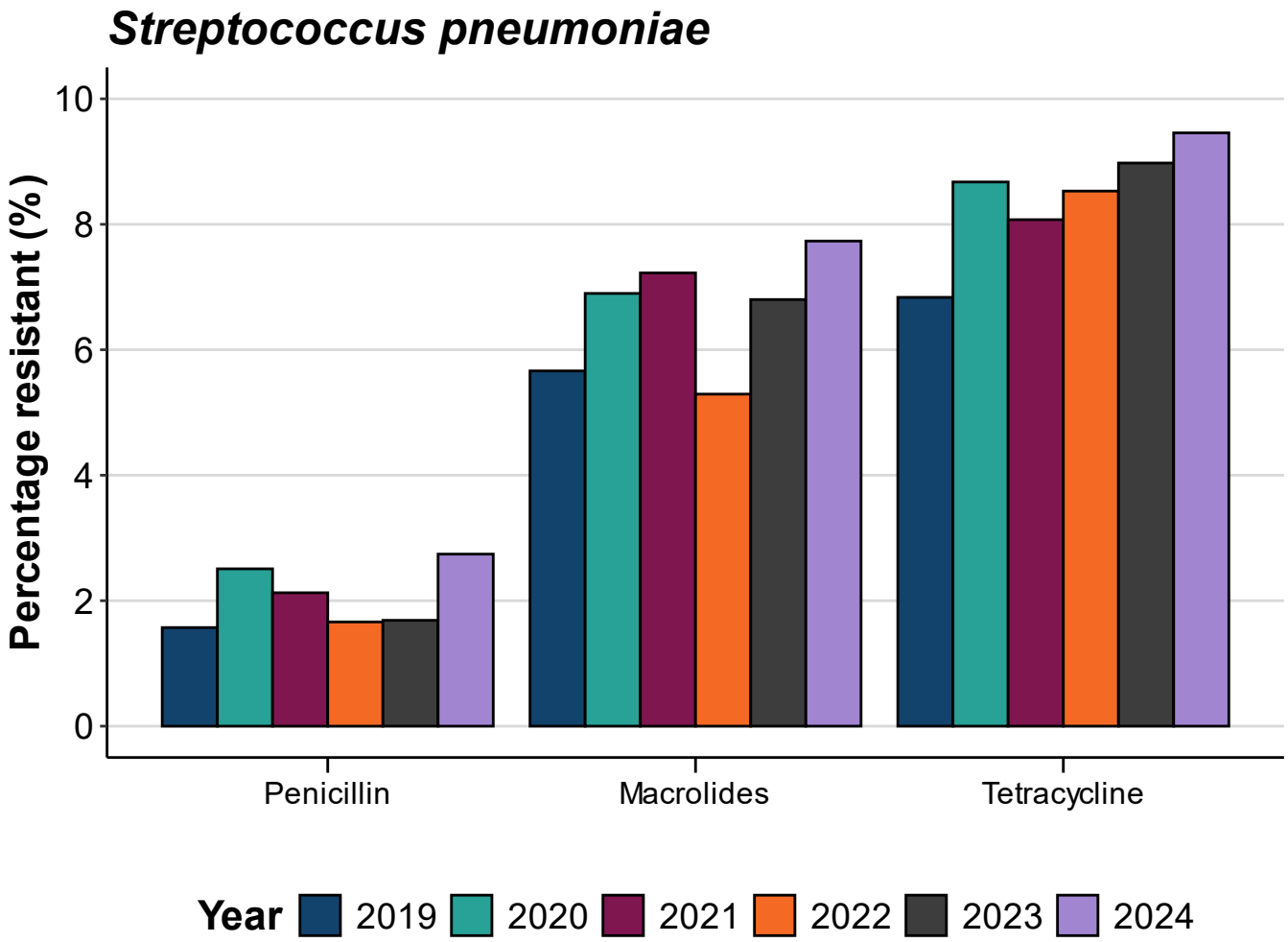
Beta-lactam antibiotics remain the most effective treatment option for susceptible infections caused by *Streptococcus* spp., and MSSA. Given the rising resistance seen to second-line agents, optimising access to beta-lactams is increasingly important. Where appropriate, penicillin allergy de-labelling should be prioritised, as it has the potential to improve patient care and ensure access to first-line (most effective) therapy. De-labelling reduces unnecessary use of broad-spectrum or second-line antibiotics, lowers the risk of antimicrobial resistance, decreases drug-related adverse events, and contributes to more effective antimicrobial stewardship (14, 15).

Figure 2.13. Trends in resistance to specified antibiotics in methicillin-susceptible S. aureus (MSSA) and methicillin-resistant S. aureus (MRSA) bacteraemia, between 2019 and 2024, England [note1]



[note 1] The *S. aureus* data in this chart is based on voluntary reports of methicillin resistance. Further details on antibiotic class groupings can be found in the Annexe (Table 2.1) accompanying this report.

Figure 2.14. Trends in resistance to specified in antibiotics in *Streptococcus pneumoniae* bacteraemia, England between 2019 and 2024

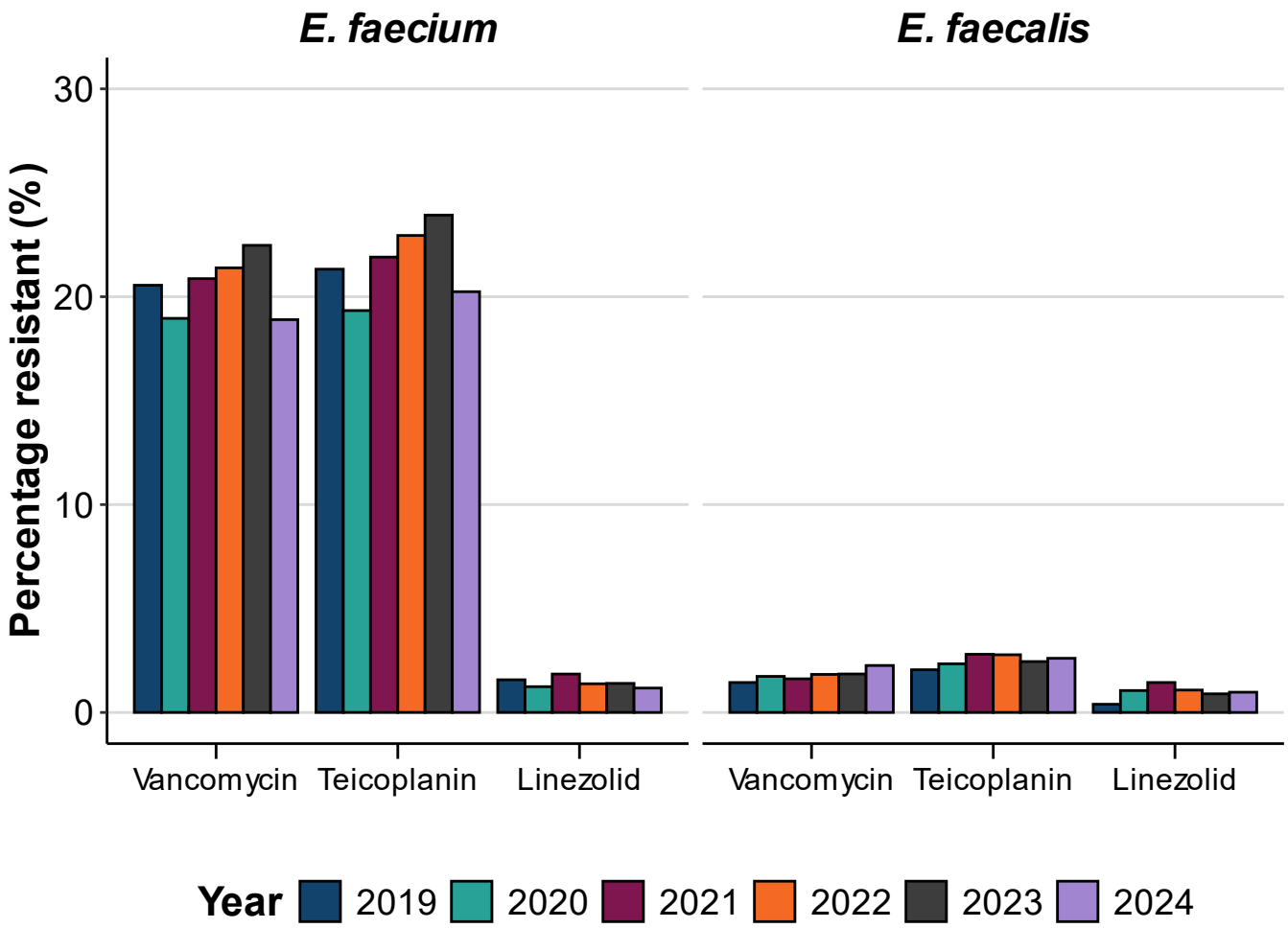


Enterococcus species

In 2024, *E. faecium* and *E. faecalis* were the predominant species causing enterococcal bacteraemia, responsible for 44.8% and 44% of cases, respectively. Overall, the reporting of both *E. faecium* and *E. faecalis* episodes increased from 2019 to 2024 by 19.6% and from 2023 to 2024 by 2.4%. The number of reported episodes for all Enterococci has increased by 18.0% between 2019 and 2024 (*n* = 7,593 to 8,956).

Resistance in *E. faecium* to both teicoplanin and vancomycin remained stable between 2019 and 2024, at 20.3% and 18.9%, respectively (Figure 2.15). Teicoplanin and vancomycin resistance in *E. faecalis* remained low in 2024 (<3%). Resistance to linezolid remained low, at 1.2% in *E. faecium* and 1.0% in *E. faecalis* in 2024.

Figure 2.15. Trends in resistance to specified antibiotics in *Enterococcus faecium* and *Enterococcus faecalis* bacteraemia, between 2019 and 2024, England



There are no EUCAST breakpoints for daptomycin for *Enterococcus* spp. Clinicians wishing to treat enterococcal bacteraemia or endocarditis with daptomycin should be aware of the uncertainties around testing (please refer to the Annexe). Daptomycin susceptibility testing results were reported in fewer than 10% of *E. faecalis* and *E. faecium* episodes, with 'resistant' results recorded for 1.1% and 3.4% in 2024, respectively. However, in the absence of defined EUCAST clinical breakpoints these figures should be interpreted with caution.

Laboratories are reminded to send isolates with exceptional antibiotic resistant phenotypes to the AMRHAI Reference Unit for confirmation. Further referral criteria and guidance on how to do this is available in the Bacteriology Reference Department user manual.

Box 2.4. Skin or soft tissue infection (SSTIs) in people in prison

The Chief Medical Officer's annual report 2025 focuses on health in prisons and probation services. Key findings from the 'Antimicrobial resistance and antimicrobial use' section, as they relate to SSTIs, are outlined below.

In people in prison, SSTIs can be associated with factors such as injecting drug use (16), tattooing (17), or other causes of skin injury, including violence and self-harm (18).

Several factors may contribute to an increased risk of AMR infections in this population, including, overcrowded living conditions (19), challenges in accessing healthcare (20) and high prevalence of risk factors. Frequent movement of individuals between (and within) facilities and the community can contribute to the spread of resistant strains. The prison population also differs from the general population, with individuals more likely to be younger and male (males comprise approximately 90% of the prison population), and to present with complex health and social needs. Ascertainment of SSTIs also differs in prison compared to the general population; all new entrants will receive a health assessment which may include taking swabs as required, increasing the level of sampling of SSTIs in the prison population compared to the general population. For this reason, direct comparison to the general population is not included here.

Primary pathogens responsible for SSTIs in this cohort were *S. aureus* and Group A streptococci (GAS), with Group C and Group G streptococci (GCS and GGS) increasingly recognised as causative pathogens in their own right.

Between April 2019 and March 2024, 19,101 SSTI episodes, defined by a specimen type recorded as ‘skin’ or ‘wound’, were reported in adults (18+ years) in an English prison or those who had been in an English prison over this period. *S. aureus* comprised 73.8% of episodes and the remaining 26.2% were due to beta-haemolytic streptococci (GAS: 14.8% and GCS and GGS: 11.5%; Box Figure 2.4.1). In people in prison, the majority of SSTIs occurred in those aged 18 to 44 years (68.4%), with the rate of SSTIs in females nearly treble that of males (13,466 versus 4,627 per 100,000 person years).

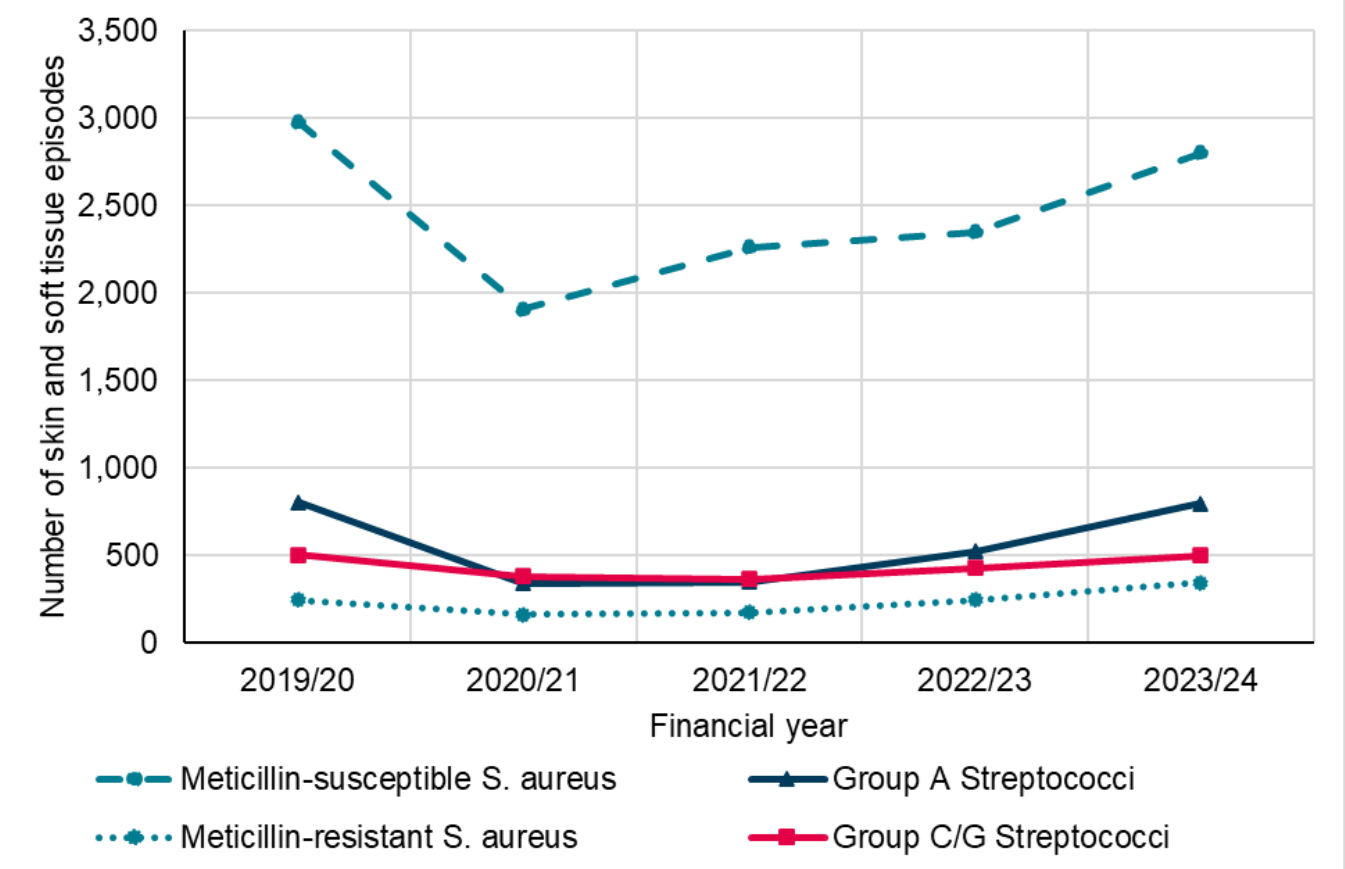
In 2023 to 2024, MRSA accounted for 10.4% of all *S. aureus* isolates. Resistance of MRSA to several commonly used antibiotics was high, including clindamycin (58.7%) and macrolides (64.3%). In MSSA, resistance to clindamycin and macrolides was also common, at 28.9% and 32.4%, respectively. Tetracycline resistance in MSSA remained low (<7.5%), supporting the continued use of doxycycline as a second-line option in appropriate clinical scenarios. Mupirocin resistance was low throughout the time period (<2%). Resistance to co-trimoxazole and linezolid remained low in both MRSA (<5% and <1%) and MSSA (<1.5% and <1%), preserving their utility in selected treatment regimens.

Group A Streptococcus (GAS) remained universally susceptible to penicillin. However, resistance of GAS from SSTIs to second-line agents was observed: 15.4% for macrolides, 71.8% for tetracyclines, and 7.8% for clindamycin.

In group C/G Streptococci, resistance to macrolides and clindamycin was more than double that seen in GAS (47.1% and 42.4%), with tetracycline resistance reported at 42.4%. Resistance to co-trimoxazole and linezolid remained low across all Streptococcal groups (<7% and <2%, respectively).

Co-trimoxazole, remains a valuable empirical option in SSTIs, when appropriate, particularly in cases requiring empiric treatment of both *S. aureus* (including MRSA) and beta-haemolytic Streptococci.

Box Figure 2.4.1. Annual trends in the number of skin and soft tissue infection episodes identified in English prisons between April 2019 to March 2024, by organism



There are clear areas requiring further investigation and targeted action to reduce the burden of infection in the prison population and to address the significant health inequalities faced by this group, particularly the disparity in rates of infection between females and males. IPC guidance for prisons is due to be published by UKHSA this year.

Further information on the analysis can be found in the Annexe accompanying this report.

Antibacterial resistance in specialist areas

AMR in urine isolates

Urinary tract infections (UTIs) are among the most commonly treated bacterial infections within the NHS, both in primary and secondary care (21). Data from NHS England shows that there were over 1.8 million hospital admissions involving UTIs between 2018 to 2019 and 2022 to 2023 – the majority being in patients aged 65 and older (22, 23). Of the 51.6% (*n* = 21,788) *E. coli* bloodstream infection cases with a reported primary focus of infection in FY 2023 to 2024, the urinary tract was the most frequently reported primary focus (45.0% (*n* = 9,810)), and has

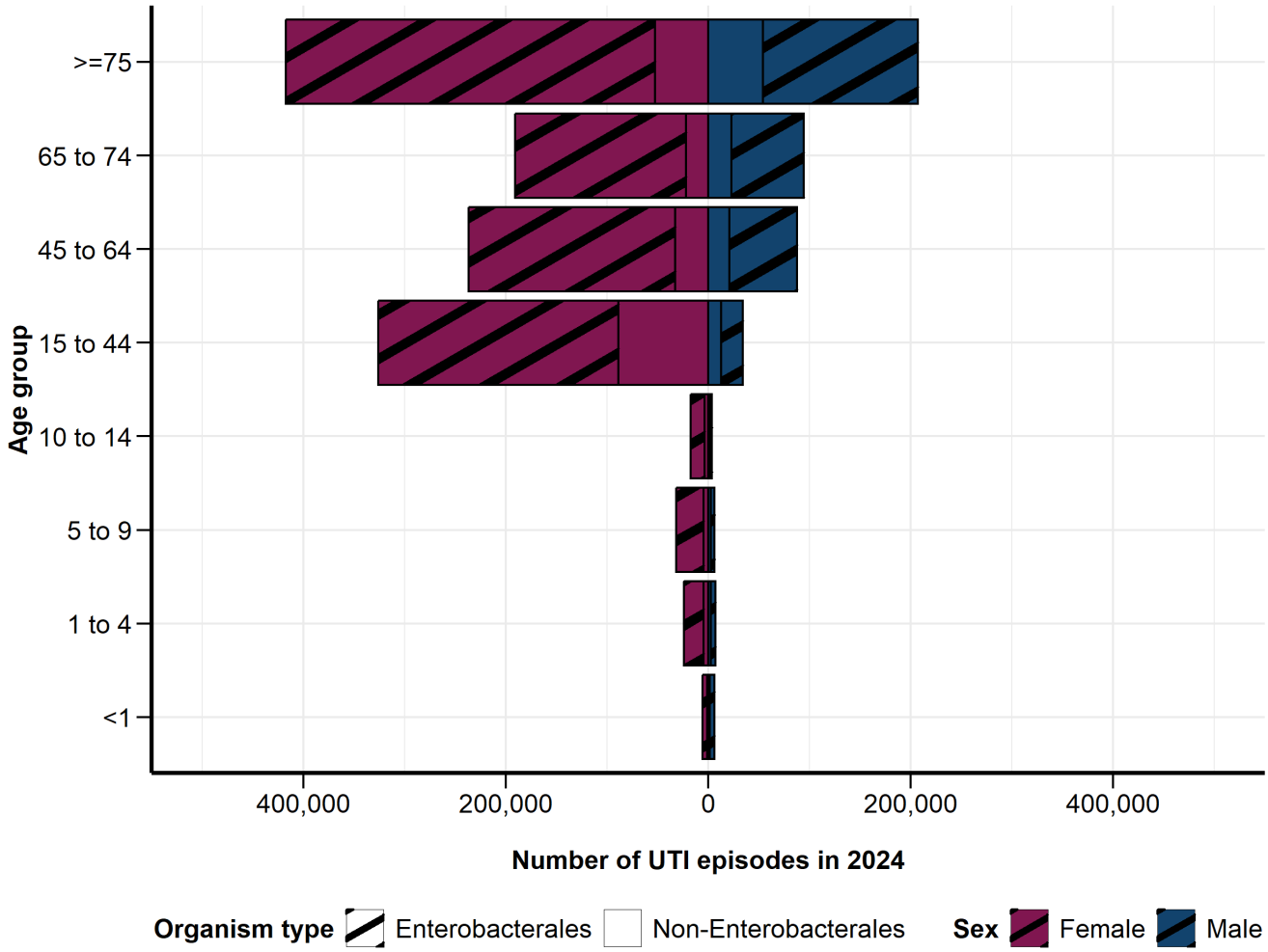
consistently been the most frequently reported primary focus over time (24). After respiratory infections, UTIs are the second most common indication for antibiotic prescribing in general practice in England (25), and in the 2023 point prevalence survey on healthcare-associated infections (HCAIs) UTIs were the second most common HCAI, accounting for 17.5% of all HCAIs (26).

Urine specimens for culture are recommended in specific circumstances as outlined in Diagnosis of urinary tract infections: quick reference tools for primary care and include patients with risk factors for resistance, and patients who fail to respond to empirical antibiotics. For women under 65 years with suspected UTI, diagnostic decision tools outline when urinary dipstick testing alone is appropriate and when urine culture is required. In men, dipstick tests can be used to rule in infection but unreliable to rule out infection. Urinary dipsticks are not recommended in adults over 65 or those with suspected catheter-associated infection due to increasing levels of asymptomatic bacteriuria (significant levels of bacteria in the urine with no symptoms of UTI).

In a recent study of English data between 2015 and 2022, around 50% of UTI episodes in general practice had an accompanying urine specimen (21). Thus, urinary specimens reported to UKHSA's SGSS AMR module may disproportionately represent more severe or resistant infections (22). In 2024, there were 1,696,232 laboratory-reported urinary episodes submitted to UKHSA's SGSS AMR module, from 1,328,957 patients; a 6.4% decrease in episodes from 1,812,860 in 2019, however a 4.1% increase from 1,629,162 in 2023. Of all reported urinary episodes in 2024, 80.6% (*n* = 1,366,688) were due to Enterobacterales, 15.7% to Gram-positive organisms, and 3.7% to non-Enterobacterales Gram-negative organisms. Among urinary Enterobacterales, *E. coli* accounted for 69.6% of episodes and *K. pneumoniae* for 7.4%.

In 2024, the highest number of urinary episodes occurred in females aged over 75 (*n* = 417,703; 24.6% of all episodes), followed by females aged 15 to 44 (*n* = 326,299; 19.2%), and females aged 45 to 64 *n* = 236,655; 14.0%) (Figure 2.16). In all age groups, the number of episodes was higher in females than in males. The majority of laboratory-reported urinary episodes in 2024 originated from general practice (GP) (*n* = 1,044,223; 61.6%), followed by acute (*n* = 569,877; 33.6%) and community or other settings (*n* = 82,132; 4.8%). (*n* = 82,132; 4.8%).

Figure 2.16. Age-sex distribution of urinary Enterobacterales episodes and non-Enterobacterales in England, 2024

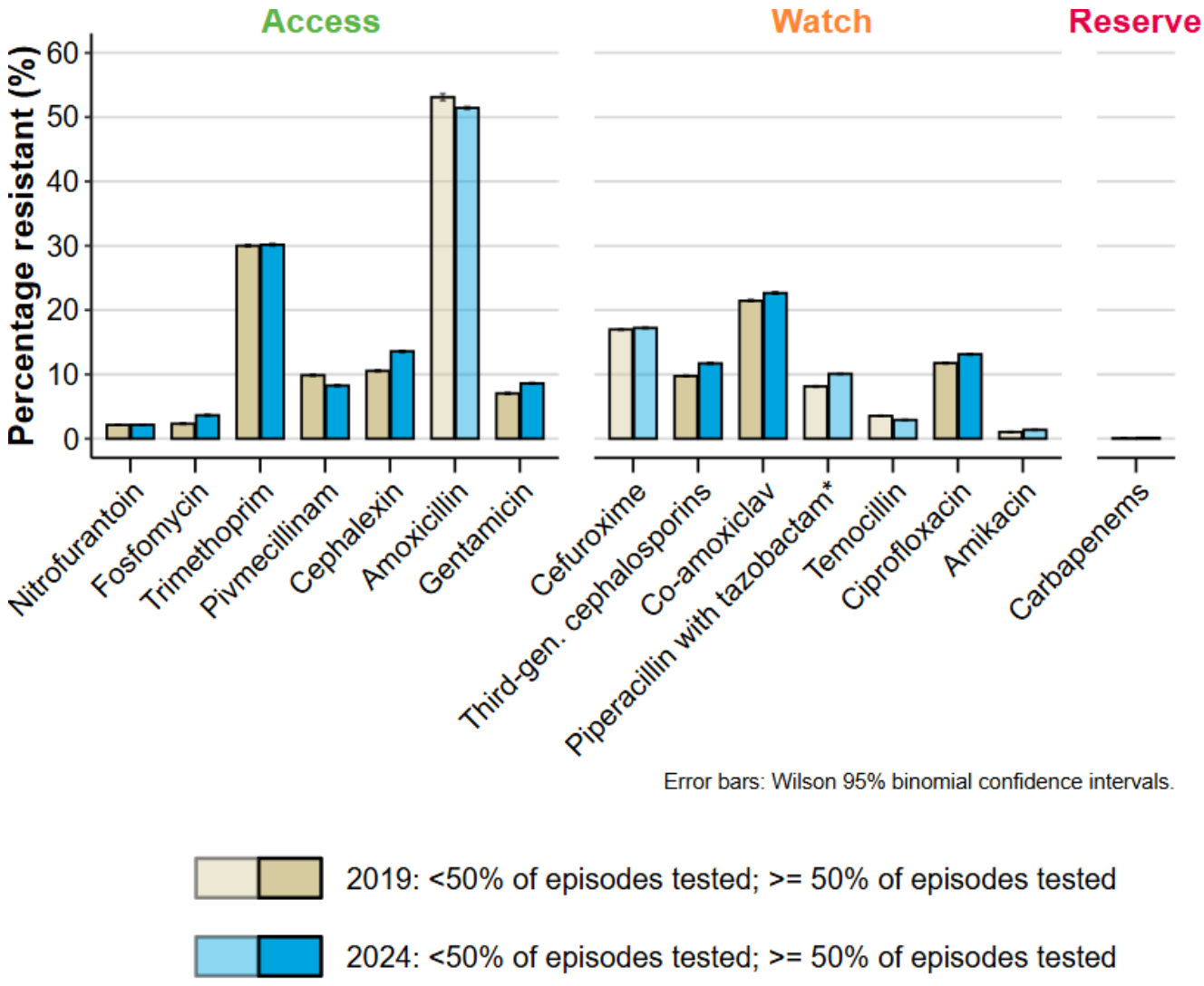


NICE guidelines for uncomplicated lower UTI (NG109) outline antimicrobial prescribing strategy with dedicated treatment tables for non-pregnant women aged 16 years and over, pregnant women aged 12 years and over, for men aged 16 years and over and for children and young people under 16 years (27).

In 2024, resistance rates in urinary *E. coli* isolates to agents used for lower UTI were: nitrofurantoin (2.2%), trimethoprim (30.1%), fosfomycin (3.6%), pivmecillinam (8.3%), cephalexin (13.6%) and amoxicillin (51.4%). No change in resistance to nitrofurantoin was observed between 2023 (2.1%) and 2024 (2.2%) following the introduction of nitrofurantoin supply via Pharmacy First Clinical Pathways in February 2024.

Resistance in urinary *E. coli* isolates to agents used in acute pyelonephritis, prostatitis and catheter-associated UTI was observed across a range of antibiotics. In 2024, resistance was reported to: ciprofloxacin (13.1%), cefuroxime (17.2%), third-generation cephalosporins (11.7%), co-amoxiclav (22.6%), piperacillin with tazobactam (10.1%), gentamicin (7.0% to 8.6%), amikacin (1.4%), temocillin (2.9%) and carbapenems (0.1%).

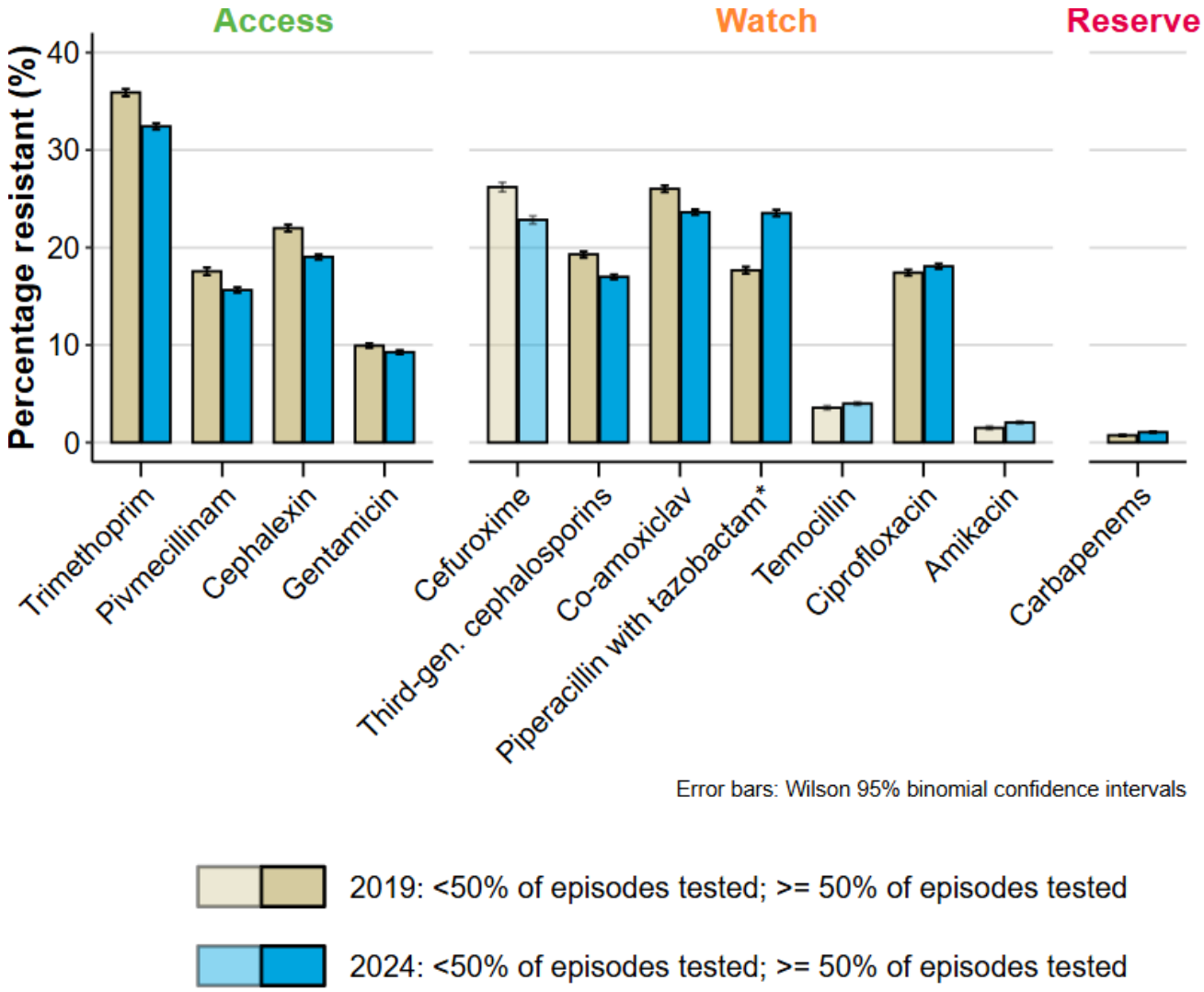
Figure 2.17. Resistance in urinary *E. coli* episodes to specified antibiotics in England, by Access, Watch, and Reserve (AWaRe) category, 2019 and 2024 [note1]



[note 1] EUCAST piperacillin with tazobactam breakpoints for Enterobacterales changed in 2021 (12); see Box 2.3 in ESPAUR 2023 to 2024 report for more details.

Urinary isolates for *K. pneumoniae* episodes demonstrated consistently higher resistance rates than urinary *E. coli* isolates across all specified agents. Urinary *K. pneumoniae* resistance to ciprofloxacin (18.0%), amikacin (2.0%), carbapenems (1.1%), gentamicin (9.3%), and temocillin (4.0%) was stable between 2019 and 2024 (Figure 2.18). Resistance to co-amoxiclav (26.0% in 2019, 23.6% in 2024), cefuroxime (26.2% in 2019, 22.8% in 2024), cephalexin (22.0% in 2019, 19.0% in 2024), pivmecillinam (17.6% in 2019, 15.6% in 2024), trimethoprim (35.9% in 2019, 32.4% in 2024), and third-generation cephalosporins (19.3% in 2019, 17.0% in 2024) decreased slightly between 2019 and 2024. Reported resistance to piperacillin with tazobactam increased, however this breakpoint changed in 2021 (see Box 2.3 in ESPAUR 2023 to 2024 report for more details) complicating estimation of the true change in resistance over this period.

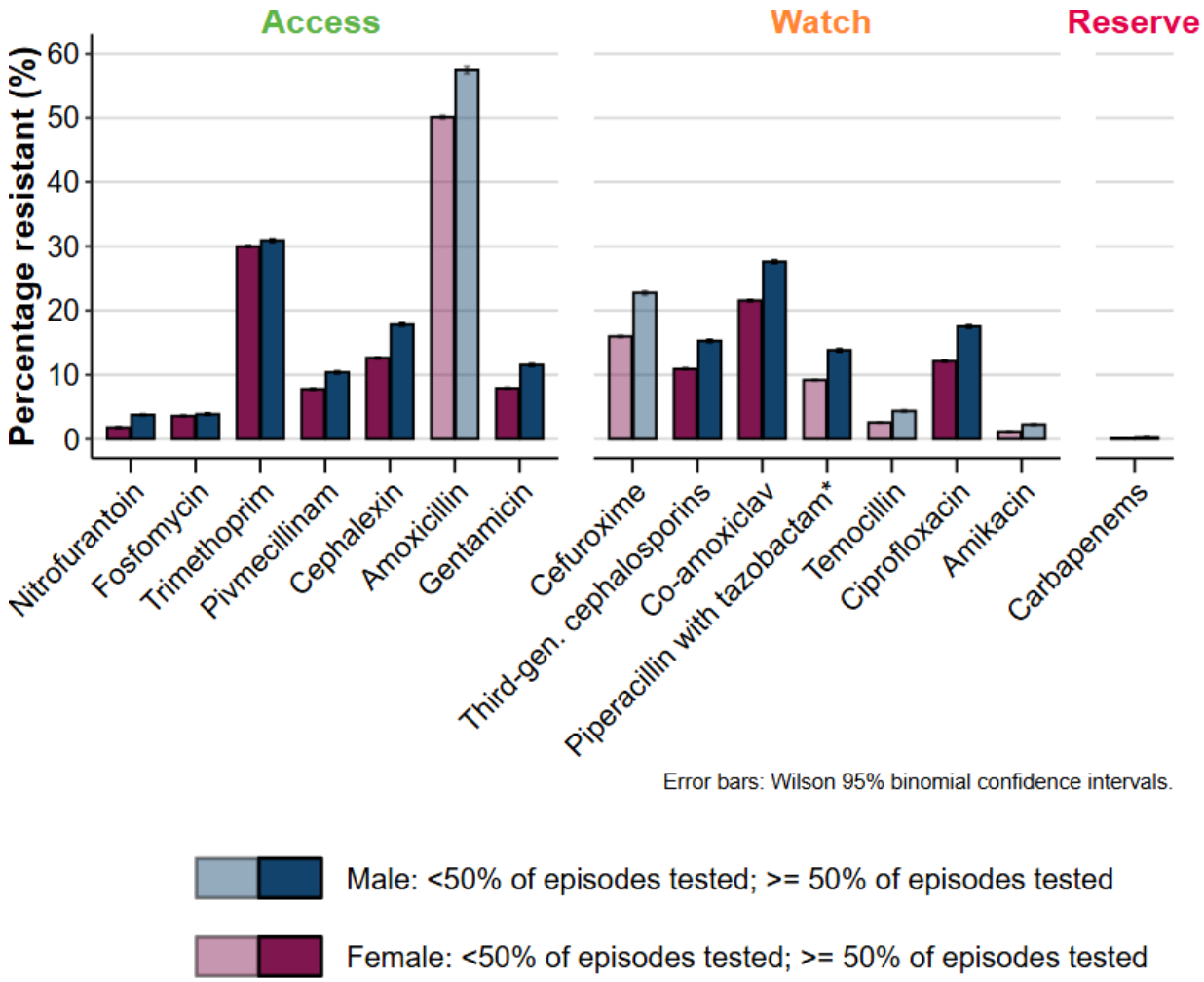
Figure 2.18. Resistance in urinary *K. pneumoniae* isolates to specified antibiotics in England, by Access, Watch, and Reserve (AWaRe) category, 2019 and 2024 [note1]



[note 1] EUCAST piperacillin with tazobactam breakpoints for Enterobacterales changed in 2021 (12); see Box 2.3 in ESPAUR 2023 to 2024 report for more details.

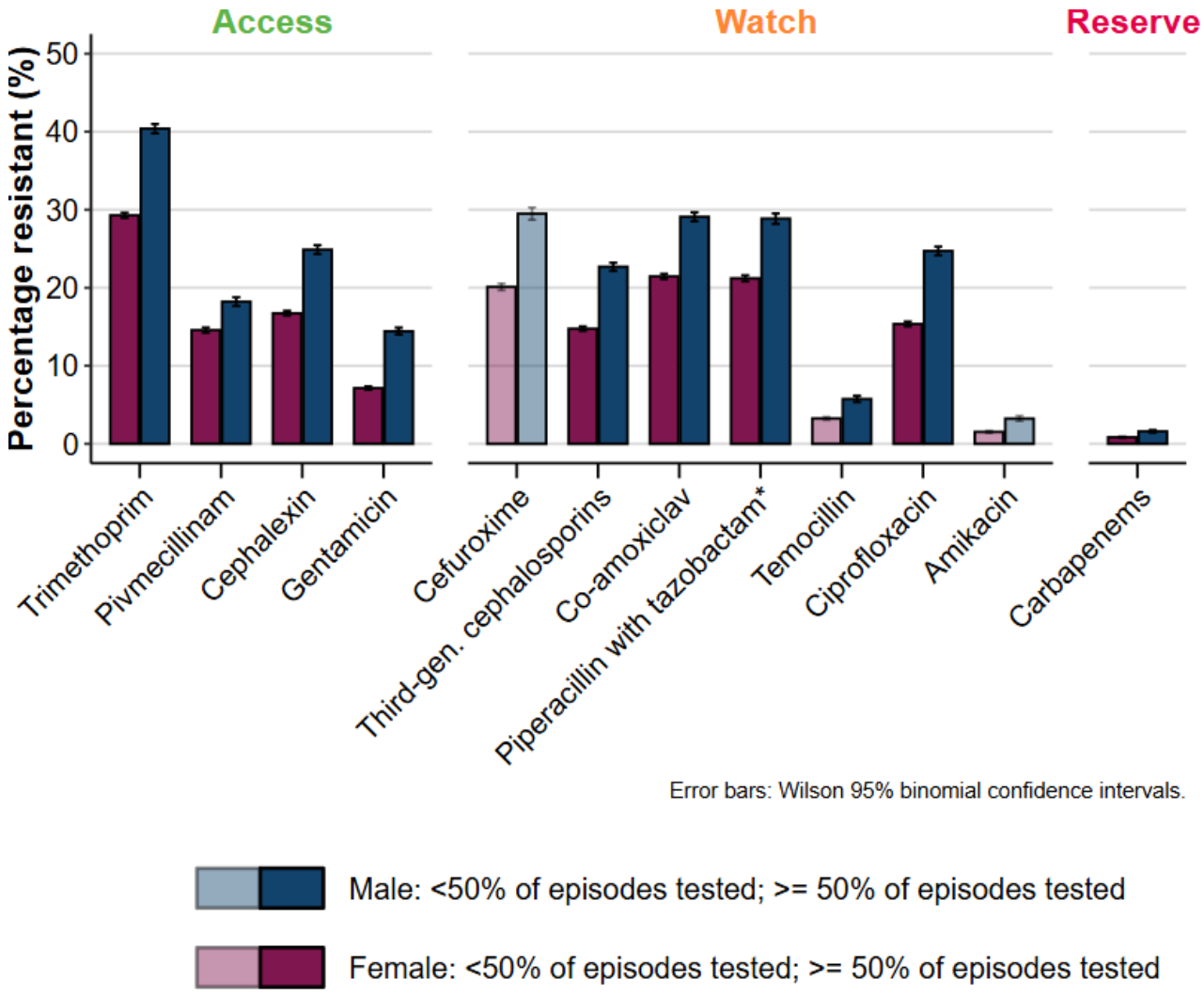
Despite the higher number of urinary episodes in females versus males across all age groups, urinary *E. coli* resistance to all specified antibiotics was higher in male patients than females (Figure 2.19). Notably, ciprofloxacin, third-generation cephalosporins, and cephalexin resistances were higher by 5.4% (17.5% in males compared to 12.1% in females), 4.4%, and 5.2% in males, respectively.

Figure 2.19 Resistance in urinary *E. coli* isolates to specified antibiotics by patient sex and Access, Watch, and Reserve (AWaRe) category in England, 2024



This trend was more pronounced in urinary *K. pneumoniae* isolates, where resistance in males was consistently higher than in females, with the largest differences seen for trimethoprim (a difference of 11.1%; 40.4% in males compared to 29.3% in females), cefuroxime (9.4%), ciprofloxacin (9.3%), third-generation cephalosporins (7.9%), and cephalexin (8.2%).

Figure 2.20 *K. pneumoniae* resistance to specified oral and intravenous antibiotics patient sex and Access, Watch, and Reserve (AWaRe) category in England, 2024



Surveillance of antibiotic resistance in *Neisseria gonorrhoeae*

Surveillance of AMR in *Neisseria gonorrhoeae* is monitored through the Gonococcal Resistance to Antimicrobials Surveillance Programme (GRASP), which detects and monitors AMR in *N. gonorrhoeae* and records confirmed treatment failures. Trend data are derived from the national sentinel surveillance system, which collects gonococcal isolates from consecutive patients attending a network of 26 participating sexual health services (24 in England, 2 in Wales) over a 2-to-3-month period each year. Gonococcal isolates are referred to the UKHSA national STI Reference Laboratory for antimicrobial susceptibility testing and whole-genome sequencing, and the results are linked to patient demographic, clinical and behavioural data for analysis of antimicrobial susceptibility trends in patient sub-groups.

In 2024, one case of ceftriaxone resistance (MIC >0.125 mg/L) was observed in the GRASP sentinel programme – the first since surveillance began in 2000. The frequency of ceftriaxone-resistant cases reported outside of this sentinel programme has continued to increase. Ceftriaxone-resistant cases reported thus far in 2025 (15 cases) have exceeded the total reported in 2024 (13 cases), which had been the highest to date. Seven out of 15 ceftriaxone-

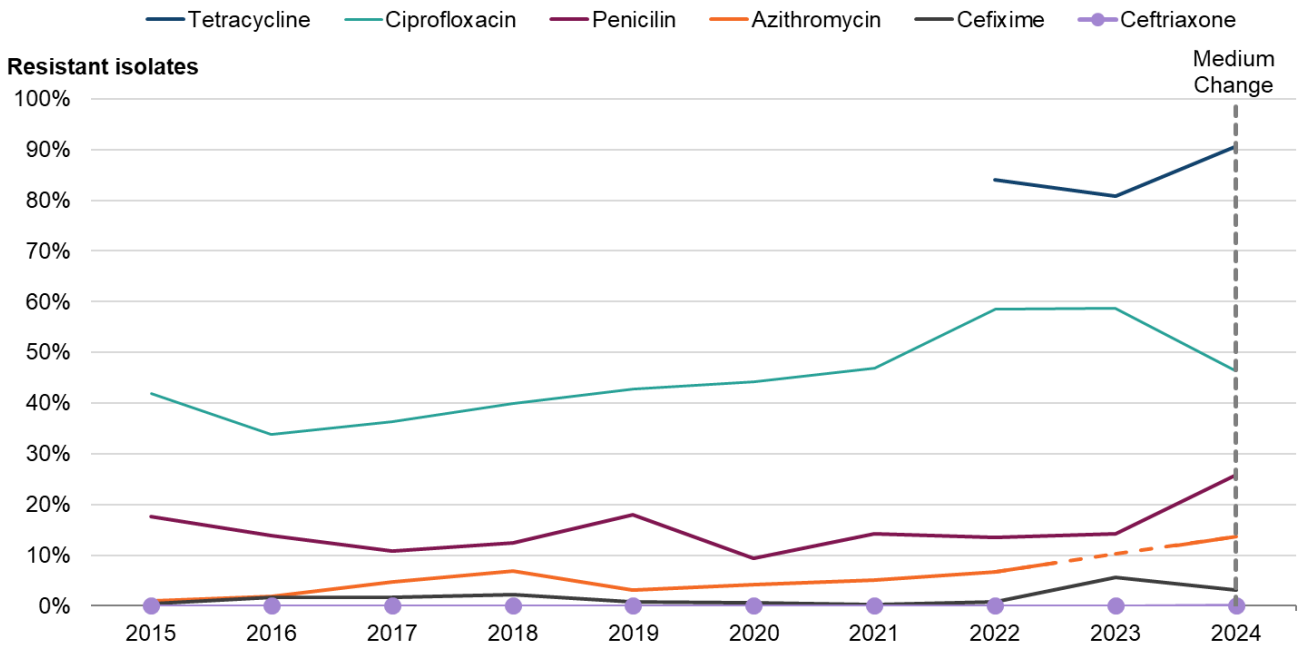
resistant cases in 2025 were also extensively drug-resistant (XDR) with resistance to both first- and second-line treatment options and to other antibiotics. Most cases continue to have travel links with the Asia-Pacific region, which has been shown to have the highest prevalence of ceftriaxone-resistant *N. gonorrhoeae* globally. However, as some cases appear to have acquired infection within the UK and as not all partners could be contacted, undetected transmission within England is possible.

Figure 2.21 describes the trends in tetracycline, ciprofloxacin, penicillin, azithromycin, cefixime and ceftriaxone resistance. Tetracycline resistance (MIC >0.5 mg/L) is high with nearly all isolates (90.6%) considered resistant. There was a 12.2% decrease in predicted ciprofloxacin resistance (MIC >0.06 mg/L) compared to 2023 (58.6% to 46.4%). A quarter of isolates are penicillin resistant (MIC >1 mg/L) at 25.9%, which has nearly doubled in the previous year. Reduced susceptibility to azithromycin (ECOFF >1.0 mg/L) is high at 13.6%. Cefixime resistance (MIC >0.125 mg/L) decreased from 5.6% in 2023 to 3.1% in 2024. However, cefixime resistance in 2024 remained higher than estimates between 2015 to 2022 which ranged from 0.3 to 2.2%.

Prescribing data collected through the sentinel surveillance system demonstrates excellent compliance with the UK guidelines, with 97% of individuals receiving the recommended first-line therapy of ceftriaxone 1g IM monotherapy. Health practitioners are encouraged to continue reporting all possible cases of ceftriaxone treatment failure to UKHSA via the HIV and STI Data Exchange.

Further AMR in *N. gonorrhoeae* data as well as whole genome sequencing data is available online in the most recent GRASP report.

Figure 2.21. Percentage of *N. gonorrhoeae* isolates in the GRASP sentinel surveillance system that were resistant to selected antimicrobials, England and Wales, 2015 to 2024 [note1] [note2] [note3] [note 4]



[note 1] Due to changes to the medium used to test antimicrobial susceptibility of sentinel surveillance isolates, MICs for the 2024 collection should be interpreted with caution when compared to previous years. Point of change in AST medium is indicated by the vertical dashed black line).

[note 2] Azithromycin data for 2023 have not been presented due to a laboratory technical issue as indicated by the dashed trend line.

[note 3] In 2023, EUCAST updated the resistance breakpoint for tetracycline against *N. gonorrhoeae* from 1 mg/L to 0.5 mg/L. Breakpoint plates at 0.5 mg/L were introduced in 2022; therefore, no data for this breakpoint is available prior to 2022.

[note 4] Ciprofloxacin resistance in 2024 was predicted using a subset of data where whole-genome sequencing results were available (n=1,482).

Surveillance of antibiotic resistance in *Mycoplasma genitalium*

Mycoplasma genitalium is a bacterial sexually transmitted pathogen associated with non-gonococcal urethritis, cervicitis and pelvic inflammatory disease. Despite high levels of antimicrobial resistance, azithromycin is recommended as the first-line treatment and moxifloxacin is used as second-line treatment due to the limited availability of alternatives (28). Doxycycline is commonly given as pre-treatment to lower the bacterial load and increase the effectiveness of the subsequent antibiotic prescribed. Resistance to both azithromycin and moxifloxacin in *M. genitalium* is a global public health concern (29).

The *M. genitalium* Antimicrobial Resistance Surveillance (MARS) programme is a sentinel surveillance programme that aims to estimate the prevalence of macrolide and fluoroquinolone resistance and investigate the demographic, behavioural and clinical factors associated with resistance.

Pilot collections for this programme were conducted in 2019 and 2020, before MARS was launched as an annual programme in 2023 (30 to 32). Specimens were tested for molecular markers predictive of macrolide and fluroquinolone resistance. Further details on MARS methodology is available in the Annexe.

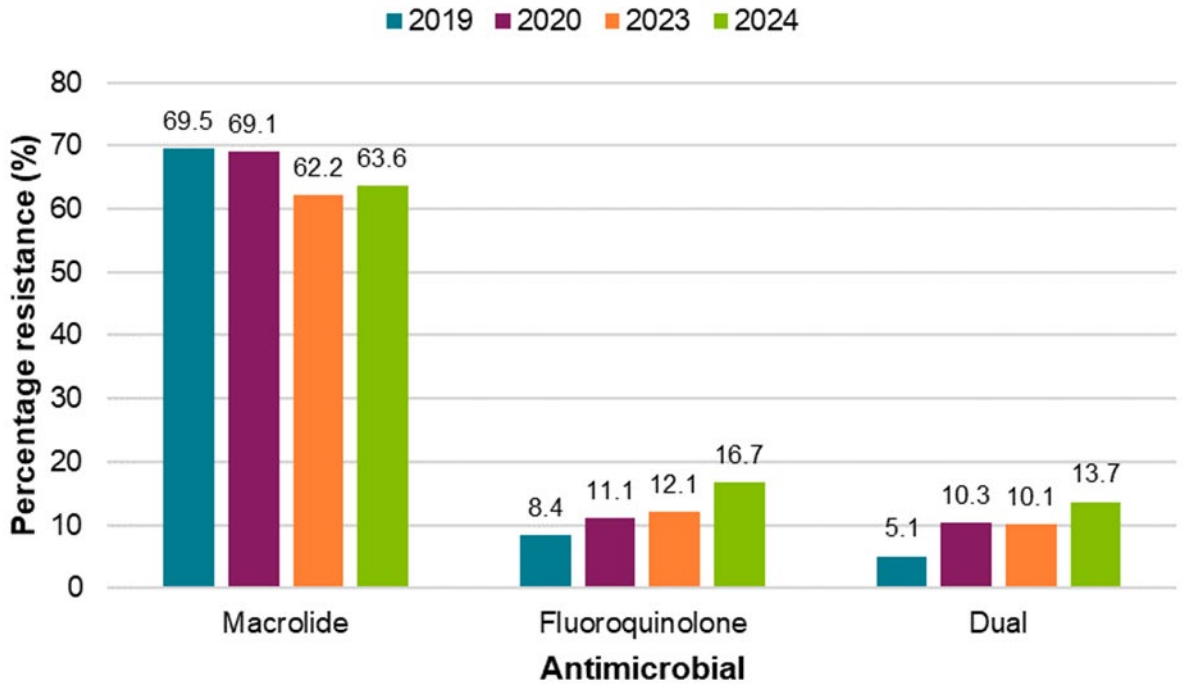
Figure 2.22 shows the percentage of specimens that had mutations associated with macrolide, fluoroquinolone, and dual resistance. The MARS 2024 sample included 1,049 specimens. Macrolide resistance data were available for 89.9% (*n* = 943) specimens; fluoroquinolone resistance data were available for 83.3% (*n* = 874) specimens; and data for both were available for 81.1% (*n* = 851) specimens.

In 2024, 63.6% (600 out of 943) of sequenced specimens had mutations associated with macrolide resistance and 16.7% (146 out of 874) had mutations predictive of fluoroquinolone resistance. Where both macrolide and fluoroquinolone resistance results were available, dual resistance was detected in 13.7% (117 out of 851) of specimens.

Macrolide resistance in 2024 increased slightly compared to 2023 (63.6% vs 62.2%), though levels in both years remained lower than those observed in the pilot years (~69%) – albeit at very high levels. Fluoroquinolone resistance increased to 16.7% in 2024, rising substantially from 12.1% in 2023 and 11.1% in 2020. Similarly, dual resistance also increased to 13.7% in 2024, compared to around 10% in both 2020 and 2023.

The complete results from the 2024 MARS Programme are available online in the UKHSA MARS Report.

Figure 2.22. The percentage of *Mycoplasma genitalium* specimens with genetic predictors of macrolide, fluoroquinolone, and dual resistance in the MARS pilots (2019 and 2020), MARS 2023 and 2024



Surveillance of antibiotic resistance in *Mycobacterium tuberculosis* infections

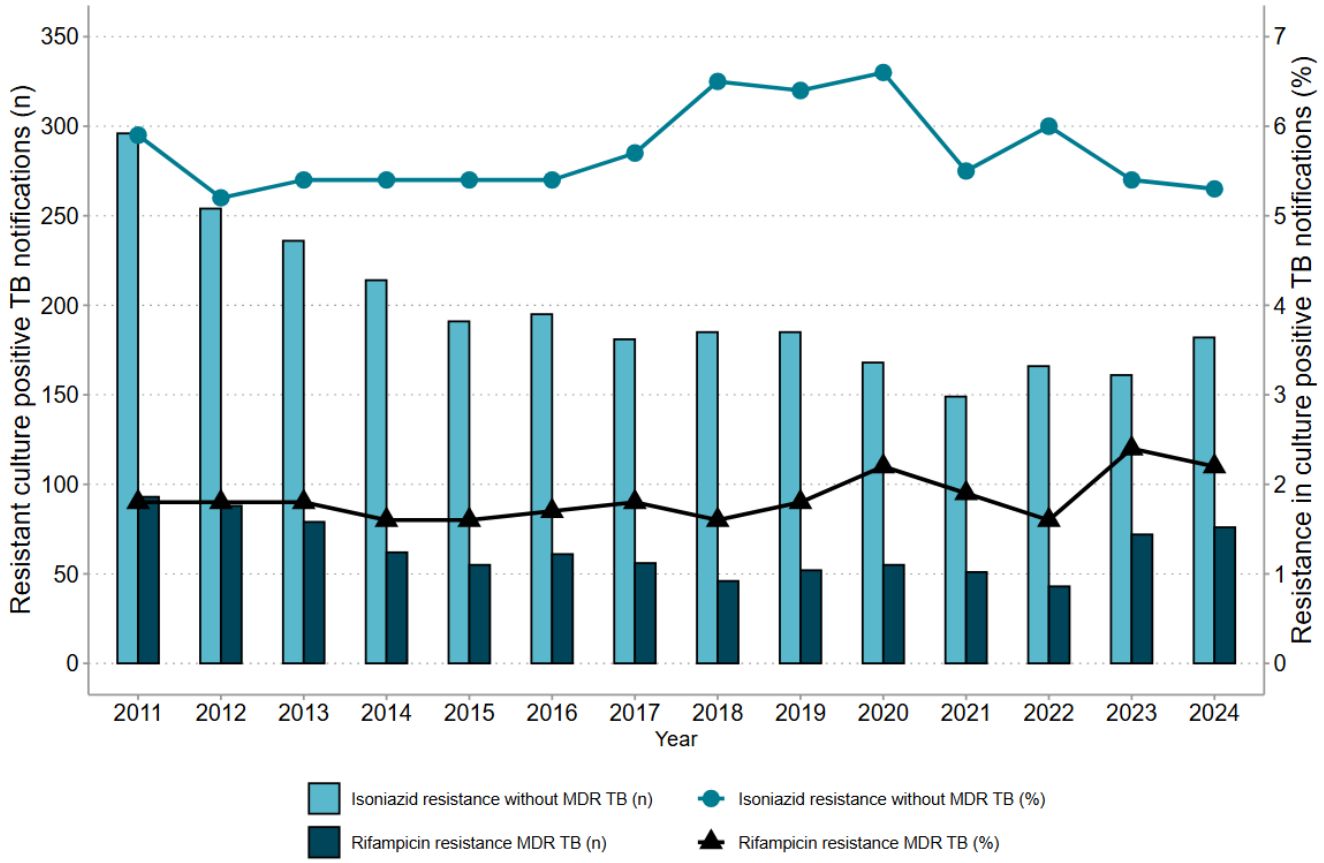
The number of tuberculosis (TB) disease notifications has increased since the peak-pandemic year of 2020, a rebound effect seen globally (World Health Organization Global TB report 2023). England remains a low TB incidence country (less than 10 per 100,000 population) with a low incidence of multidrug-resistant (MDR) TB. However, the number of MDR TB increased slightly in 2024 compared to 2023 making it the second subsequential year with an increase in numbers.

MDR TB is defined here as TB resistant to both INH and rifampicin, or to rifampicin alone. Since 2011, MDR/rifampicin resistant (RR)-TB has been diagnosed in under 2% of culture-positive notifications apart from 2020 and 2023, with the peak observed in 2023 and 2024 at 2.4% and 2.2% (corresponding to 72 and 76 people), respectively. This compares with 43 people in 2022, the largest year on year increase observed over this period and similar to numbers reported pre-2014 (Figure 2.23).

Included in these numbers are people with acquired drug-resistant strains after initially having tested sensitive at diagnosis. Numbers and proportions of acquired drug resistance are low and have decreased in recent years. In 2024, only one person acquired multi-drug resistance post-diagnosis.

Outcomes for patients with MDR TB are worse than for drug sensitive disease. The drugs used for treatment of MDR TB are often poorly tolerated and patients need careful monitoring because of toxicity. More detail on trends in drug resistance and treatment outcomes of MDR TB is presented in the most recent Tuberculosis in England annual report, and Official Statistics.

Figure 2.23. Number and proportion of culture-confirmed notifications of people with drug-resistant *Mycobacterium tuberculosis*, England, 2011 to 2024



Critical antibiotic resistance in foodborne bacteria

UKHSA's Gastrointestinal Bacteria Reference Unit routinely performs whole genome sequencing (WGS) on referred isolates of food-borne or zoonotic bacteria cultures from cases with gastroenteritis or bacteraemia. Overall, 10,143 isolates of *Salmonella* spp., 3,140 of Shiga toxin-producing *E. coli* (STEC) and 776 *Campylobacter* spp. from England underwent WGS in 2024. The vast majority of these (≥90%) were isolated from humans (*Campylobacter* spp. *n* = 722/776, 93%; STEC *n* = 3,064/3,140, 98%; *Salmonella* spp. *n* = 9,939/10,143, 98%). Details on methodology can be found in the Annexe.

In 2024, genes encoding carbapenemases were detected in isolates from 3 cases. Specifically *blaOXA-48* was detected in 2 genetically closely related *Salmonella* Kentucky cases identified using UKHSA's SnapperDB clustering tool. There was one *blaOXA-181* detected in one case of STEC.

Mobile resistance genes conferring resistance to colistin (specifically *mcr-1*, *mcr-3* and *mcr-9*) have been found in isolates from STEC (*n* = 1) and *Salmonella* spp. (*n* = 12) cases.

Tetracycline resistance, specifically variants of the gene *tet(X)* have been found in isolates from STEC (*n* = 1) and *Salmonella* spp. (*n* = 12) cases, 4 of which fell into 2 closely genetically related clusters of *Salmonella* Kentucky. An additional 4 were also *S.* Kentucky, as well as one each of *S*. Agona, *S*. Bredeney, *S*. Heidelberg and *S*. Stanley. The *tet(X)* genes confer resistance to tetracyclines, including resistance to tigecycline, eravacycline and omadacycline, which are drugs often used in last-line multidrug-resistant regimes.

Overall, the critical resistance detection in foodborne bacteria in 2024 remains in line with what was detected similar as in previous years.

Most foodborne bacteria cause self-limiting gastroenteritis, and antibiotics are rarely necessary to treat these infections; various treatment options remain available despite critical resistance determinants. However, there is concern that mobile resistance determinants can be transferred from foodborne pathogens to healthy gut bacteria in the human host. Acquisition of resistance genes such as *tet(X)* or *mcr* by *E. coli* and other gut commensals could significantly reduce effective treatment options in individuals unwell from community-acquired infections such as UTIs caused by gut commensals. Thorough cooking of food to piping hot temperatures and maintaining good kitchen hygiene is one way of reducing the acquisition of foodborne infections (33, 34).

Box 2.5. Extensively drug-resistant (XDR) *Shigella* spp. in England

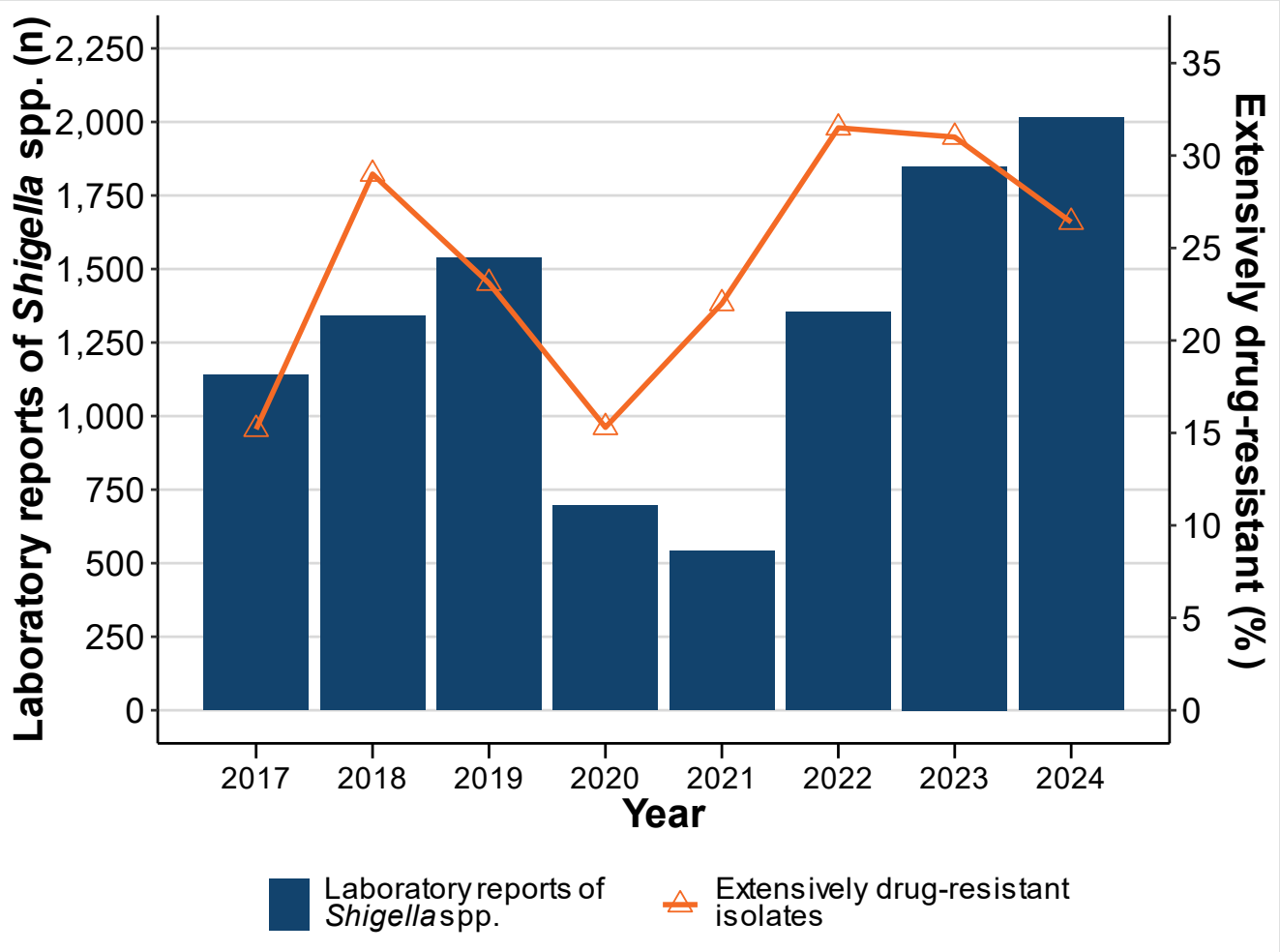
Shigella spp. are Gram-negative bacteria transmitted through faecal-oral contact, which cause acute bacillary dysentery, a gastrointestinal illness characterised by diarrhoea, fever and abdominal cramps. In England, shigellosis has previously been associated with travel to endemic regions, but is now a leading cause of sexually transmissible gastroenteritis among gay, bisexual and other men who have sex with men (GBMSM). Genotypic AMR profiles are available for *Shigella* spp. isolates referred by diagnostic laboratories to the Gastrointestinal Bacteria Reference Unit at UKHSA. Extensively drug-resistant (XDR) *Shigella* spp. was defined as non-susceptibility to at least one agent in all but 2 or fewer antibiotic classes (35).

The number of *Shigella* spp. detections (*n* = 2,015) has increased, as has the proportion of isolates that are XDR (15.2% in 2017 to 26.4% in 2024) (Box Figure 2.5.1). In 2024, there were 532 XDR detections, most (70.0%) were among males, the median age was 35 years (IQR: 26 to 51), and 13.5% (72 out of 532) were children under 10 years. Most XDR *Shigella*

cases (76.3%) did not report international travel in the past month and were speciated as *Shigella sonnei* (82.9%), followed by *Shigella flexneri* (15.6%).

The number of *Shigella* spp. isolates in 2024 harbouring known resistance determinants was high, especially dfrA-1, sul-2, aph(6)-Id, gyrA, parC, mph-A, tetA and *bla*CTX-M-15 (Box Table 2.5.1). Given this concerning resistance, the World Health Organization has included *Shigella* spp. (specifically fluoroquinolone-resistant *Shigella* spp.) as a high priority pathogen in their Bacterial Priority Pathogens List 2024 (36).

Box Figure 2.5.1. Laboratory reporting of *Shigella* spp. and extensive-drug resistance (XDR) in England, 2017 to 2024



Box Table 2.5.1. Number and proportion of *Shigella* spp. isolates harbouring resistance determinants, 2024

Antibiotic Class	Resistance determinants	Number and proportion of isolates harbouring resistance determinants
Amoxicillin/ampicillin/3rd generation cephalosporin	blaCTX-M-15	609 (30.2%)

Amoxicillin/ampicillin/3rd generation cephalosporin	blaCTX-M-27	97 (4.8%)
Amoxicillin/ampicillin/3rd generation cephalosporin	TEM-1	274 (13.6%)
Aminoglycosides (Gentamicin/amikacin/tobramycin/ streptomycin)	aadA-5	215 (10.7%)
Aminoglycosides (Gentamicin/amikacin/tobramycin/ streptomycin)	aph(6)-Id	797 (40.0%)
Fluoroquinolones	Single mutation in gyrA	215 (10.7%)
Fluoroquinolones	Double mutation in gyrA	2 (0.1%)
Fluoroquinolones	Double mutation in gyrA and mutation in parC	783 (38.9%)
Azithromycin	mph-A	666 (33.1%)
Azithromycin	ermB	360 (17.9%)
Tetracycline	tetA	647 (32.1%)
Sulphonamides	sul-1	297 (14.7%)
Sulphonamides	sul-2	1,032 (51.2%)
Trimethoprim	dfrA-1	1,819 (90.3%)
Trimethoprim	dfrA-5	48 (2.4%)
Trimethoprim	dfrA-17	255 (12.7%)

Antifungal resistance

Trends in incidence and antifungal resistance

The incidence of fungaemia (fungal bloodstream infection) was 3.9 per 100,000 population (*n* = 2,247) in 2024, and has increased year on year since 2020, with an overall increase of 15.4% since 2020 (3.4 per 100,000, *n* = 1,901). This is likely due to a combination of factors, including changing patient demographics, increases in at-risk patients (for example immunocompromised patients), and improved detection and reporting. *Candida albicans* was the most frequently isolated yeast species across the 5-year period followed by *Nakaseomyces glabratus* (formerly *Candida glabrata*), accounting for 40% and 27% of fungaemia episodes, respectively. Additional data on regional fungaemia incidence can be found in the ‘Laboratory surveillance of fungaemia in England: 2024 health protection report’.

Routine laboratory surveillance reports submitted to the UKHSA's SGSS showed that in 2024, 69.7% (1,567 out of 2,247) of yeasts isolated from blood were subjected to susceptibility testing. This section will focus on susceptibility test results for 3 antifungals (amphotericin B, caspofungin and fluconazole, see Figure 2.24). Further detailed trend data, including numbers reported as susceptible or resistant, is available in the data tables accompanying the 2024 Fungaemia Health Protection Report (HPR). Supplementary analyses on fungaemia cases are available in the Chapter 2 Annex which further outlines the rates of yeast isolated from blood cultures and regional breakdowns, along with an update from the UKHSA National Mycology Reference Laboratory (MRL) on antifungal susceptibilities in emerging fungal pathogens referred to the laboratory.

Figure 2.24. Percentage of a) *C. albicans* b) *N. glabratus* and c) *C. parapsilosis* isolates from blood displaying resistance to antifungals in England, 2020 and 2024

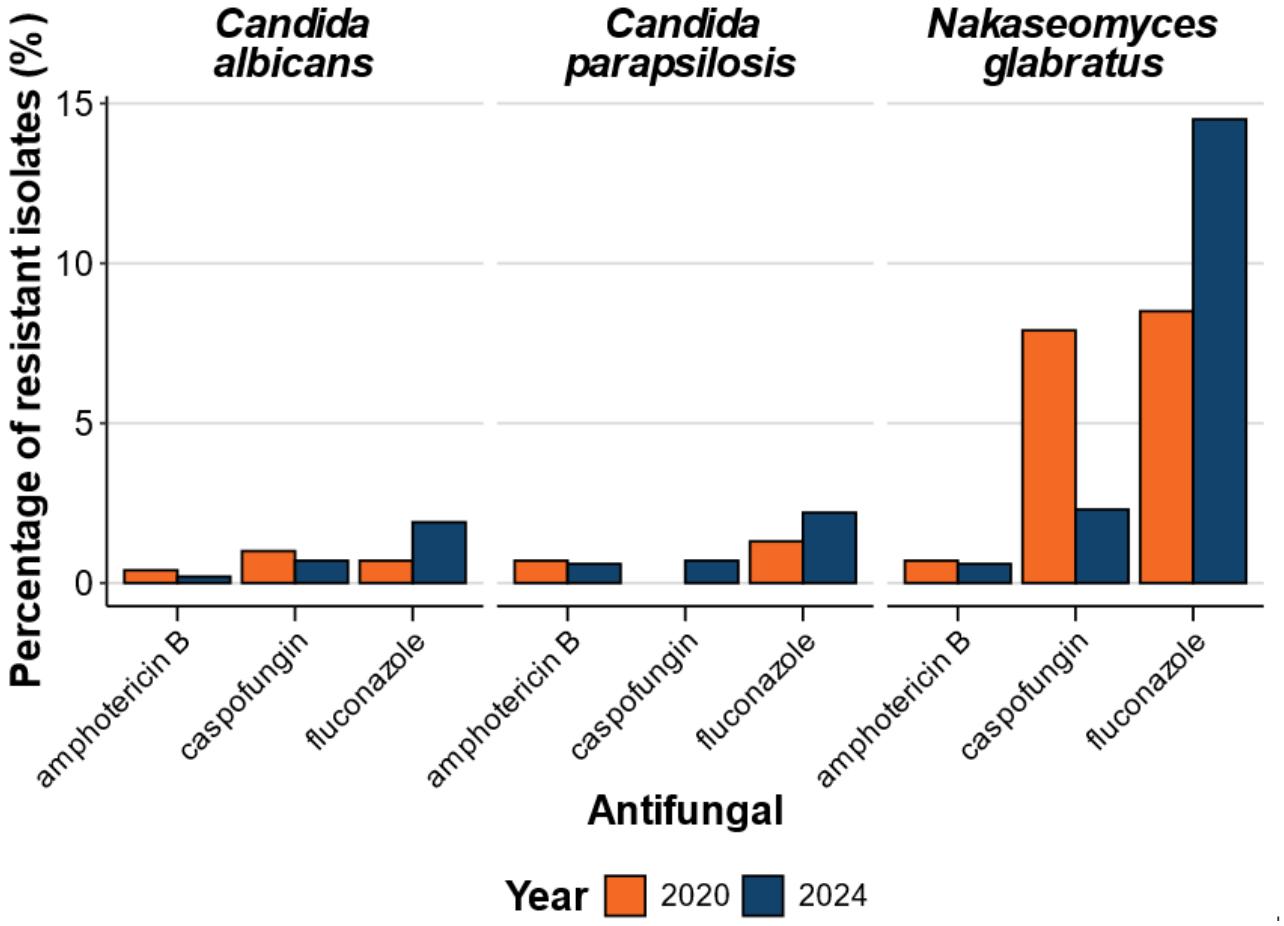


Figure 2.24 depicts the percentage of isolates resistant to 3 antifungals, comparing 2024 with 2020, for *C. albicans*, *N. glabratus* and *C. parapsilosis*. In 2024, resistance to fluconazole was detected in 1.9% of *C. albicans*, 14.5% of *N. glabratus* and 2.2% of *C. parapsilosis* isolates.

Box 2.6. *Trichophyton indotineae*

Outbreaks of superficial skin infections caused by the emergent dermatophyte *Trichophyton indotineae* (*Trichophyton mentagrophytes* genotype VIII) were first reported in southern Asia in

2014, where it is now endemic. Cases have since been reported worldwide including Europe, Canada and the USA, South America and Africa with mounting evidence of infection acquisition and transmission outside original areas of endemicity (37).

T. indotineae infections typically initially involve the groin and respond poorly to treatment, resulting in widespread disfiguring lesions affecting multiple body sites. Many isolates exhibit *in vitro* resistance to terbinafine, and most infections are clinically resistant to this first-line drug. There are also reported cases with poor response to second-line itraconazole treatment. Thus infections typically require protracted treatment regimens, with potential stigma associated with the prolonged presence of lesions and impacts on patient mental health.

The UKHSA MRL have detailed the introduction and rapid spread of *T. indotineae* in the UK. There were 161 *T. indotineae* referrals to the MRL in 2024 in comparison to 31 in 2023. *T. indotineae* comprises an increasing proportion of dermatophyte isolates received by the MRL; 40% in 2024 compared with 13% in 2023.

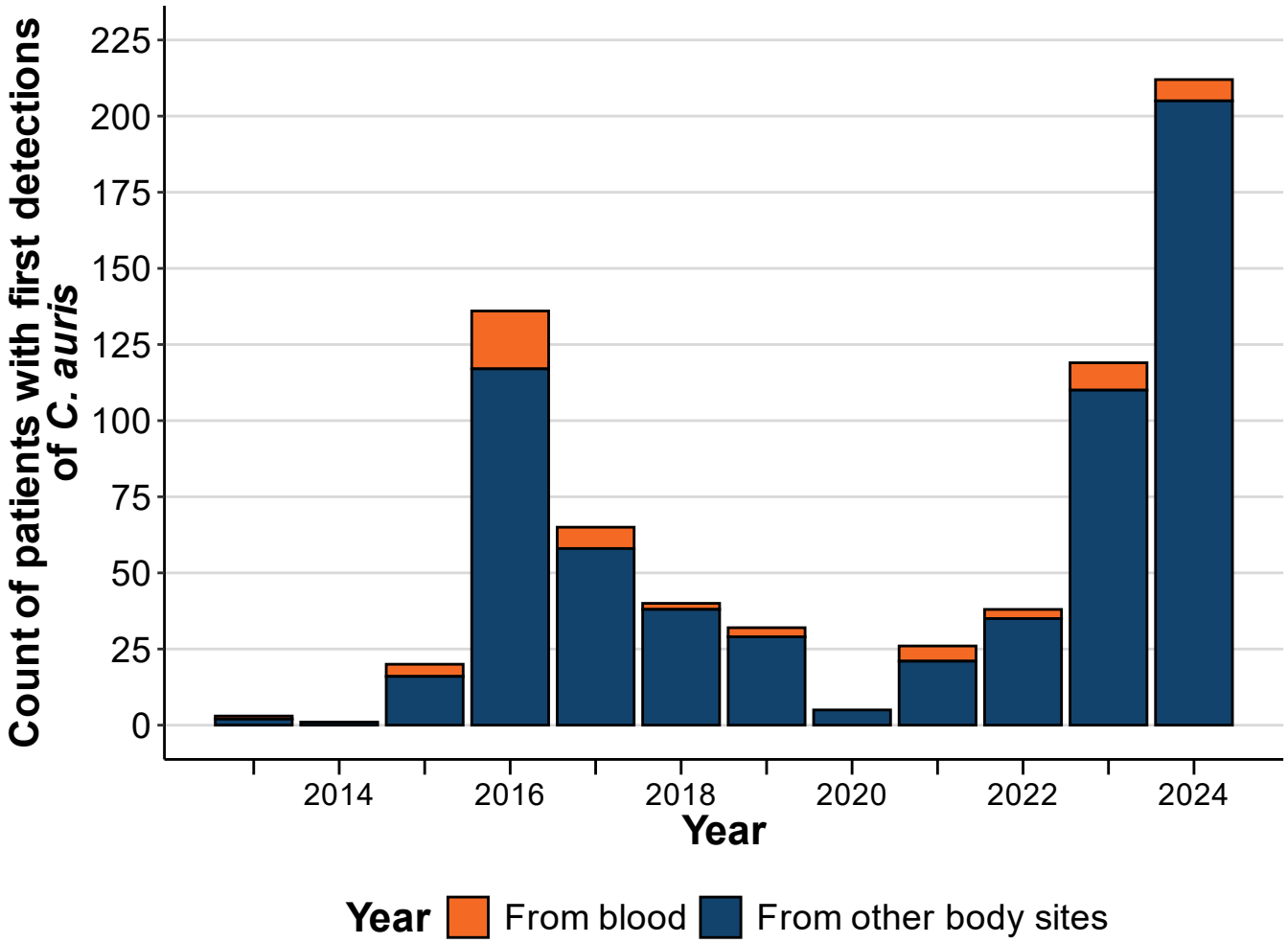
It is likely there is substantial under-ascertainment of *T. indotineae* prevalence due to a low index of suspicion amongst clinicians leading to failure to refer isolates for formal identification to expert centres and a lack of commercial methods available to local laboratories for rapid and accurate identification, and likely misidentification by phenotypic methods. A UKHSA briefing note was issued in May 2025 alerting healthcare professionals to the issue. An abstract detailing the descriptive epidemiology of *T. indotineae* can be found in the Research Chapter.

Candidozyma auris

Candidozyma auris (formerly *Candida auris*) is a rapidly emerging fungal pathogen with a global distribution. Designated a critical priority fungal pathogen by the World Health Organization, it can cause severe invasive infection, mostly within healthcare settings. Resistance to the first-line antifungal agent fluconazole, combined with the ability to rapidly acquire resistance to other antifungal agents on therapy, complicates the management of invasive disease. In non-UK settings invasive disease has been associated with significant mortality. It has high outbreak potential due to its propensity to colonise skin and survive in the environment for prolonged periods, both allowing for rapid transmission within healthcare settings. *C. auris* healthcare associated outbreaks can be disruptive, protracted and costly.

Following a period of decreased *C. auris* detection in 2020 during the COVID-19 pandemic, there have been year-on-year increases from 2020 to 2024 (Figure 2.25). Most detections of *C. auris* represent colonisation rather than infection (though colonisations can increase the risk of subsequent infections). During this period there have been 4 outbreaks in NHS Hospitals located in London and the South-East of England including 2 protracted outbreaks lasting longer than 6 months. These regions reported the majority of *C. auris* detections in England. In 2024; 212 patients were reported to the UKHSA with first detections of *C. auris*, of whom 7 had bloodstream infections.

Figure 2.25. Count of patients with first detections of *C. auris* in England, 2013 to 2024



In response to increasing case detections and outbreaks, *C. auris* was declared a national standard incident by UKHSA in February 2025. This includes a multi-stakeholder incident management team overseeing the situation and working with the NHS and partners to implement interventions to reduce risks to patients and to control transmission. Guidance for the laboratory investigation, management, and infection prevention and control of *C. auris* in acute and community healthcare settings has been updated and published by UKHSA in 2025 (38). In April 2025, *C. auris* was classified as a notifiable organism under schedule 2 of the Health Protection (Notification) Regulations 2010. There is known under-ascertainment of cases, particularly colonisation though possibly including clinical infections. Further detail of *C. auris* epidemiology in England can be found in routine *C. auris* epidemiological commentaries which are published by UKHSA every 6 months.

Antiviral resistance

Influenza virus

During the 2024 to 2025 influenza season (samples collected between week 40 2024 and week 20 2025) more than 2200 viruses were screened by WGS for antiviral susceptibility. Analysis of

324 A(H3N2) viruses by sequencing found no viruses with known markers of resistance to neuraminidase inhibitors (NAI).

Of 1,103 A(H1N1)pdm09 NA sequences analysed, 16 (1.45%) oseltamivir resistant viruses, with the H275Y amino acid substitution were detected. The majority of these were detected in samples from patients in secondary care (15 out of 16; 94%) with one detection in a sample from primary care sentinel surveillance. Ten of these were from immunocompromised oseltamivir-treated individuals. Two immunocompromised patients had not received oseltamivir treatment. Three immunocompetent cases were identified with one patient receiving oseltamivir treatment and 2 individuals with no recorded history of oseltamivir treatment. In one case the patient immune status and exposure to antiviral drugs was unknown. One virus with an I427T amino acid substitution, previously reported as conferring reduced inhibition by oseltamivir and zanamivir in vitro, was detected from an immune competent adult patient not known to have received oseltamivir treatment. One virus with a I223M amino acid substitution, previously reported as conferring reduced inhibition by oseltamivir, was detected from an immune competent child not known to have received oseltamivir treatment. The clinical relevance of these 2 mutations is not known.

Four viruses with amino acid changes previously associated with reduced susceptibility to NAI were detected in 815 influenza B NA sequences analysed. One influenza B virus with a T146K mutation and one influenza B virus with a N294S mutation, both previously known to result in reduced susceptibility to oseltamivir, peramivir and zanamivir, were detected. One influenza B virus with a G407S mutation and one influenza B virus with a G145R mutation, both previously associated with reduced susceptibility to zanamivir, were identified. One of these influenza B virus mutations was identified in an individual who received oseltamivir treatment, whereas the remaining 3 were detected in individuals with no known NAI treatment. The clinical relevance of these mutations is not known.

No viruses with known markers of resistance to baloxavir marboxil were detected in 317 A(H3N2), 795 A(H1N1) pdm09 and 800 influenza B PA sequences analysed.

A majority (10 out of 16) of A(H1N1) pdm09 viruses with H275Y emerged in immunocompromised individuals during NAI treatment, highlighting the vulnerable nature of these patients, and the need for close monitoring and low threshold of suspicion of resistance if viral load persists.

Intravenous and inhaled zanamivir is available for use in the UK in specific clinical contexts. Baloxavir has regulatory approval, with scope for use in specific clinical contexts including against NAI resistant viruses, though is not currently widely used outside of clinical trials. The UKHSA national antiviral guidance is undergoing revision, with publication expected this year.

This continues the ongoing trend of very low resistance to neuraminidase inhibitors and baloxavir, globally (36, 39).

One influenza A(H5N1) clade 2.3.4.4b virus, identified in January 2025 from a farm worker exposed at an infected premise that had confirmed influenza A(H5N1), was examined and no known markers of resistance to NAI or baloxavir marboxil were identified. The risk of A(H5N1) influenza virus infection of humans is considered to be low (40, 41).

Markers of neuraminidase inhibitor or baloxavir resistance have been identified sporadically in highly pathogenic avian influenza A(H5N1) sequences obtained from surveillance of wild birds, poultry outbreak and mammals but at very low levels (data analysed from GISAID sequence submissions).

An unprecedented dairy cattle outbreak of HA clade 2.3.4.4b A(H5N1) genotype B3.13 occurred from March 2024, with an additional genotype, D1.1 also infecting dairy cattle from September 2024. A(H5N1) genotype D1.1 viruses with the H275Y oseltamivir resistance marker have been isolated from birds in 8 poultry farms in Canada, all closely related, suggesting a single emergence with limited spread (42).

The frequency of the H275Y mutation remains very low in all available A(H5N1) D1.1 and B3.13 sequences (<0.5%).

Zoonotic infection of 52 humans with B3.13 occurred in the US and 19 humans with D1.1 in the US (17), Canada (1) and Mexico (1). No baloxavir resistance has been identified in viruses with available sequence from these cases.

Three A(H5N1) genotype D1.1 viruses from human cases in the US have an S247N substitution in neuraminidase. While this mutation has historically been shown to cause mild reductions in oseltamivir inhibition in vitro, the clinical impact is likely to be minimal. No other markers of neuraminidase inhibitor resistance have been identified in B3.13 or D1.1 A(H5N1) viruses from human infections.

There have been sporadic human infections with HA clade 2.3.2.1e (formerly reported as clade 2.3.2.1c) A(H5N1) viruses in the Mekong Delta region of Vietnam and Cambodia, and clade 2.3.2.1a A(H5N1) viruses in Bangladesh and India. No markers of NAI or baloxavir resistance were identified in any of the available viral sequences from these human infections.

Further information on influenza virus trends and antiviral resistance testing for the 2024 to 2025 season can be found in the annual influenza report.

SARS-CoV-2

UKHSA established a robust surveillance programme between December 2021 and June 2023 monitoring COVID-19 therapeutics usage and SARS-CoV-2 genome changes that may adversely impact the effectiveness of therapeutics via viral resistance or reduced susceptibility to monoclonal antibodies or direct acting antivirals. Access to therapeutic use data and volume of sequencing was limited after June 2023, and UKHSA are exploring routes to securing capability to undertake therapeutics surveillance in future.

In 2023, a study by Sanderson et al. suggested that SARS-CoV-2 genomes shared in public databases had a specific mutation signature that was a possible post-molnupiravir treatment effect (43). This study did not, however, have access to treatment records to confirm the effect detected was molnupiravir induced. Molnupiravir functions by inducing mutations in the virus genome during replication, such that no new functional virus particles can be made and therefore clears the virus from the individual and prevents transmission to new individuals. Viruses with this mutation signature do not exhibit reduced susceptibility to molnupiravir, but identifying these sequences does indicate that virus can persist for a period during or after molnupiravir treatment, and these viruses with mutated genomes could therefore transmit person to person, and risk introduction of novel variant viruses to the population.

To investigate the role of molnupiravir in inducing the specific mutation signature detected in the Sanderson study, UKHSA undertook analysis of SARS-CoV-2 sequences from clinical samples collected in England pre- and post-molnupiravir treatment between December 2021 and June 2023. The analysis confirmed that this mutation signature is more likely to be identified in post-treatment samples than pre-treatment samples, confirming the role of molnupiravir in the effect observed. However, no indication of any onward transmission to further individuals could be identified from the population sequence analysis.

Human immunodeficiency virus (HIV)

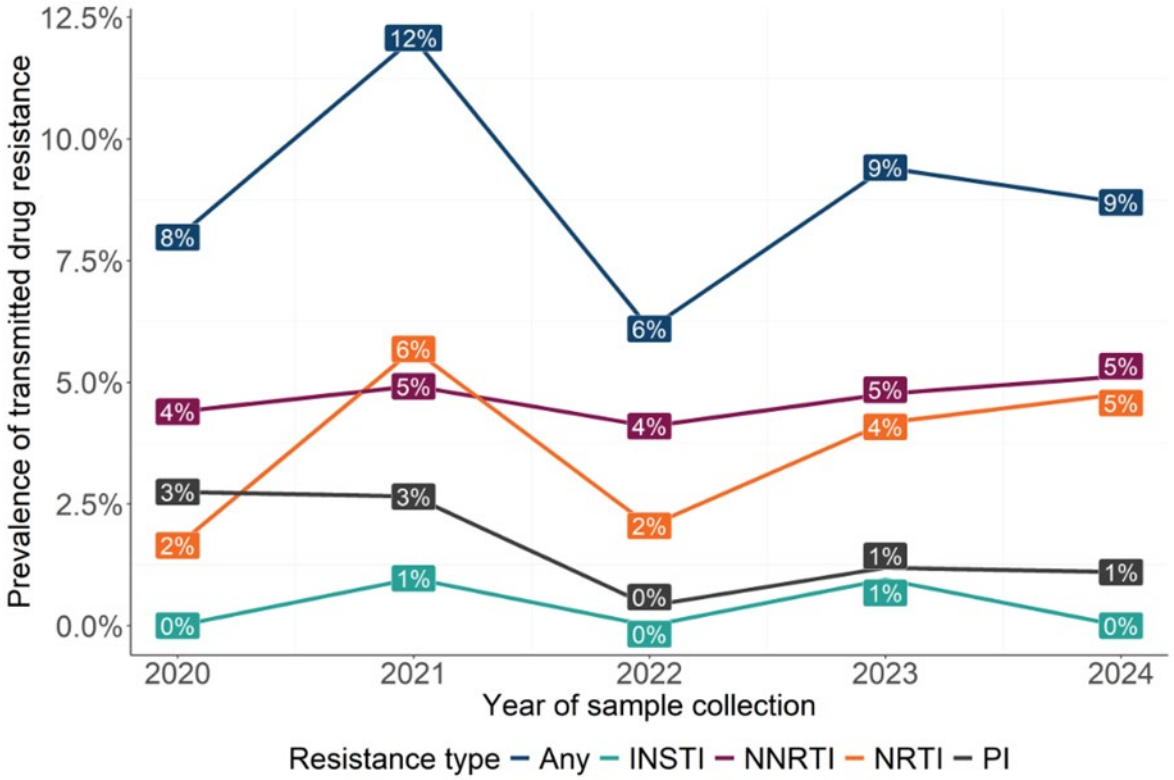
HIV sequences generated as part of routine clinical care by UKHSA and NHS laboratories are collected by the UK HIV Genomics Database at UKHSA. This Database, previously called the UK HIV Drug Resistance Database, was hosted by University College London until 2019, but was moved to UKHSA in 2024 and aims to provide regular updates on HIV drug resistance. The data used here comes from 2 UKHSA labs, which perform HIV genotyping on behalf of multiple hospitals across the UK, and have contributed data up to 2024. We are still in the process of collecting data from other NHS labs from 2020 onwards, following the Database relaunch at UKHSA.

HIV drug resistance in drug-naïve individuals

The HIV sequence data in the UK HIV Genomics Database was linked to recency and treatment data held within the HIV and AIDS Reporting System (HARS) at UKHSA. Data used for this report were from 2020 to 2024 and overall, 1,315 individuals were included.

Drug resistance prevalence in the drug-naïve population remained relatively constant at 8% in 2020 and 9% in 2024 although with some annual fluctuation (Figure 2.26). There was minimal increase in resistance to nucleos(t)ide reverse transcriptase inhibitors (NRTIs), at a prevalence of 2% in 2020 and 5% in 2024, and a decrease in resistance to protease inhibitors (PI) from 3% in 2020 to 1% in 2024. Resistance to non-nucleoside reverse transcriptase inhibitors (NNRTI) remained constant between 4% and 5%, whereas Integrase strand transfer inhibitor (INSTI) resistance was rare at ≤1% throughout the period.

Figure 2.26. The prevalence of transmitted HIV drug resistance, 2020 to 2024 (source Antiviral Unit, UKHSA)

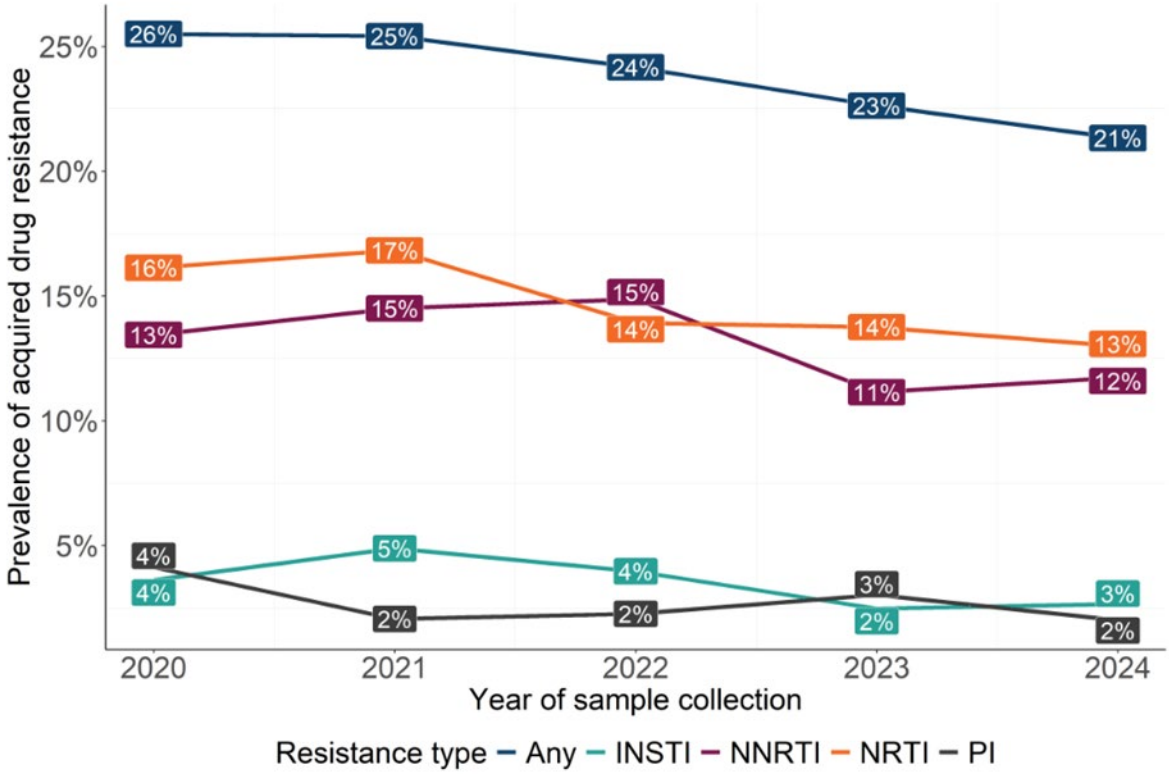


HIV drug resistance in drug-experienced individuals

Drug resistance prevalence in people exposed to therapy was ascertained by linkage of viral sequences from the HIV Genomics Database to HARS, where the sample date was collected at least 90 days after initiation of antiretrovirals. Individuals were included for each year in which they were sampled from 2020 to 2024 (*n* = 4,336). Overall, drug resistance declined from 26% to 21%, predominantly driven by a fall in NRTI resistance from 16% to 13% (Figure 2.27). NNRTI resistance was fairly stable at 13% in 2020 and 12% in 2024. By contrast, the prevalence of INSTI and PI resistance remained rare at 5% and 4%, respectively, throughout the period.

UKHSA is undertaking further analyses involving linkage of the HIV drug resistance database with GUMCAD (surveillance system for sexually transmitted infections (STIs) in England) to understand whether there has been any impact from the roll out of oral pre-exposure prophylaxis (PrEP) containing the NRTIs tenofovir and emtricitabine on the prevalence of K65R and M184V/I, as markers of resistance against these agents.

Figure 2.27. The prevalence of acquired HIV drug resistance, 2020 to 2024 (source Antiviral Unit, UKHSA)



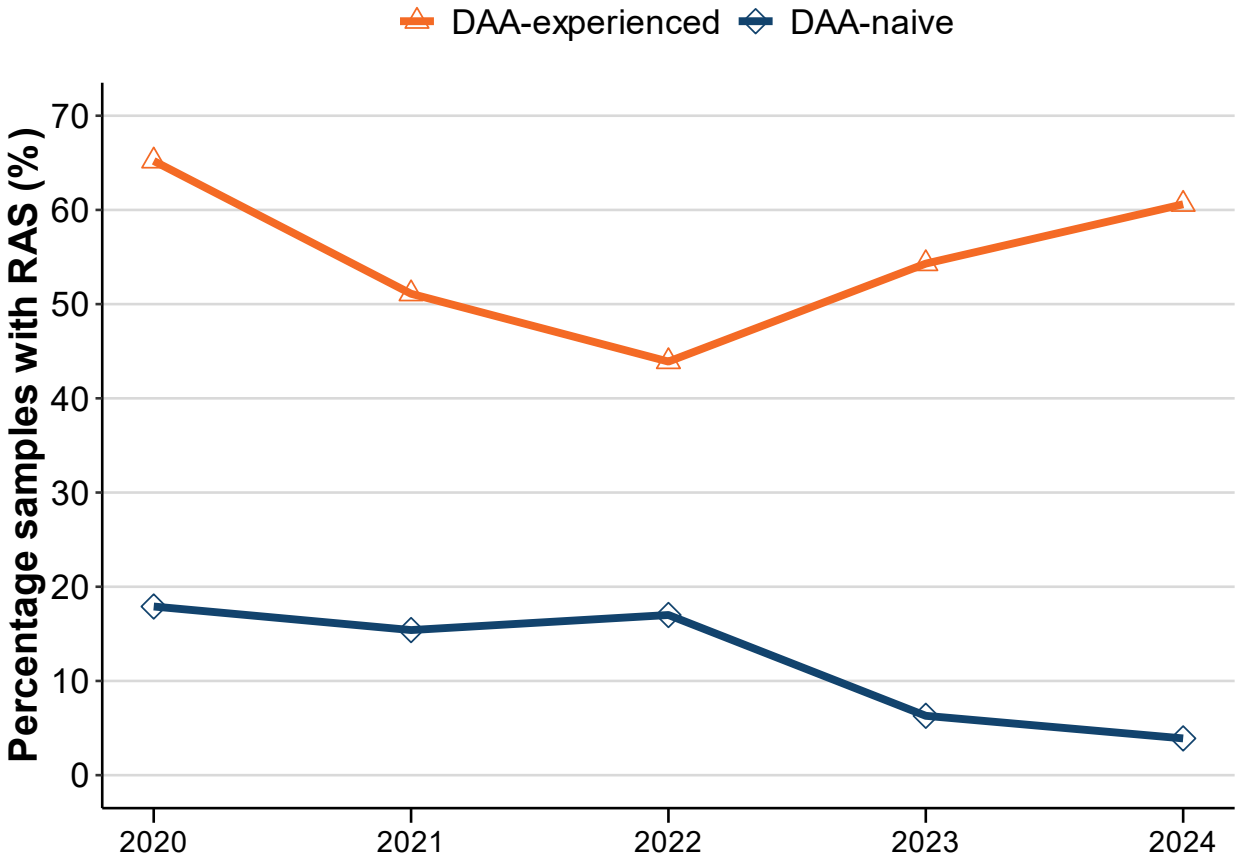
Hepatitis C virus (HCV)

Since 2019, the Antiviral Unit at UKHSA has offered HCV Whole Genome Sequencing (WGS) as a clinical service. This determines the HCV genotype/subtype and resistance pattern for the 3 HCV Direct Acting Antiviral (DAA) drug classes (NS3, NS5A and NS5B inhibitors).

HCV genomic data generated through this service was used to ascertain DAA drug resistance prevalence. For patients in England, data was linked to the English HCV Treatment Register to ascertain treatment status, that is, whether DAA-naïve or previously exposed to DAAs.

Figure 2.28 shows the prevalence of resistance to HCV DAA drugs in the NS5A gene of subtype 1a in 956 samples received from England between 2020 and 2024. In drug-naïve individuals, resistance prevalence declined over time, from 18% (24 out of 134) in 2020 to 4% (2 out of 51) in 2024, suggesting that transmitted resistance is not currently a significant concern. The prevalence of NS5A resistance in treatment-experienced individuals remains high. In October 2024, UKHSA established a national HCV genomics surveillance programme to provide a representative sampling framework in support of HCV elimination goals. The surveillance uses leftover blood samples collected as part of routine care in patients with HCV infection for WGS. Results are linked to treatment outcomes in the English HCV Treatment Register. Outputs will include monitoring of the prevalence of antiviral drug resistance, transmission networks and viral subtype distribution.

Figure 2.28. The percentage of tests where resistance-associated substitutions (RAS) were detected in the NS5A gene for HCV subtype 1a (source Antiviral Unit, UKHSA)



Antiparasitic resistance

Malaria

In 2023, 2,106 cases of imported malaria were reported in the UK, the highest total number of cases seen in the UK since 2001. Of those, 83% were due to *Plasmodium falciparum,* which causes the most clinically severe infection among the 5 *Plasmodium* species that infect humans and also accounts for the vast majority of drug-resistant malaria parasites.

In the UK, clinical management of uncomplicated *P. falciparum* malaria is with oral artemisinin-based combination therapies (ACT). Since their introduction from 2004, the efficacy of ACT in sub-Saharan Africa has remained high. In south-east Asia, however, waning efficacy of ACT, characterised by slow parasite clearance after treatment, has been reported since 2008 (44). This slow clearance is associated with certain mutations in the propeller domain of the *P. falciparum* kelch protein K13, which have now also emerged in Africa (45).

The Malaria Reference Laboratory (MRL) has been routinely monitoring reports of ACT treatment failure in UK travellers since 2016. As of March 2025, 6 *P. falciparum* isolates among over 50 genotypes evaluated during this period carried propeller domain mutations in the *pfk13* locus (Table 2.4).

Table 2.4. Variants in *pfk13* locus identified by year and country of travel

Variants	Country of travel	Year
C580Y	Cambodia	2018
A446I	Kenya	2022
A675V	Uganda (2 isolates)	2022
N458D	Côtes d'Ivoire	2023
P443S	Namibia	2023

We also reported on an additional 2022 isolate, also of Ugandan origin, derived from a UK patient with post-artemether-lumefantrine *P. falciparum* recrudescence, but not harbouring a pfk13 propeller domain mutation, showed equally significant reduction in susceptibility to both artemisinin and lumefantrine (46). The emergence of lumefantrine resistance in concert with the recently described increase in pfk13 variants, poses a potential threat to therapeutic management of falciparum malaria in travellers returning from East Africa. It is assumed that mutations at additional parasite loci underly this reduced lumefantrine efficacy, but these are yet to be identified. Overall, however, artemether-lumefantrine (Riamet®) retains good efficacy against the overwhelming majority of imported falciparum malaria infections in the UK. To cover those instances where treatment failure (recrudescence) in falciparum malaria occurs, the UKHSA Malaria Expert Advisory Group (MEAG, formerly known as the Advisory Committee on Malaria Prevention) has published guidance on alternative ACT for use whilst the full UK Malaria Treatment Guidelines are undergoing full revision (4).

In contrast to the overuse of antibiotics in high-income settings, there is significant underutilisation of antimalarial prophylactic drugs by travellers from the UK visiting areas where malaria is endemic. In 2023, where the history of chemoprophylaxis was recorded, 89% of those diagnosed with imported malaria in the UK took no chemoprophylaxis, a similar pattern to previous years. Given that the regimens currently advised for UK travellers provide at least 90% protection, this represents a substantial failure of preventative advice. The MRL is actively engaging with relevant groups of travellers to develop better approaches to communicate the message and improve uptake. The following chapter discusses antimalarial consumption data in England in further detail.

Giardiasis

In the last 2 decades, clinicians have experienced increasing rates of nitroimidazole (metronidazole or tinidazole) treatment failure. The proportion of nitroimidazole refractory infections ranges from 1% to 50% worldwide, with studies showing the highest rates among infections acquired from India (17 to 50% in various studies) (47 to 49). In the UK, a study from the Hospital for Tropical Diseases, London between 2008 to 2013 and a re-audit between 2020 to 2024 showed that for patients who acquire *Giardia* infections in India, between 36 to 50% fail treatment with a nitroimidazole (47). In addition to travel to India, other risk factors associated with refractory disease are underlying immunodeficiency (for example Common Variable

Immune Deficiency (CVID), IgA deficiency, untreated HIV, immunosuppression). It is recommended therefore that the first line treatment regimen for proven imported giardiasis from India should be a combination of albendazole and nitroimidazole for one week (47).

However, *in vitro* antimicrobial susceptibility testing is not routinely available in clinical laboratories, as *Giardia* has limited ability to grow in culture, highlighting the challenges with determination of antiparasitic drug resistance.

Whole genome sequencing studies to identify molecular markers of drug resistance are underway.

UK participation in international surveillance of AMR

The most recent WHO global antimicrobial resistance and use surveillance system (GLASS) report was published in October 2025, and includes modelled resistance estimates based on data from the UK, covering blood, urine, stool and urogenital isolates from 2018 to 2023, and a description of the current status of AMR surveillance nationally. Unadjusted UK 2023 data are not available in the report due to an administrative oversight in the processing of data submitted by the UK, however the most up-to-date UK data are readily available in the WHO GLASS Dashboard.

Annual submissions are provided to the WHO Central Asian and European Surveillance of Antimicrobial Resistance (CAESAR) network with UK data. The 2021 data were included in its 2023 report, Antimicrobial resistance surveillance in Europe 2023 to 2021 data.

Main AMR resources and reports

In addition to ESPAUR, the UKHSA routinely publishes a range of reports on AMR and infections, a number of which are shown below. A longer list of AMR resources and reports is available in the ‘Methods and caveats’ section of the Annexe accompanying this report. Research-based outputs including peer reviewed publications using the data referred to in this report and the listed resources are documented in the Research chapter (Chapter 7) and include:

- carbapenemase-producing Gram-negative bacteria laboratory surveillance quarterly reports
- weekly carbapenemase Notifications of Infectious Diseases (NOIDs) reports
- annual epidemiological commentary: Gram-negative, MRSA, MSSA bacteraemia and *C. difficile* infections
- pyogenic and non-pyogenic Streptococcal bacteraemia annual data from voluntary surveillance
- Group A streptococcal infections seasonal activity reports
- Fingertips: AMR local indicators

- UK One Health report: Joint report on antibiotic use, antibiotic sales and antibiotic resistance
- Tuberculosis in England: national quarterly reports
- Gonococcal resistance to antimicrobials surveillance programme GRASP
- Mycoplasma genitalium antimicrobial resistance surveillance (MARS)
- Enteric fever (typhoid and paratyphoid) England, Wales and Northern Ireland
- Laboratory surveillance of paediatric bacterial bloodstream infections and antimicrobial resistance in England
- Laboratory surveillance of Enterococcus spp. bacteraemia (England)
- UKHSA dashboard
- UK 2024 to 2029 AMR National Action Plan: Confronting antimicrobial resistance 2024 to 2029

Chapter 3. Antimicrobial consumption

Main messages

Antibiotics: Under the 2024 to 2029 UK AMR National Action Plan (NAP) (50), a target was set to reduce total human antimicrobial use by 5% from the 2019 baseline, by 2029.

This builds on the 2019 to 2024 UK NAP, which aimed to reduce antibiotic consumption by 15% from 2014 levels, to 16.9 defined daily doses (DDDs) per 1,000 inhabitants per day (DID). By 2024, total NHS antibiotic consumption in England had decreased by 11.3% from 2014 levels to 17.4 DID, demonstrating strong progress, although falling short of the 15% reduction target (3.7% or 0.36 DID above). Data was not adjusted for population change including age, sex or risk factors.

Antibiotic use in the NHS in 2024 was 2% lower than the 2019 pre-pandemic level of 17.9 DID, suggesting a return to more stable prescribing patterns following earlier disruptions caused by the pandemic and the very large surge in group A *Streptococcus* (GAS) in 2022 to 2023.

In 2024, antibiotic use remained slightly lower than 2019 across most settings, except in ‘other community’ settings, where consumption increased by 43.8% (0.74 to 1.06 DID), and in hospital inpatients, which saw a 2.7% increase (2.3 to 2.4 DID). The rise in ‘other community’ consumption partly reflects different access to antibiotics and additional data being captured following the introduction of the Pharmacy First service (Box 3.5).

Regional variation persisted, with the highest consumption in the North East (20.3 DID) and lowest in London (14.7 DID). Most regions saw prescribing declines between 2023 and 2024, notably the North West primary care, which may in part be related to the TARGET training rollout in this region.

Penicillins remained the most frequently used antibiotic group in both primary and secondary care. Between 2023 and 2024, prescribing increased across several antibiotic groups, including a notable 54.1% rise in methenamine use (+0.25 DID), an antibiotic-sparing agent. While most antibiotic groups remained below 2019 levels, some exceeded them: first- and second-generation cephalosporins (+0.028 DID, +11.9%), anti-*Clostridioides difficile* agents (+0.005 DID, +114.1%), sulfonamides and trimethoprim (+0.034 DID, +4.4%), and other antibacterials (+29.9%). Rising use of anti-*C. difficile* agents likely reflects increased *C. difficile* infection rates (51).

Quinolone prescribing saw the largest percentage reduction since 2019, dropping 23.2% (from 0.502 to 0.385 DID), likely in response to updated Medicines and Healthcare products Regulatory Agency (MHRA) guidance (Box 3.2).

Following the 2023 WHO classification update, the UK 4 nations re-adapted the AWaRe classification for national use (52). The revised 2024 UK-AWaRe classification underpins the new NAP, which set a target for 70% of total antibiotic use to be from the Access category. While the proportion of Access antibiotic use has increased since 2021, surpassing pre-pandemic 2019 levels in 2024, comparison of the most recent years shows a slight decrease in percentage Access use, from 64.1% in 2023 to 63.2% in 2024. This was due to reduced primary care prescribing and a rise in 'Other' classification of antibiotics (2.7% to 4.0%).

In 2024, primary care accounted for 79.6% (with 70.4% being GP practices) of total antibiotic use. When measured as items per 1,000 inhabitants per day, primary care antibiotic consumption in 2024 showed a slight increase compared with 2019. This trend contrasts with the decrease observed when measured using DID, suggesting a shift toward smaller average quantities per prescription. While general practice and dental prescribing fell below 2019 levels, 'other community' use exceeded 2019 (0.11 to 0.18 items per 1,000 inhabitants per day), which was largely attributed to the additional data being captured as part of the 2024 introduction of the Pharmacy First service, which now represents 34.5% of antibiotic use within the 'Other community' setting (0.061 items per 1,000 inhabitants per day) (53). Small increases in other community-based settings, such as walk-in centres (+1.2%, +0.001 items per 1,000 inhabitants per day) and community services (+4.1%, +0.003 items per 1,000 inhabitants per day), also suggest an increase in community demand, marking a significant change in how antibiotics are accessed in the community.

While overall GP practice prescribing in 2024 has declined compared to 2019 levels, this has not been consistently seen across all age groups. Antibiotic consumptions rates among the paediatric (<14 years) age groups have not returned to pre-pandemic levels.

Secondary care antibiotic use in 2024 was similar to 2019 (+0.6%), with increases in inpatient prescribing and decreases in outpatient use noted. Secondary care prescribing of anti-*C. difficile* agents increased during this time period, reflecting rising rates of hospital-onset *C. difficile* infections.

Use of cefiderocol has steadily increased since its 2020 UK launch but fell slightly (−1.7%) from 2023 to 2024. In contrast, use of ceftazidime-avibactam continues to rise, albeit overall consumption remains low. Further details can be found in the antimicrobial product subscription model section.

Antifungals: Total use of systemic antifungals in 2024 was similar to that seen in 2019 (+2.0%). There was a large decrease in 2020 during the COVID-19 pandemic, with usage subsequently increasing year-on-year. In comparison to 2019, use of systemic antifungals in 2024 in primary care and in NHS acute trusts increased by 2.6% and decreased by 2.5%, respectively.

Terbinafine, the most frequently prescribed antifungal in the community, demonstrated year-on-year increases in use between 2020 and 2024. Its use has surpassed pre-pandemic levels (+4.9%, 0.835 to 0.876 DID).

Posaconazole secondary care prescribing increased markedly from 2019 to 2020 (+48.5%, 28.3 to 42.0 DDDs per 1,000 admissions) and remains at an increased rate in 2024 (48.7 DDDs per 1,000 admissions).

Antivirals: The total usage of the COVID-19 therapeutic agents in England showed a decrease of 29.7% (370,711 to 260,452 DDDs) between 2023 and 2024. This decline corresponds to the decline in the number of reported COVID-19 cases in 2024 and changes in testing and guidance.

Antiparasitic agents: Among agents used to treat malaria, the most frequently prescribed was quinine; its use has decreased since 2019. Note that it can be used for non-infectious indications.

Mebendazole, indicated for treatment of threadworm infections, was the most frequently used anthelmintic in 2024, and saw a declining trend in use within the NHS from 2019 to 2024, whilst prescriptions and supply from private (non-NHS) settings have increased within the same period.

Albendazole, however, saw an increase in the rate of use by 75% between 2021 and 2023, across NHS and private (non-NHS) prescribing, followed by a decrease in 2024 to 0.005 DID.

Additions to this year’s chapter

Expanded data access and analysis of non-NHS antibiotic prescribing. In 2024, total antibiotic purchasing within the independent sector was 1.31 DID, while total dispensing was 4.40 DID. It should be noted that purchasing data do not equate to antibiotic usage, as not all purchased antibiotics are subsequently dispensed or administered. For comparable prescribing activity, NHS primary care accounted for 13.96 DID, while private prescriptions dispensed in community pharmacies accounted for 3.93 DID, representing 22% of total (NHS and non-NHS) primary care prescribing.

Assessment of antibiotic prescribing trends in the context of rising *C. difficile* infection rates.

Discussion of antibiotic prescribing under the newly introduced Pharmacy First service.

Highlighting the increasing use of methenamine, a non-antibiotic, antibiotic-sparing agent.

Description of trends in the use of direct-acting antiviral (DAA) therapies for hepatitis C treatment.

Introduction to Chapter 3

This chapter presents data on antimicrobial consumption in England from 2019 to 2024 in primary and secondary care and includes surveillance data since the COVID-19 pandemic was declared. Total antimicrobial consumption includes antibiotic use across the healthcare system; both the primary and secondary care settings listed below. Independent healthcare settings are not included within the NHS specific data but presented separately in Box 3.2. Antimicrobial prescribing settings referred to in this chapter comprise primary care, which includes general practices (GP), dental practices, out-of-hours services, and the new Pharmacy First service, and secondary care, which includes hospital inpatient and outpatient services.

Antimicrobials (which include antibiotics, antivirals, antifungals and antiparasitics) are medicines used to stop the growth of microorganisms causing infection. The use of antimicrobials not only impacts individual health outcomes but also has implications for the wider population. While antimicrobial resistance (AMR) is a natural phenomenon, use of antimicrobials is a modifiable driver of AMR (further details on AMR surveillance can be found in Chapter 2). Efforts have been focused on improving appropriate use of antimicrobials to maintain the efficacy of the antimicrobials currently available.

The UK's 2024 to 2029 AMR National Action Plan (NAP) (50) has an ambition to reduce total UK antimicrobial consumption in humans by 5% by 2029, from a 2019 baseline, with an increase in the relative proportion of narrow-spectrum antibiotics used. 'Information for action' is required to mobilise public health engagement and inform on where efforts should be targeted to ensure progress towards these national targets. Surveillance enables the interpretation of antimicrobial consumption trends at a national level and helps identify which antimicrobial stewardship (AMS) interventions may have the greatest impact (further details found in Chapter 4). This chapter illustrates the importance of access to robust national data from sources across different prescribing settings, ensuring the timely evaluation of antimicrobial consumption trends, including unusual periods, such as the COVID-19 pandemic and out-of-season trends in infection transmission, across the healthcare system.

Methods can be found in the Annexe. Data and figures presented in this chapter are available in the Chapter 3 data table and the downloadable infographics figures slide deck.

Antibiotic consumption

Total NHS antibiotic consumption

In England, total NHS antibiotic consumption in 2024 was 17.5 defined daily doses (DDDs) per 1,000 inhabitants per day (DIDs), a 2% reduction compared with 2019 levels (17.9 DIDs), which serves as the baseline for pre-pandemic antibiotic use. This reflects NHS prescribing only and excludes prescriptions issued in the independent sector (refer to Box 3.1). Following a 10.5% decline between 2019 and 2020 with the onset of the COVID-19 pandemic, consumption gradually increased from 2022, reaching 17.4 DIDs in 2023, the first full calendar year without

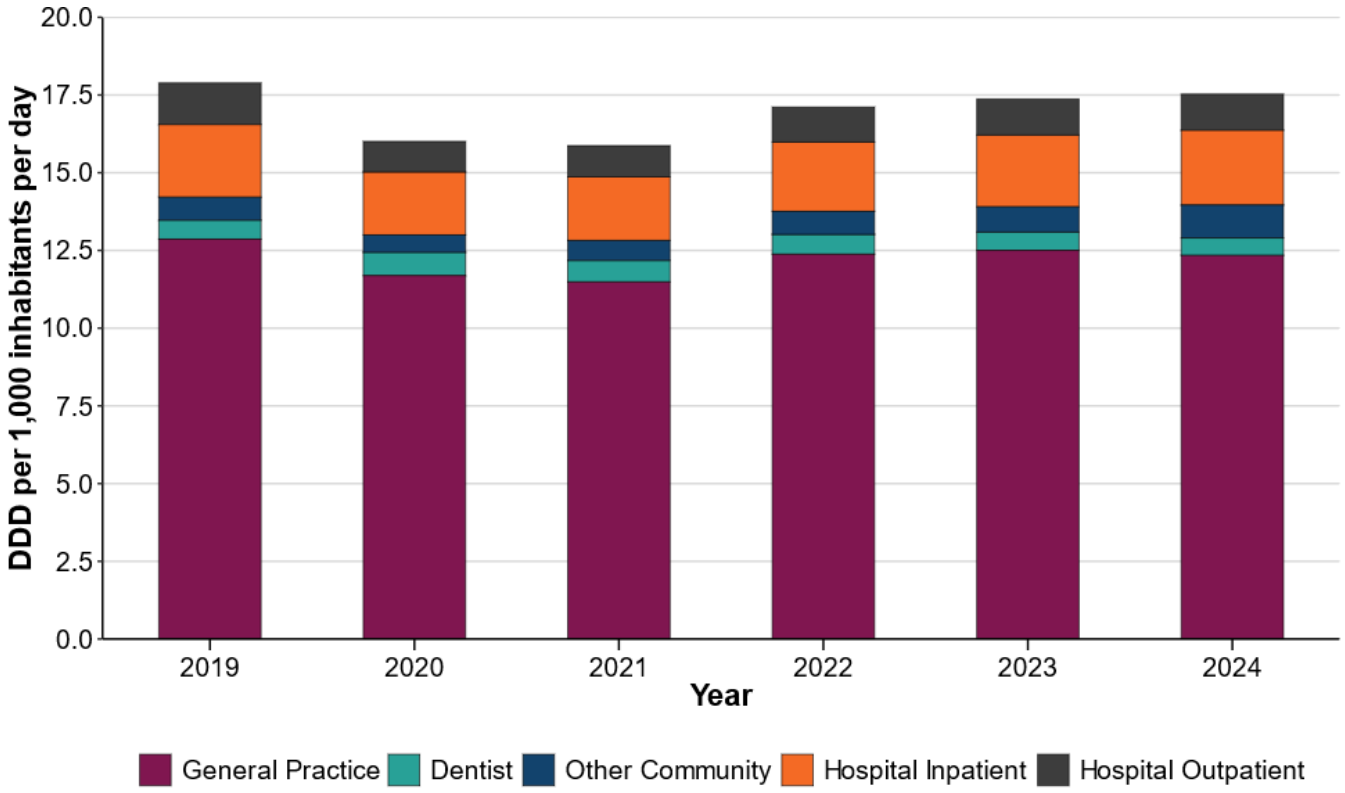
nationally mandated COVID-19 measures. In 2024, consumption increased marginally by 0.9% compared with 2023, suggesting a stabilisation of prescribing patterns following the pandemic-related disruptions.

From September 2022, out-of-season very large increases in invasive Group A streptococcal (GAS) infections were observed. The winter of 2022 to 2023 also saw an unusual rise in co-circulating viral infections, including respiratory syncytial virus (RSV), influenza and hepatitis related to adeno-associated virus. The atypical infection patterns continued into 2023, with the winter of 2023 to 2024 seeing an exceptional rise in *Mycoplasma pneumoniae* (54). Such unusual rises in infections are frequently associated with increased demand for antibiotics (55, 56).

In 2024, general practice accounted for 70.4% of antibiotics prescribed in England (12.3 DID, a decrease from 72% in 2023), with other settings comprising hospital inpatients (13.7%, 2.4 DID), hospital outpatients (6.6%, 1.2 DID), other community settings (6.0%, 1.1 DID; which increased from 4.7% in 2023, in part related to new data being captured following the introduction of the Pharmacy First service, discussed further in the Other community use section of the chapter), and dental practices (3.2%, 0.56 DID).

Figure 3.1 shows antibiotic consumption across the NHS from 2019 to 2024. Following substantial declines during the COVID-19 pandemic, consumption rebounded from 2021 across most settings, and from 2022 in GP practices, with the exception of dental practices. NHS Dental practice consumption increased in 2020 (from 0.61 to 0.75 DID) and has steadily continued to decline since, returning to below 2019 levels in 2023 (0.59 DID) and decreasing further in 2024 (0.56 DID). In 2024, antibiotic use remained slightly lower than 2019 levels across most settings, with the exception of other community settings, where consumption increased by 43.8% (0.74 DID in 2019 to 1.06 DID in 2024), and in hospital inpatients where use slightly increased by 2.7% (from 2.3 to 2.4 DID). When measured as items per 1,000 inhabitants per day, similar reductions were seen in GP practices and dental use, alongside an increase in other community settings. However, when combined as total primary care use, DID values decreased between 2019 and 2024 (from 17.9 to 17.5 DID, −2.0%), while items per 1,000 inhabitants per day increased (from 1.66 to 1.71 items per 1,000 inhabitants per day, +2.7%). This divergence suggests that the average quantity of antibiotic per prescription may have reduced. This pattern could be consistent with improved prescribing practices, such as shorter treatment courses (57) or lower doses, alongside potential effects of the 2024 Pharmacy First service. While the change cannot be attributed solely to this service or to any single setting within primary care without further analysis, the data suggests that prescribing is trending toward smaller quantities per course, even as prescription numbers in some settings have risen.

Figure 3.1. Total NHS antibiotic consumption by setting, expressed as DID, England, 2019 to 2024



Note: In 2024, 'Other community' includes new data being captured following the introduction of the Pharmacy First service.

Regional variation in antibiotic consumption in England

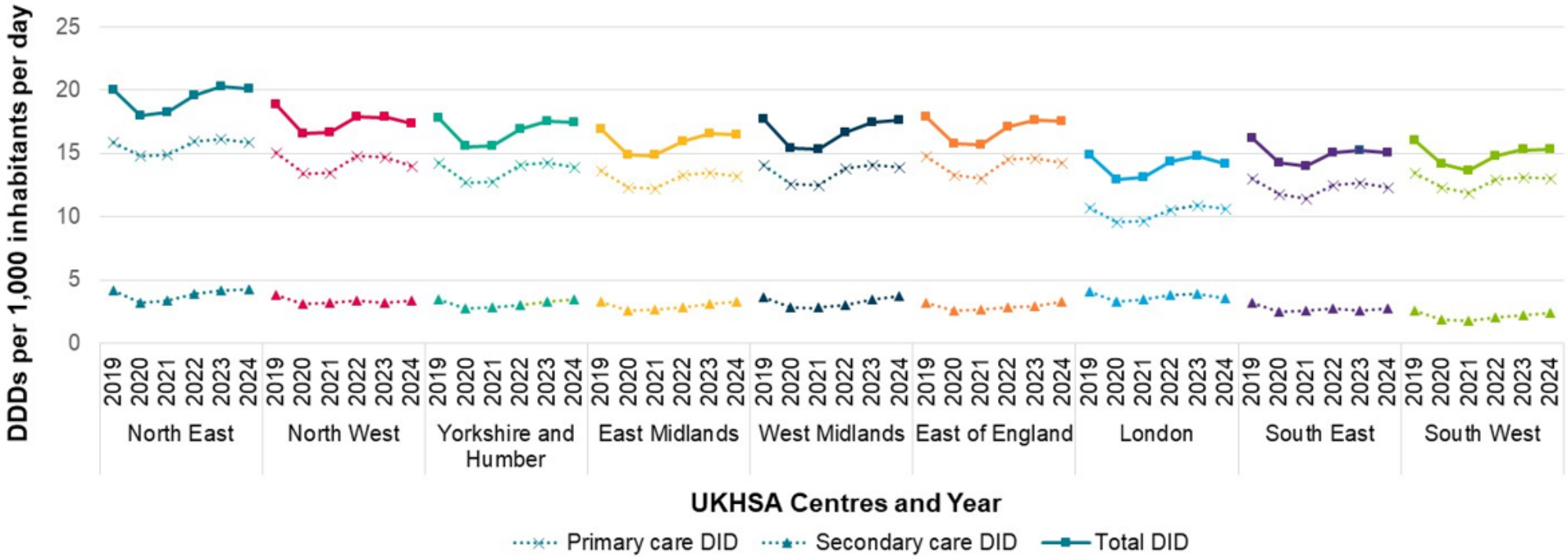
In 2024, antibiotic consumption was highest in the North East (20.3 DID), where usage has consistently been the highest, while London (14.7 DID) reported the lowest total consumption (Figure 3.2). London also displayed a clear contrast between care settings, with the lowest primary care use (10.62 DID) but the second highest in secondary care (4.08 DID). This reflects regional differences in population demographics (with a younger population in London), prescribing patterns and healthcare access (58). London has greater access to walk-in centres, urgent treatment centres and hospital emergency departments, which may reduce reliance on GP practices (59). The higher hospital bed capacity and greater concentration of specialist and tertiary services may contribute to the consistently higher prescribing observed in secondary care within the region. In contrast, the North East and other areas with a higher proportion of older residents (aged 65 years and over) tend to have greater healthcare needs, which can drive higher antibiotic use. These areas may also face challenges such as lower GP provision per head of population, which can further influence antibiotic prescribing (59 to 62).

All regions reported lower total antibiotic use than in pre-COVID 2019, except for the North East, where 2024 levels were 1.3% higher, and the West Midlands (0.4% higher). Compared to 2023, total antibiotic use declined in 7 of 9 UKHSA centres in 2024, with the largest reductions

in London (−5.9%), the North West (−2.7%) and the South East (−1.7%). In contrast, slight increases were seen in the West Midlands (+0.8%) and South West (+0.2%).

These overall declines were largely driven by reductions in primary care prescribing, which decreased across all regions in 2024 compared with 2023. The largest decrease was in the North West (−4.5%), where AMS initiatives in primary care since 2022, including roll out of Treat Antibiotics Responsibly, Guidance, Education and Tools (TARGET) training in this region, may have contributed to the reductions seen. In secondary care, 8 of the 9 regions showed increased consumption, with notable increases in the East of England (+9.2%) and the West Midlands (7.4%). London was the only region to see a decline in secondary care use (−14.1%).These regional differences warrant further analyses to identify successful interventions or antimicrobial stewardship activities for shared learning.

Figure 3.2. Total, NHS primary and secondary care antibiotic consumption by UKHSA centres, expressed as DID, 2019 to 2024 (excludes dental practice data) [note 1]



[Note 1] Primary care data does not include dental care prescribing as UKHSA centre-level data was not available at the time of production. The order of UKHSA centres presented is based on geographic location from North to South of England.

Antibiotic group

Figure 3.3 displays the antibiotic groups with the highest total consumption in England. As was observed in previous years, in 2024, penicillin and its derivatives, excluding beta-lactam/beta-lactamase-inhibitor combinations (BLIs), were the most used antibiotic group in England, accounting for 31.7% (5.55 DIDs) of total consumption. This was followed by tetracyclines (25.7%, 4.50 DIDs), and 'macrolides, lincosamides and streptogramins' (13.7%, 2.39 DIDs). These groups were consistent across primary and secondary care in accounting for the greater proportion used, with the addition of a high percentage of penicillins with beta-lactamase inhibitors observed in secondary care settings (Figure 3.3).

Between 2023 and 2024, antibiotic prescribing patterns showed notable shifts, with overall increases observed across several antibiotic groups (Figure 3.3, Appendix tables). The most significant absolute increase was seen in the 'Other antibacterials' category, which rose by 0.21 DID (+11.4%), driven primarily by a substantial rise in methenamine prescribing (+0.25 DID, +54.1%), particularly in general practice and other community settings. Methenamine hippurate, a urinary antiseptic classified under the ATC J01 group (anti-infectives for systemic use), was included in the December 2024 by NICE (guideline NG112) as one of several recommended alternatives to antibiotic prophylaxis for preventing recurrent urinary tract infections (UTIs), alongside options such as vaginal oestrogens and other non-antibiotic agents (63). However, the observed increase in methenamine prescribing lacks a clear temporal relationship to the December 2024 guidance update, as prescribing levels were already on the rise prior to its publication. The rise in methenamine use likely reflects ongoing stewardship efforts, early adoption prior to the NICE guidance, and growing awareness of supporting evidence driving this antibiotic-sparing strategy aimed at combating antibiotic resistance.

Another noteworthy change between 2023 and 2024 was a decline in penicillins (excluding beta-lactam/beta-lactam inhibitor combinations) use, driven by reductions in amoxicillin (−0.07 DID, −2.3%), flucloxacillin (−0.04 DID, −2.5%) and phenoxymethylpenicillin (−0.02, −2.5%). This follows a previous increase in use of these 3 antibiotics reported between 2022 and 2023, following the unprecedented levels of GAS infection in December 2022 to March 2023 (64).

Meanwhile, between 2023 and 2024, prescribing of first-line antibiotics for uncomplicated lower UTIs showed inconsistent trends; nitrofurantoin (also within the 'Other antibacterials' group) decreased by 0.025 DID (−2.1%), while trimethoprim use increased slightly by 0.011 DID (+2.2%), and pivmecillinam increased by 7.4% (+0.007 DID). These changes may reflect updated recommendations supporting pivmecillinam as an alternative to trimethoprim and nitrofurantoin for treating UTIs in adults (27). Continuous high trimethoprim resistance levels and successful, safe use internationally, may also be contributing to the increasing use of pivmecillinam (65). Efforts such as the Improving Prescribing of Antibiotics for Primary care (IPAP) programme in England, launched in 2023 to improve antibiotic use for UTIs in general practice, are expected to influence UTI prescribing patterns in the longer term (66). Increases between 2023 and 2024 were also notable in macrolides, lincosamides and streptogramins

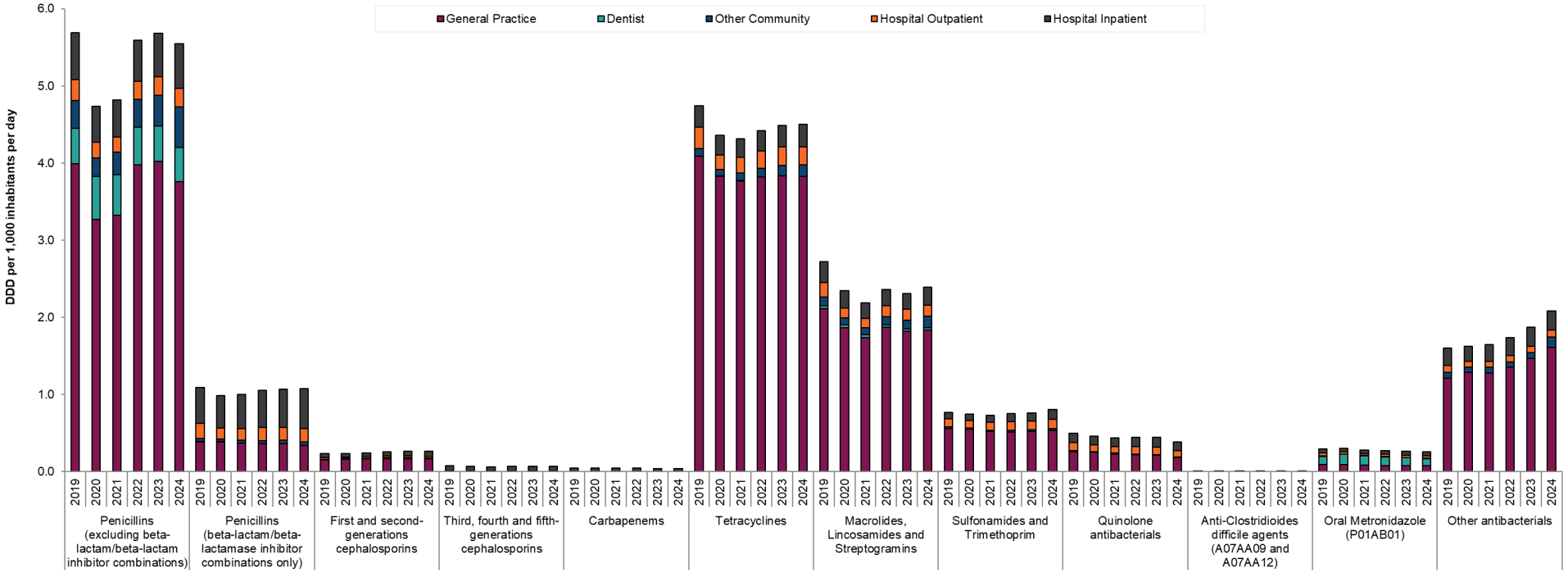
(+0.081 DID, +3.5%, related specifically to a slight increase in use of clarithromycin and azithromycin), and sulfonamides and trimethoprim (+0.041 DID, +5.3%).

Antibiotic use by group largely remained below 2019 levels. However, first and second-generation cephalosporins (+0.028 DID, +11.9% between 2019 and 2024), anti-*C. difficile* agents (+0.005 DID, 114.1%), sulfonamides and trimethoprim (+0.034 DID, 4.4%) and other antibacterials (which includes methenamine as discussed above; +0.48 DID, 29.9%) were in exceedance of 2019 levels. Although anti-*C. difficile* agents represent the antibiotic group with the lowest consumption, use within this group continued to rise in 2024 and demonstrated the largest percentage increase among all groups (+0.001 DID, +18% between 2023 and 2024). This increase is likely linked to the noted rise in *C. difficile* infections (51). It should be noted that agents classified as anti-*C. difficile*, such as metronidazole, may also be used for other indications, such as treatment of infections caused by other anaerobic bacteria. The largest percentage reduction in consumption between 2019 and 2024 was seen in quinolone prescribing (−23.2%, −0.117 DID, from 0.502 to 0.385 DID), this is likely related to MHRA guidance changes, discussed further in Box 3.3. It's important to note that this reflects a quinolone decline from an already low baseline. WHO GLASS data shows that UK's quinolone use remains among the lowest compared to many other European countries (67).

The top 3 antibiotics used in primary care in 2024 were amoxicillin, doxycycline and lymecycline (Table 3.1). The high consumption of amoxicillin and doxycycline highlights the role of AMS in guiding appropriate treatment durations, and ensuring that these antibiotics are prescribed for the appropriate duration to reduce unnecessary exposure (68, 69). Lymecycline, primarily prescribed for long-term management of acne, remains among the most prescribed despite its limited clinical indications, highlighting a potential area for targeted AMS and review of treatment duration.

The top antibiotics used in secondary care are co-amoxiclav (the most widely used in inpatients and classified as Watch in the UK AWaRe classification, Table 3.1.b), followed by doxycycline (most commonly used in outpatients), and flucloxacillin (Table 3.1.a). This pattern reflects the high proportion of antibiotics used for respiratory infection in both inpatient and outpatient care (70), with flucloxacillin also indicated for skin and soft tissue infections (71). While high doxycycline use, particularly in outpatients, supports the UK NAP target for greater than 70% Access use, the overall Access-to-Watch balance indicates scope to reduce broad-spectrum prescribing, especially co-amoxiclav to minimise resistance and *C. difficile* risk. Compared with other European countries, penicillins also accounted for a large proportion of secondary care consumption, whereas tetracyclines a small proportion, highlighting England's differing prescribing patter of doxycycline use (72).

Figure 3.3 Total antibiotic consumption by antibiotic group and setting, expressed as DID, England, 2019 to 2024 [note 1]



[Note 1] Other antibacterials (ATC 3rd level pharmacological subgroup ‘J01X’) include: glycopeptide antibacterials, polymyxin, steroid antibacterials, imidazole derivatives, nitrofuran derivatives, methenamine and others (full list in chapter 3 of the Annexe accompanying this report).

Table 3.1.a The top 3 antibiotics used in primary and secondary care, along with top 3 by Access, and Watch and Reserve (AWaRe), England, 2024

Setting	Antibiotic	Class	AWaRe classification	2024 antibiotic consumption, DDDs per 1,000 inhabitants per day
Primary care	Amoxicillin	Penicillin (excluding beta-lactam/beta-lactamase inhibitor combinations)	Access	2.59
	Doxycycline	Tetracyclines	Access	2.44
	Lymecycline	Tetracyclines	Watch	1.32
	Clarithromycin	Macrolides, Lincosomamides and Streptogramins	Watch	1.22
	Azithromycin	Macrolides, Lincosomamides and Streptogramins	Watch	0.51
	Flucloxacillin	Penicillin (with beta-lactam/beta-lactamase inhibitor combinations)	Access	1.19
Secondary care	Co-amoxiclav	Penicillin (with beta-lactam/beta-lactamase inhibitor combinations)	Watch	0.60
	Doxycycline	Tetracyclines	Access	0.49
	Flucloxacillin	Penicillin (with beta-lactam/beta-lactamase inhibitor combinations)	Access	0.44
	Clarithromycin	Macrolides, Lincosomamides and Streptogramins	Watch	0.24
	Ciprofloxacin	Quinolone antibacterials	Watch	0.12
	Amoxicillin	Penicillin (excluding beta-lactam/beta-lactamase inhibitor combinations)	Access	0.29

Table 3.1.b The top 3 antibiotics used in secondary care inpatients and outpatients, along with top 3 by Access, and Watch and Reserve (AWaRe), England, 2024

Secondary care type	Antibiotic	Class	AWaRe classification	2024 antibiotic consumption, DDDs per 1,000 inhabitants per day
Inpatients	Co-amoxiclav	Penicillin (beta-lactam/beta-lactamase inhibitor combinations)	Watch	0.432
	Flucloxacillin	Penicillin (beta-lactam/beta-lactamase inhibitor combinations)	Access	0.315
	Doxycycline	Tetracyclines	Access	0.282
	Amoxicillin	Penicillin (excluding beta-lactam/beta-lactamase inhibitor combinations)	Access	0.204
	Clarithromycin	Macrolides, Lincosomamides and Streptogramins	Watch	0.166
	Piperacillin/ tazobactam	Penicillin (beta-lactam/beta-lactamase inhibitor combinations)	Watch	0.087
Outpatients	Doxycycline	Tetracyclines	Access	0.21
	Co-amoxiclav	Penicillin (beta-lactam/beta-lactamase inhibitor combinations)	Watch	0.17
	Flucloxacillin	Penicillin (beta-lactam/beta-lactamase inhibitor combinations)	Access	0.13
	Sulfamethoxazole / trimethoprim	Sulfonamides and Trimethoprim	Access	0.10
	Clarithromycin	Macrolides, Lincosomamides and Streptogramins	Watch	0.08
	Ciprofloxacin	Quinolone antibacterials	Watch	0.05

AWaRe: Access, Watch and Reserve

The AWaRe classification was first introduced by the World Health Organization (WHO) in 2017 and has since been updated every 2 years, with the latest revision in 2023 (73). It categorises antibiotics into 3 groups: Access, Watch, and Reserve. The 'Access' group comprises antibiotics where there is a need to improve availability to patients, particularly in countries where access is currently limited. The 'Watch' group comprises antibiotics with a higher potential for toxicity and/or increased risk of resistance. The 'Reserve' group comprises new and 'last resort' broad-spectrum antibiotics, where use should be limited to exceptional circumstances, to reduce selective pressure for emergence and spread of resistance. A nationally adapted AWaRe classification has been used in England since 2019, with several national- and trust-level antibiotic consumption targets based on it (50, 74, 75).

Following the 2023 WHO classification update, the 4 nations of the UK collaborated to re-adapt the AWaRe classification, ensuring it remains relevant to current national context (76). The updated 2024 UK-AWaRe classification will support national AMS efforts (see Chapter 4) and the UK's NAP for AMR 2024 to 2029 (50), which sets a UK target for 70% of total antibiotic use (in DDDs) to be from the Access category. Compared with the WHO classification, the UK re-adaptation makes achieving the Access target more challenging, as widely used antibiotics such as co-amoxiclav are placed in the Watch group rather than Access. This reduces the proportion of prescribing that contributes to the Access category.

The use of Access antibiotics as a percentage of total antimicrobial consumption declined during the COVID-19 pandemic but has gradually increased since 2021, surpassing pre-pandemic 2019 levels in 2024 (Figure 3.4). Comparison of the most recent years shows a slight decrease in percentage Access use, from 64.1% in 2023 to 63.2% in 2024. This was related to a decrease in prescribing within the primary care setting, and corresponding increase in the use of antibiotics classified under the Other category, which rose from 2.7% in 2023 to 4.0% in 2024 (Figure 3.5).

Access use in primary care has been consistently higher than in secondary care between 2019 and 2024 (Figure 3.4). In 2024, 65.6% of antibiotics used in primary care were in the Access category, 53.8% of antibiotics in secondary care.

In 2024, the most frequently used Watch or Reserve antibiotics in primary care were lymecycline, clarithromycin and azithromycin, whilst the top Access antibiotics were amoxicillin, doxycycline and flucloxacillin (Table 3.1.a). In secondary care, the most frequently used Watch or Reserve antibiotics were co-amoxiclav, clarithromycin and ciprofloxacin. Co-amoxiclav was also the most frequently used antibiotic in secondary care, reflecting the contribution of this antibiotic to the overall proportion of Watch and Reserve use in these settings. Doxycycline, flucloxacillin and amoxicillin were the most frequently used Access antibiotics in secondary care (Table 3.2).

Figure 3.4. 'Access' antibiotics as a proportion of antibiotic use in primary care, secondary care, and total use across the healthcare system, in England, 2019 to 2024 (2024 UK AWaRe classification)

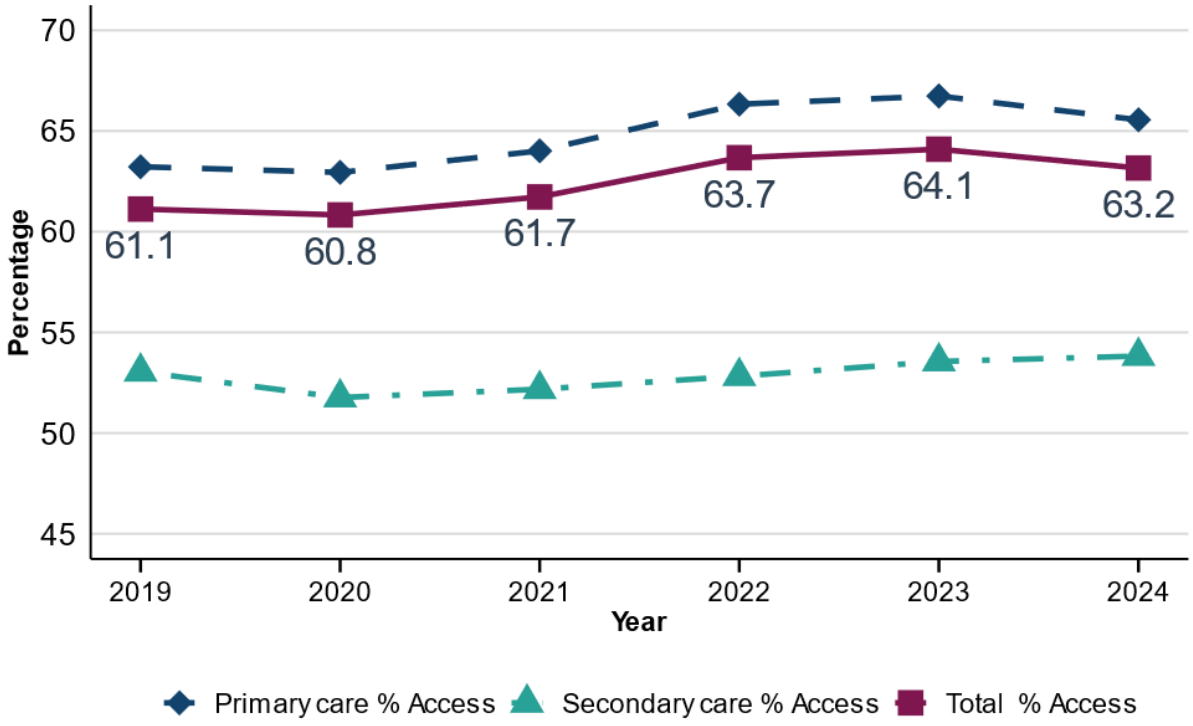
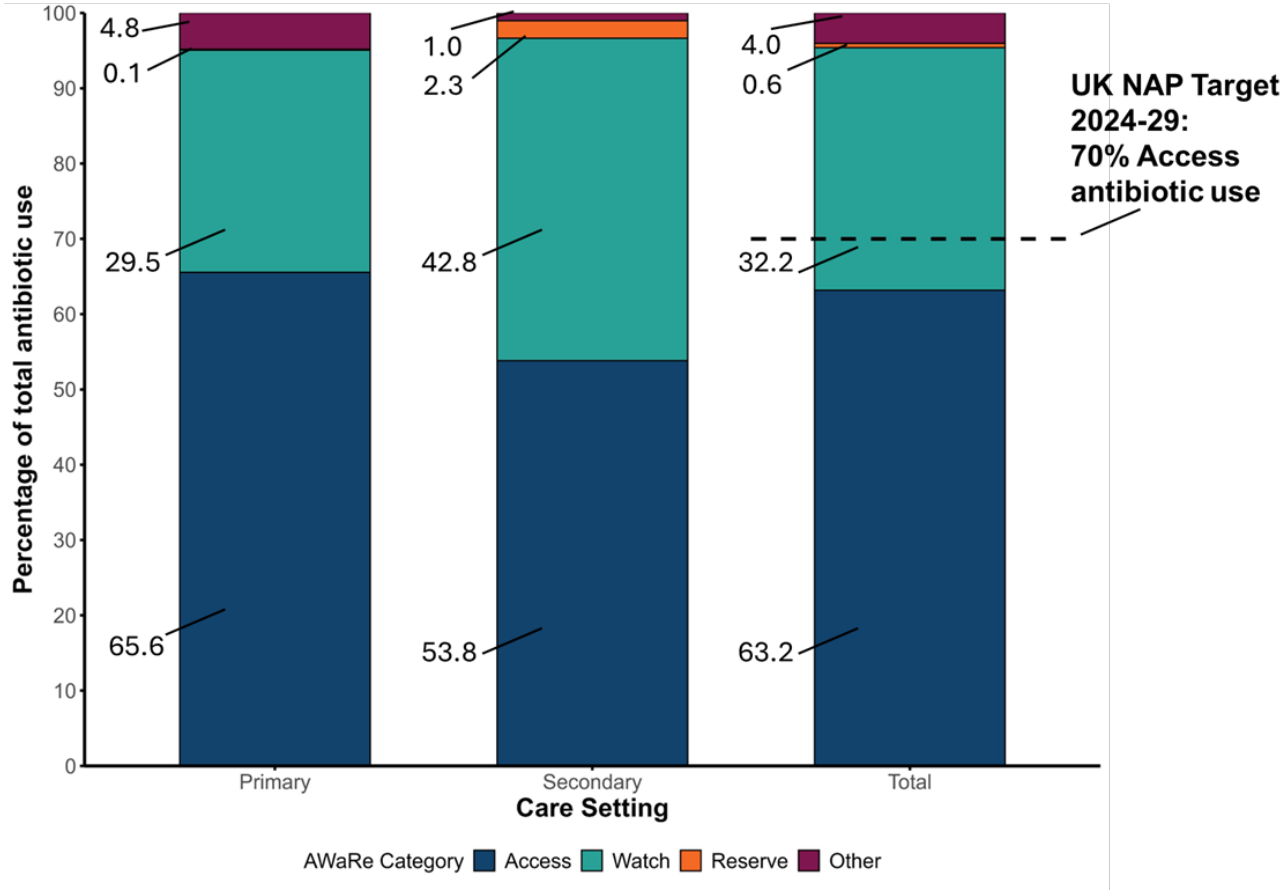


Figure 3.5. Proportion of AWaRe antibiotic use across the healthcare system in 2024 (2024 UK AWaRe classification)



Progress against the UK AMR National Action Plan's (NAP) human health targets: England data

The 2019 to 2024 UK NAP has concluded and the UK's progress against the ambitions to reduce total antibiotic use in humans by 15% from a 2014 baseline (that is to below 16.92 DID), and a 10% reduction in use of Watch and Reserve antibiotics in hospitals from a 2017 baseline (using the England 2019 AWaRe categorisation), by 2024, were evaluated. The NAP ambitions apply to the UK as a whole, whilst this report presents data for England only.

The COVID-19 pandemic had a marked impact on total antibiotic consumption in England, supressing antibiotic use during the peak pandemic years (16.01 DID in 2020 and 15.87 DID in 2021). However, subsequent increases in total antibiotic use were seen in 2022 (17.11 DID) and since, reaching 17.53 DID in 2024. While total antibiotic use in 2024 remained below pre-pandemic levels in 2019 (17.89 DID), it exceeded the previous NAP's 15% reduction target (by 3.7% or 0.63 DID), highlighting the need for sustained improvements in antimicrobial stewardship to meet the ambitions of the new NAP. Encouragingly, a reduction in the proportion of total antibiotic use comprising Watch and Reserve antibiotics was observed between 2019 and 2024 in England, decreasing by 5.3% (from 38.1% to 32.8%), highlighting positive

movement towards appropriate antibiotic prescribing practices, even against increasing overall infection and drug resistance rates.
UK AMR NAP targets have been set for the 5-year period of 2024 to 2029 (77), with the main antimicrobial prescribing ambition being to reduce UK antimicrobial total use in humans by 5% from the 2019 baseline, the most recent pre-COVID-19 pandemic period, by 2029.

Following revision of the WHO AWaRe categorisations in 2021, the UKHSA has, in the past year, led a review of the respective AWaRe classifications of antibiotics used across the UK, involving the 4 devolved administrations of the UK. A new nationally-adapted AWaRe classification has been produced following a modified-Delphi consensus seeking process, further details of which can be found in Chapter 4.

Updates to the categorisation were implemented for the 2024 to 2029 NAP, with a new target aiming to achieve 70% of total use of antibiotics from the Access category (UK 2024 categorisation) across the healthcare system.

Box 3.1. Antibiotic prescribing through private (non-NHS) routes in England, January 2019 to December 2024

IQVIA, a commercial provider of healthcare data, collects data on antimicrobial usage via several non-NHS routes. These routes include:

- supply to private hospitals (referred to as private hospital purchasing): covering sales and usage data from hospitals operating outside the NHS
- supply to private pharmacy (referred to as private pharmacy purchasing): includes sales to pharmacies that dispense purely private prescriptions and do not hold a contract to dispense NHS prescriptions
- private prescriptions dispensed in community pharmacies: includes private prescriptions dispensed in community pharmacies that hold NHS dispensing contracts but also dispense private prescriptions
- private prescriptions linked to private healthcare services provided in NHS facilities (referred to as private usage in NHS hospitals): includes private prescriptions issued as part of non-NHS work undertaken within NHS hospitals (for example private wards within NHS hospitals)

Further details on data included and definitions can be seen in the Annexe.

In 2024, total antibiotic purchasing within the independent sector was 1.31 DID, while total dispensing was 4.40 DID. It should be noted that purchasing data do not equate to antibiotic usage, as not all purchased antibiotics are subsequently dispensed or administered. For comparable prescribing activity, NHS primary care accounted for 13.96 DID, while private prescriptions dispensed in community pharmacies accounted for 3.93 DID, representing 22% of total (NHS and non-NHS) primary care prescribing.

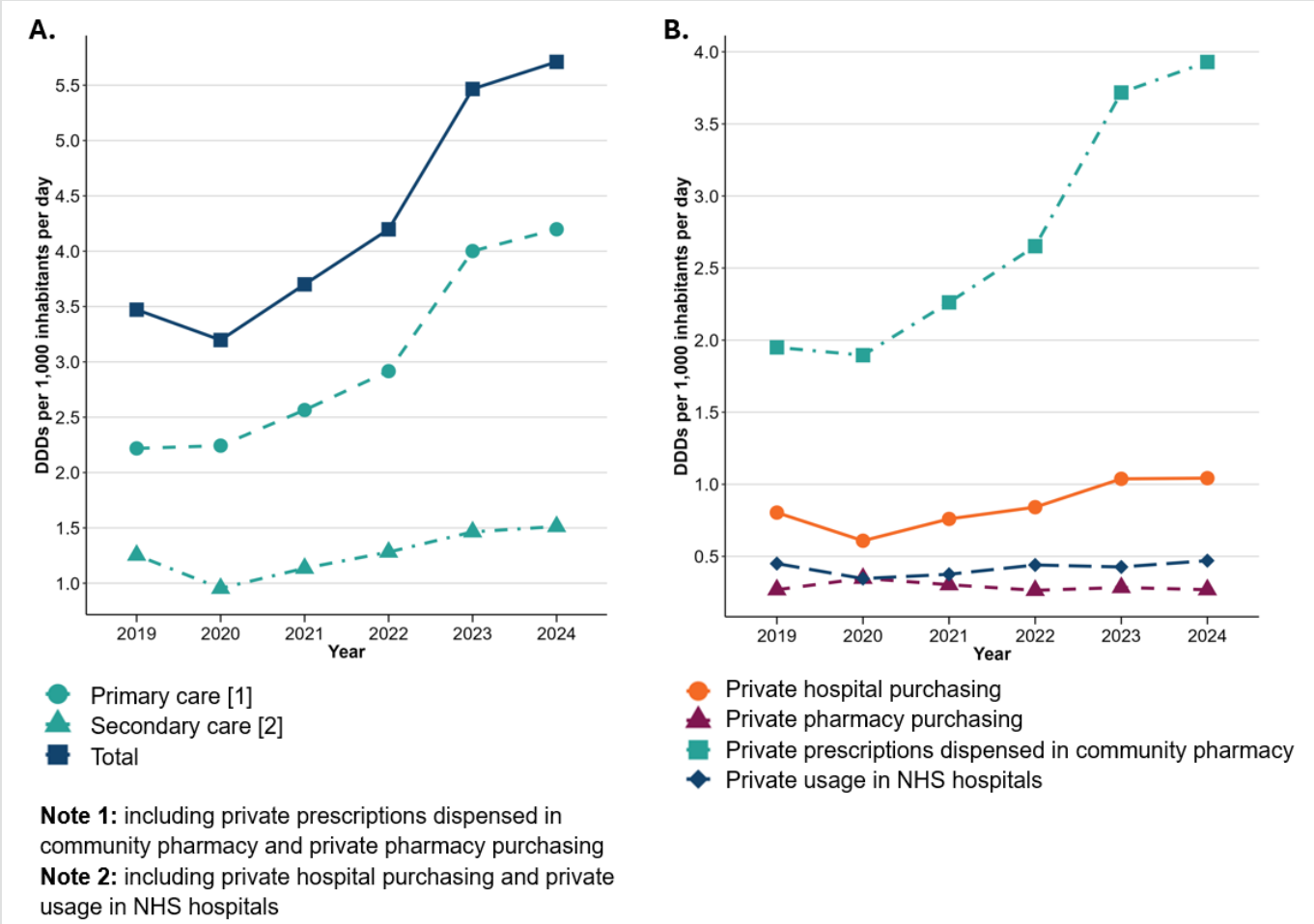
This section presents data from private (non-NHS) routes to support our understanding of antimicrobial use across all healthcare sectors in England. While these data provide valuable insight, there are important caveats to consider. Independent sector data encompass both purchasing and dispensing but do not provide complete coverage of dispensing activity across all settings, and are therefore not directly comparable with total NHS usage data. For example supply of antibiotics to dental practices are not included, meaning that antimicrobials such as metronidazole used pre-surgery are often not captured. Neither are those issued under NHS or non-NHS Patient Group Directions (PGDs) or dispensing via online routes. In addition, aesthetics practice is thought to account for a substantial proportion of antimicrobial use, but much of this may fall outside legitimate or regulated sources, making it difficult to fully ascertain the extent of consumption.

Total antibiotic use (combined purchasing and prescribing) in the independent sector in 2024 was 5.71 DID, demonstrating a steady incline from 2019 to 2024 (from 3.47 DID to 5.71 DID, +64.5%), with the greatest increases observed in non-NHS prescriptions dispensed in community pharmacy during this period (Box Figure 3.1.1). This increase in non-NHS prescriptions dispensed in community pharmacy was most evident between 2022 and 2023 (+40.2%, from 2.65 DID to 3.72 DID), with a similar incline noted within NHS primary care antibiotic use, likely related to the group A *Streptococcus* (GAS) outbreak.

Private hospital purchasing remained stable from 2023 to 2024. However, increases were observed in private usage in NHS hospitals (+10.3%, from 0.43 DID to 0.47 DID), private prescriptions dispensed in community pharmacy (+5.7%, from 3.7 DID to 3.9 DID), whilst private pharmacy purchasing decreased (-5.4%, from 0.28 DID to 0.27 DID) from 2023 to 2024.

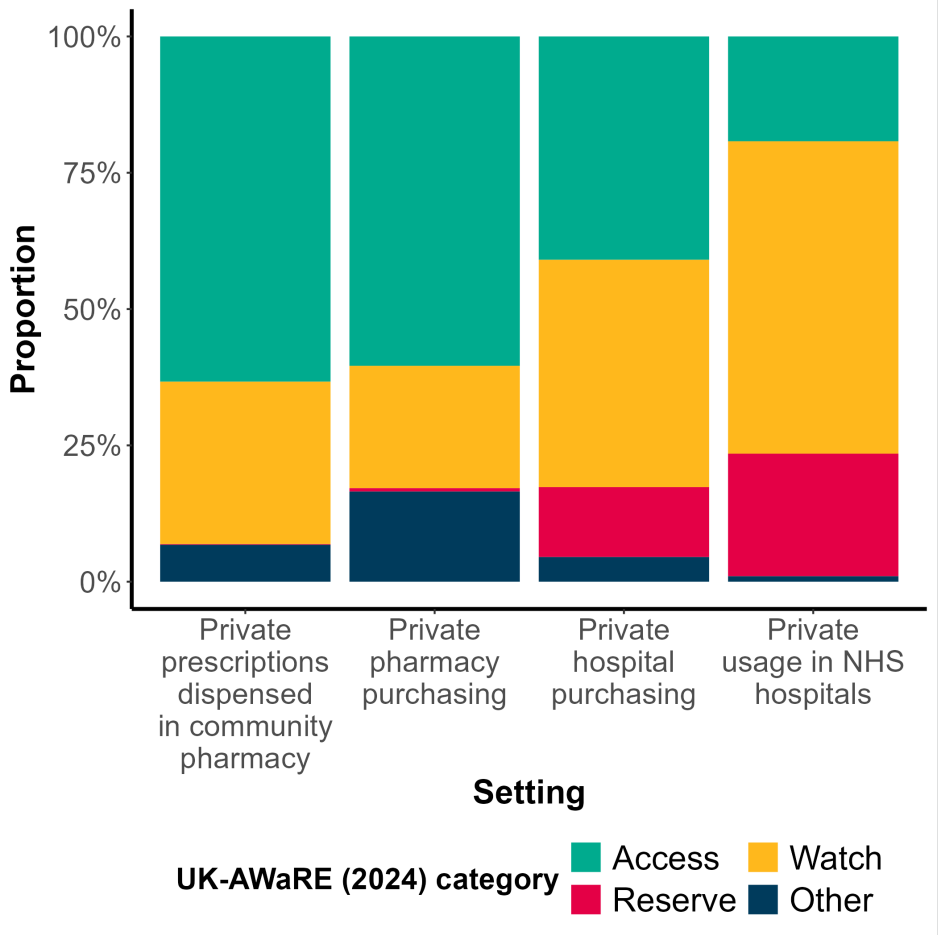
Use of antibiotics from the Access, Watch, Reserve and Other AWaRe categories varied between non-NHS routes. In 2024, the proportion of antibiotic use from the Access category was highest in primary care settings (private prescriptions dispensed in community pharmacy: 63.3% Access; private pharmacies purchasing: 60.4% Access) (Box Figure 3.1.2). Whilst, in the secondary care settings, Watch antibiotics comprised the highest proportion of antibiotic use (private hospital purchasing: 41.7% Watch; private usage in NHS hospitals: 57.3% Watch). Reserve antibiotic use comprised the highest proportion of non-NHS use within NHS hospitals (22.5% Reserve).

Box Figure 3.1.1. Private (non-NHS) routes of antibiotics dispensed and purchased in England, by setting, 2019 to 2024, England, A. by primary and secondary care setting, B. all non-NHS routes



Note 1: including private prescriptions dispensed in community pharmacy and private pharmacy purchasing
Note 2: including private hospital purchasing and private usage in NHS hospitals

Box Figure 3.1.2. Proportion of AWaRe antibiotic use across private (non-NHS) routes in 2024 (2024 UK AWaRe classification)



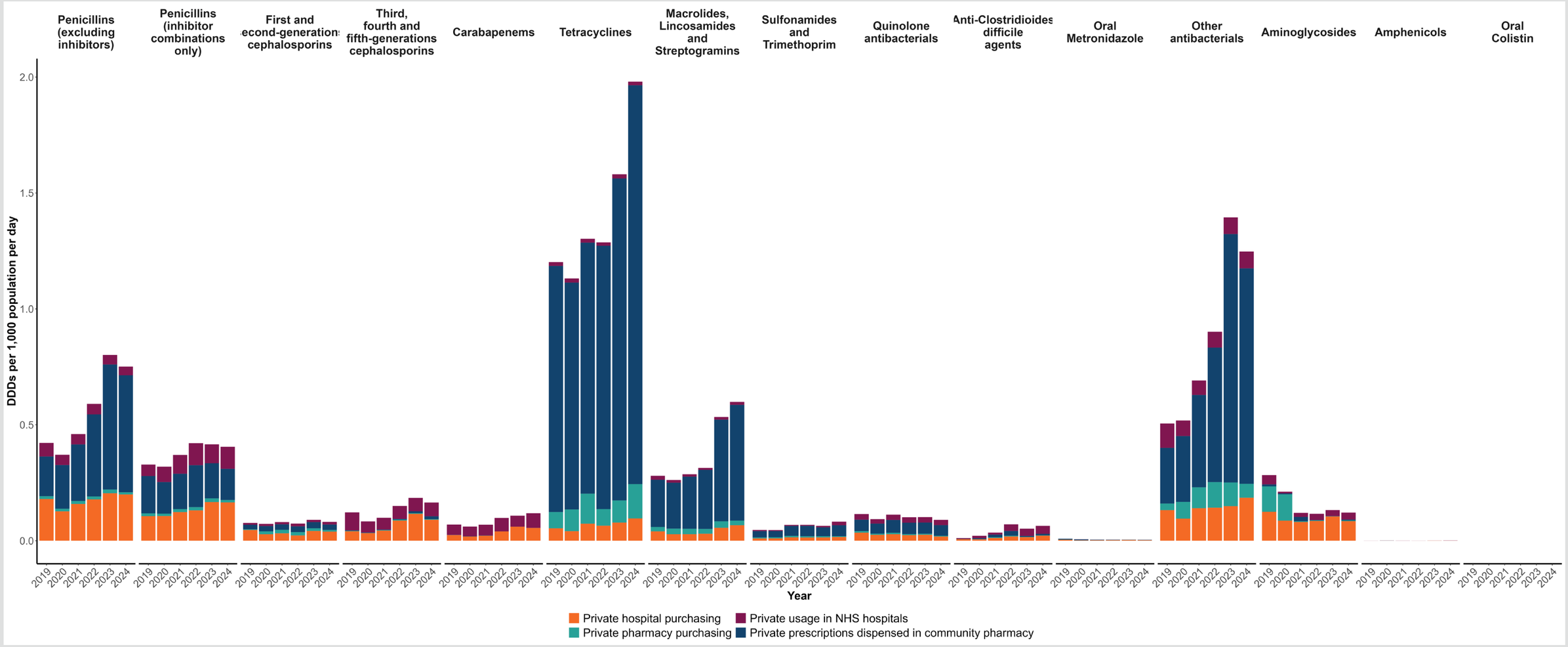
In 2024, tetracyclines (1.98 DID) were the most frequently used antibiotic group across the combined non-NHS routes (primarily driven by private prescriptions dispensed in community pharmacy; Box Figure 3.1.3), followed by 'other antibiotics' (1.25 DID) and penicillins (1.16 DID, combined penicillins and beta-lactam and beta-lactamase-inhibitor combinations) (Box Figure 3.1.3). Within the tetracycline class, doxycycline accounted for 1.43 DID (72.1% of tetracycline use). Overall, doxycycline was the most frequently used antibiotic across all non-NHS routes, followed by nitrofurantoin (0.70 DID, in the 'other antibiotics' group discussed below) and lymecycline (0.50 DID; 25.3% of tetracycline use). This differs markedly from NHS prescribing patterns, where penicillins (excluding beta-lactam/beta-lactamase-inhibitor combinations) are the most frequently used. The higher tetracycline use via non-NHS routes may reflect differences in case mix, including management of chronic respiratory conditions, dermatological conditions such as acne, or tick-borne infections, which are more commonly treated in independent outpatient care.

Within the 'other antibiotics' group, use was predominantly nitrofurantoin (0.70 DID) and methenamine (0.36 DID), reflecting the trends observed in NHS settings. Use of methenamine in non-NHS routes increased by 312% from 2019 to 2024 (+0.27 DID), while quinolone use has

decreased gradually over the same period (-0.03 DID, -22%), consistent with NHS declines following MHRA safety alerts (Box 3.2).

Box Figure 3.1.3 also shows notable levels of aminoglycoside within private pharmacy purchasing in 2019 and 2020, although aminoglycosides are usually used primarily in NHS inpatient settings. This may reflect differences in patient populations and case-mix, prescribing practices, and that purchasing data captures stock supply rather than direct patient use.

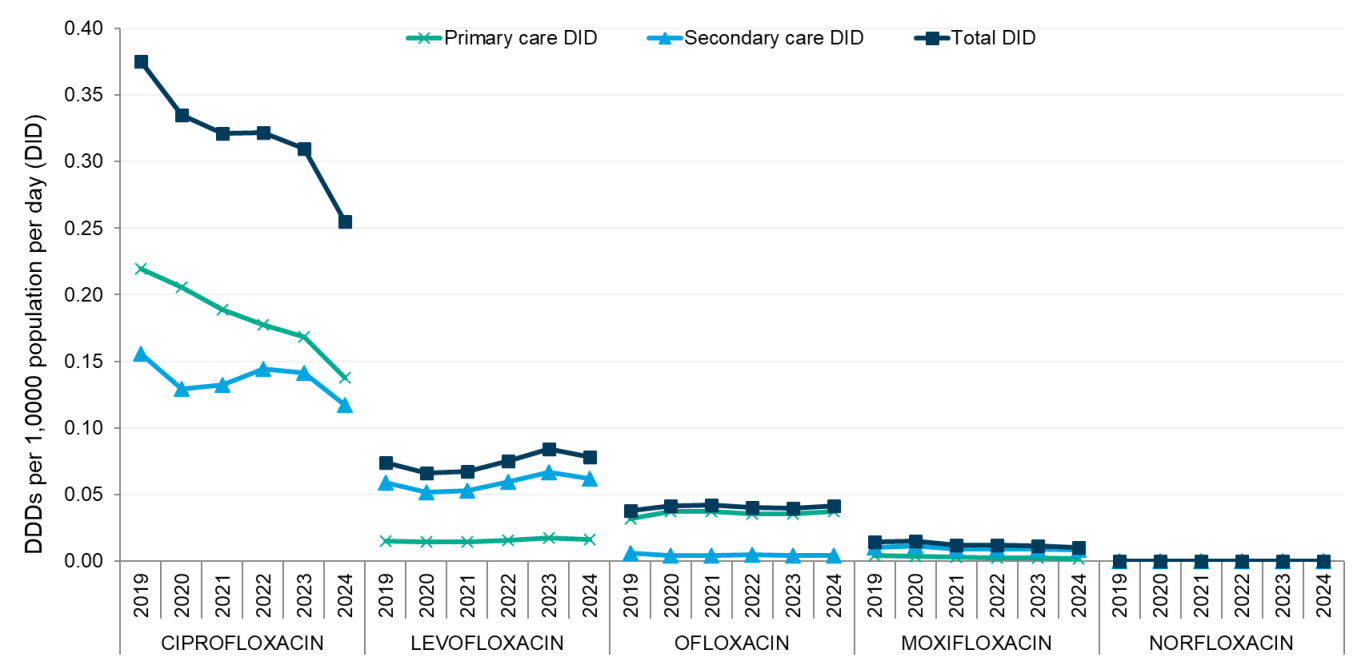
Box Figure 3.1.3. Antibiotic use in private (non-NHS) routes by antibiotic group and setting, 2019 to 2024, England



Box 3.2. MHRA guidance impact on fluoroquinolone use

In October 2018, the European Medicines Agency reviewed fluoroquinolone safety following rare reports of serious, long-lasting side effects (78). In response, the UK Medicines and Healthcare products Regulatory Agency (MHRA) issued a safety update in March 2019 restricting fluoroquinolone use, particularly, those most commonly used: ciprofloxacin, levofloxacin, moxifloxacin and ofloxacin (79).The MHRA reiterated concerns in a 2023 alert, with further prescribing restrictions introduced in January 2024 (80), emphasising that fluoroquinolones should only be used when alternative antibiotics were deemed inappropriate (11). (Further information on the response to the MHRA alert can be found in Chapter 5.) As a result, fluoroquinolone usage has continued to decline (Box Figure 3.2.1) and is expected to decrease further, although the pace of reduction may slow due to limited suitable alternative antibiotics for certain clinical indications.

Box Figure 3.2.1. Total, primary and secondary care consumption of fluoroquinolones, expressed as DDDs per 1,000 population per day in England



Box Figure 3.2.1. illustrates trends in fluoroquinolone use from 2019 to 2024, following the review of fluoroquinolone safety, ordered by decreasing frequency of use. Ciprofloxacin, the most commonly used fluoroquinolone, showed a 32% decrease in overall consumption over the 6-year period (from 0.375 to 0.255 DID); with reductions of 37.3% in primary care (0.219 to 0.138 DID) and 24.5% in secondary care (0.156 to 0.117 DID). A marked decline occurred between 2023 and 2024, with total usage decreasing by 17.7% (primary care: −19.3%, secondary care: −16.9%).

Between 2023 and 2024, usage declined for all fluoroquinolones across both primary and secondary care, with the exception of ofloxacin in primary care (+4.5% (0.36 to 0.37 DID)

(Box Figure 3.2.1). Despite overall reductions in fluoroquinolone use from 2019 to 2024, levofloxacin usage increased in both primary care (+8.0%; from 0.015 to 0.016 DID) and secondary care (+4.7%; from 0.059 to 0.062 DID), while ofloxacin use in primary care also rose (+16.4%; from 0.032 to 0.037 DID). These increases may indicate a continued reliance on fluoroquinolones for certain clinical indications. In particular, levofloxacin, which is prescribed more in secondary than primary care, likely due to its role in managing more severe infections, broader spectrum of activity, and its availability in intravenous formulation.

Box 3.3. Antibiotic use following the roll out of RSV vaccination

The NHS initiated its first national Respiratory Syncytial Virus (RSV) vaccination programme on the 1 September 2024. The rollout targeted 2 key population groups: pregnant women at 28 weeks gestation and beyond, and adults aged 75 to 79. Maternal vaccination aims to protect infants via transferred antibodies, providing approximately 70% protection against severe RSV infection in the first 6 months of life (81).

Early evidence of impact from Scotland, which began rollout in August 2024, indicates the programme's effectiveness with a 62% reduction in RSV-related hospitalisations among older adults during the 2024 to 2025 winter, alongside inclining uptake rates in both older adults and pregnant women (82).

Modelling studies suggest that RSV vaccination may indirectly reduce inappropriate antibiotic prescribing by preventing viral lower respiratory tract infections that are often treated empirically with antibiotics (83-85). However, given the timing of programme implementation, a measurable reduction in antibiotic prescribing is not anticipated within the data presented in this year's ESPAUR report. Surveillance of primary care antibiotic consumption for 2025, will include stratification by age and season, to enable assessment of changes in prescribing potentially attributable to RSV vaccine uptake. Data from 2024 and earlier will serve as baseline comparators.

Box 3.4. Antibiotic prescribing and *C. difficile* infection (CDI)

The below is a summary of a paper submitted for publication (Qureshi and Amin-Chowdhury, et al, 2025).

Rimsha Qureshi, Zahin Amin-Chowdhury, Andrea Mazzella, Christopher R Bell, Sobia Wasti, Charlotte Stevens, et al. Climbing incidence of *Clostridioides difficile* post-COVID-19 pandemic: a descriptive surveillance study, England, 2011 to 2024; Unpublished manuscript submitted for publication.

CDI is a leading cause of healthcare-associated infection in England, causing illness ranging from mild diarrhoea to severe, life-threatening colitis and sepsis (86). CDI also places a

substantial economic burden on the healthcare system, with prolonged inpatient stays and average treatment costs to the NHS exceeding £30,000 per patient (87).

CDI cases in England peaked in the early 2000s, exceeding 100 cases per 100,000 population. Following national initiatives aimed at reducing infection rates, hospital-onset cases declined by 85% between 2007 to 2008 Q1 to 2013 to 2014 Q1, averaging 10.6 cases per 100,000 population in 2013 to 2014 (88). However, since the COVID-19 pandemic, CDI incidence is on an incline(+33% between financial year 2020 to 2021 and 2023 to 2024), with the underlying cause remaining largely unknown (89).

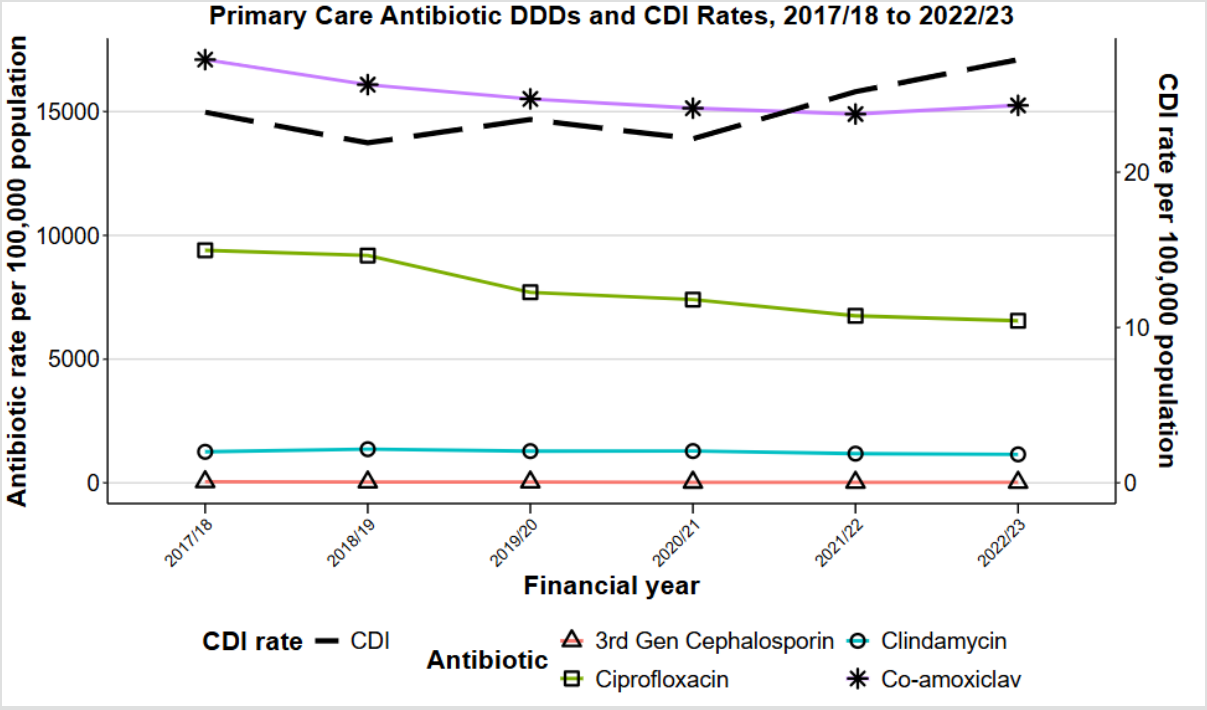
Established risk factors for CDI include the circulation of highly virulent and transmissible ribotypes, such as ribotype 027, and exposure to certain high-risk antibiotics that disrupt the gut microbiome (89, 90). The antibiotics most commonly associated with CDI, often referred to as the ‘4 Cs’, are: ciprofloxacin (and other fluoroquinolones), co-amoxiclav, clindamycin, and (third-generation) cephalosporins (91).

Since 2019, use of 4C antibiotics in primary care has declined, contrary to the increasing CDI rates (Box Figure 3.4.1). A slight increase in co-amoxiclav prescribing (+2.4%) was observed since financial year 2021 to 2022, although remaining considerably lower than pre COVID-19 levels.

Within secondary care, ciprofloxacin, third-generation cephalosporin and clindamycin use has remained stable (Box Figure 3.4.2). Co-amoxiclav use declined in financial year 2020 to 2021, coinciding with the COVID-19 pandemic, but has since increased to pre-pandemic levels (18,225.05 DDDs per 100,000 inhabitants). The increasing trend in secondary care co-amoxiclav prescribing parallel the increasing trend in CDI incidence.

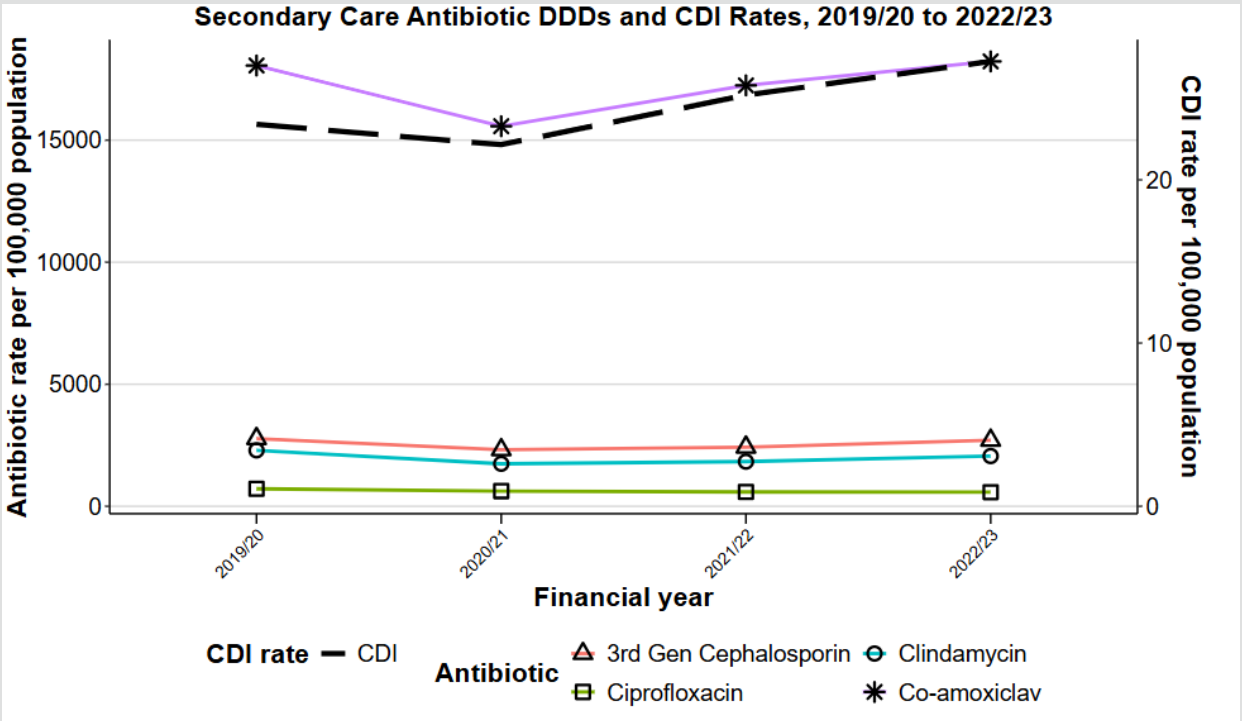
Ongoing research using patient-level data aims to clarify the relationship between antibiotic exposure and subsequent CDI incidence.

Box Figure 3.4.1. Primary care antibiotic prescribing by antibiotic, expressed as DDDs per 100,000 inhabitants, and CDI incidence, expressed per 100,000 inhabitants [note 1]



[Note 1] Figure has been replicated from unpublished data: Qureshi and Amin-Chowdhury and others, 2025.

Box Figure 3.4.2. Secondary care antibiotic prescribing by antibiotic, expressed as DDDs per 100,000 inhabitants, and CDI incidence, expressed per 100,000 inhabitants [note 1]



[Note 1] Figure has been replicated from unpublished data: Qureshi and Amin-Chowdhury and others, 2025.

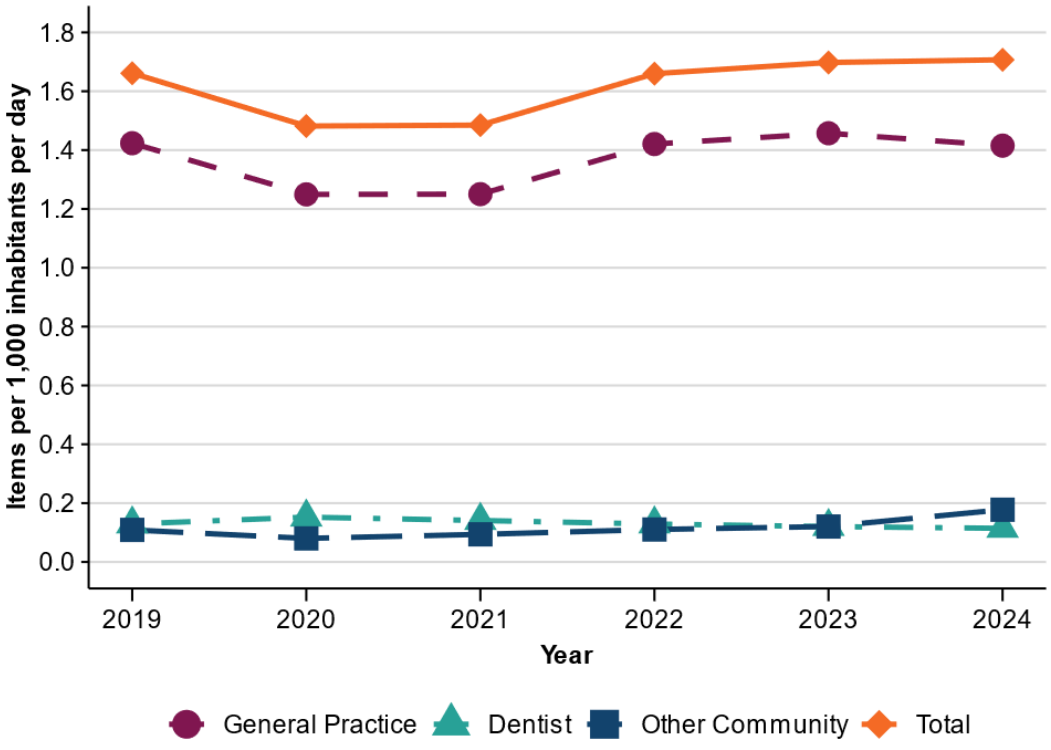
Antibiotic use in primary care (items by population)

Total antibiotic use in primary care

In 2024, primary care accounted for 79.6% of all antibiotics prescribed. Overall antibiotic use increased slightly by 1.6% (1.68 to 1.71 items per 1,000 inhabitants per day) from 2023. However, since the COVID-19 related decline in 2020, antibiotic use has risen by 15.2% (1.48 items per 1,000 inhabitants per day in 2020). Primary care antibiotic use in 2024 exceeded pre-pandemic levels (+3.1%, from 2019 1.66 items per 1,000 inhabitants per day) (Figure 3.6), emphasising the continued importance of antimicrobial stewardship. When expressed as items per 1,000 inhabitants per day, primary care antibiotic consumption in 2024 showed a slight increase compared with 2019. This trend contrasts with the decrease observed when measured in DID, suggesting a shift toward smaller average quantities per prescription (as noted in the total antibiotic consumption section). One contributing factor could be increased prescribing of lymecycline, identified above as one of the most commonly used antibiotics in primary care. Lymecycline is typically prescribed as a once-daily capsule over extended durations, resulting in a higher number of prescription items but a relatively low DDD total.

Within primary care, the slight increase in antibiotic use from 2023 to 2024 was mainly related to higher use in the Other community setting, which increased from 0.12 to 0.18 items per 1,000 inhabitants per day. Antibiotic use in Other community settings in 2024 exceeded 2019 levels (0.11 items per 1,000 inhabitants per day). In contrast, dental and general practice settings saw reduced use compared to 2019 (0.13 to 0.11, and 1.42 to 1.42 items per 1,000 inhabitants per day, respectively).

Figure 3.6. Total antibiotic consumption in primary care, including trends of settings within, expressed as items per 1,000 inhabitants per day, England, 2019 to 2024



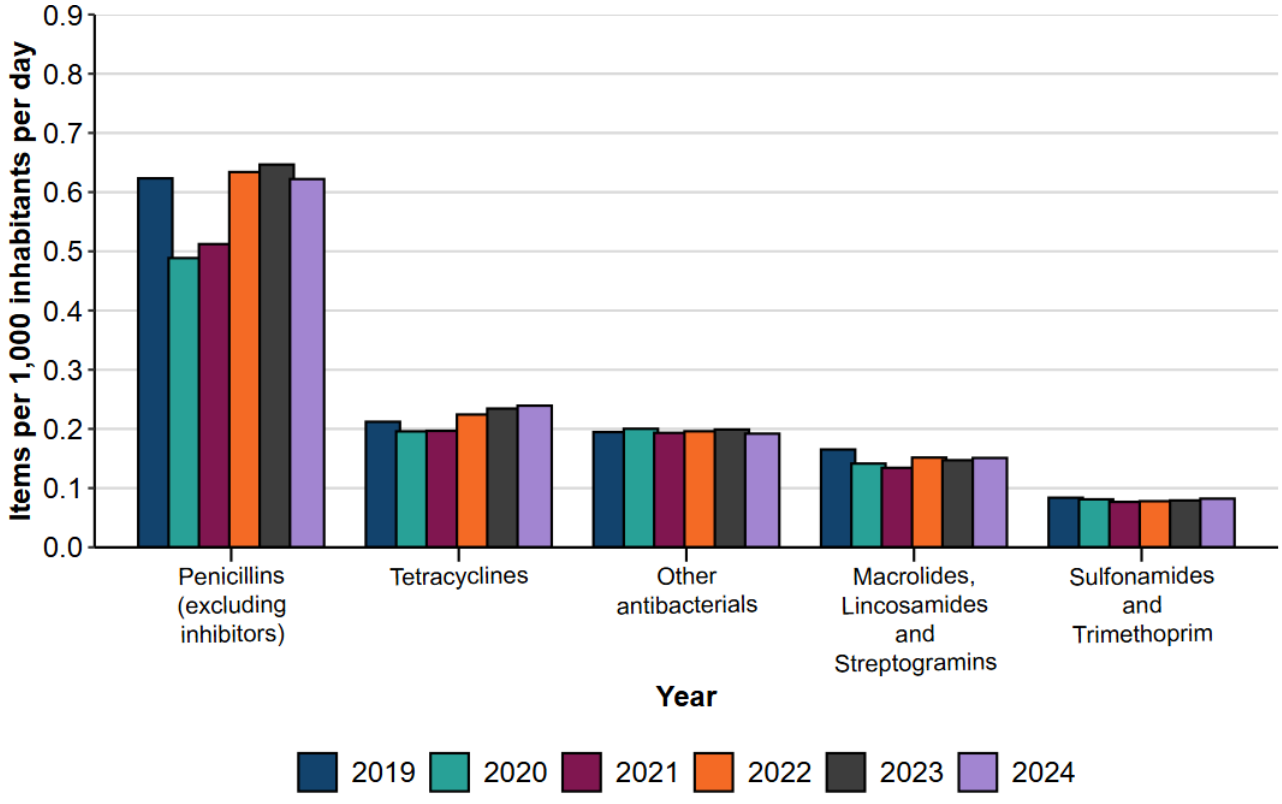
General practice (GP) use

Following the marked decrease in GP prescribing between 2019 and 2020, prescribing subsequently increased from 1.25 to 1.42 items per 1,000 inhabitants per day between 2021 and 2024 (+13.3%). Since 2022, GP prescribing slightly decreased by 1.9% between 2023 and 2024 (1.44 to 1.415 items per 1,000 inhabitants per day), bringing the rate marginally below pre-pandemic levels by −0.6% (1.423 items per 1,000 inhabitants per day) (Figure 3.6).

Penicillins (excluding beta-lactam/beta-lactamase inhibitor combinations) remain the most commonly used antibiotic group (Figure 3.7) within the GP setting, accounting for 44% of all antibiotic consumption within this setting in 2024, followed by tetracyclines (16.9%), other antibacterials (13.6%), and 'macrolides, lincosamides and streptogramins' (10.7%).

Following a marked decline in penicillin (excluding beta-lactam/beta-lactamase inhibitor combinations) use between 2019 and 2020 (−21.6%, the largest drop among all antibiotic groups), consumption rebounded, showing the greatest increase between 2020 and 2023 (32.3%). Since 2022, prescribing levels have surpassed those of 2019, with the substantial increase in use during 2022 likely related to the unusual increase in circulating GAS. However, in 2024, penicillin (excluding beta-lactam/beta-lactamase inhibitor combinations) use declined for the first time since the pandemic, decreasing by 3.8% compared to 2023 (from 0.647 to 0.622 items per 1,000 inhabitants per day) and by 0.2% compared with 2019 (0.623 items per 1,000 inhabitants per day).

Figure 3.7. Most commonly used antibiotics in the GP setting, expressed as items per 1,000 inhabitants per day, England, 2019 to 2024



The COVID-19 pandemic resulted in a large reduction in antibiotic use across all ages between 2019 and 2020. This was most evident in children aged 0 to 4 years and 5 to 14 years; −39.8% (from 1.61 to 0.97 items per 1,000 inhabitants per day) and −25.2% (0.79 to 0.59 items per 1,000 inhabitants per day), respectively (Figure 3.8a). This was followed by a post-pandemic increase in antibiotic consumption for paediatric age categories (<14 years) from 2020 through to 2024, with a sharp increase in 2022 across all age groups, but particularly in paediatric patients, likely attributable to the surge in group A *Streptococcus* (GAS) in 2022 to 2023.

In 2024, most age groups saw a slight decrease in the rate of consumption compared with 2023, apart from children aged 5 to 14 years and adults 75 years and over (+0.7% from 0.878 to 0.884 items per 1,000 inhabitants per day, and +2.6% from 3.40 to 3.49 items per 1,000 inhabitants per day, respectively).

When compared with 2019, rates of antibiotic consumption in 2024 were lower across all age groups, except in the paediatric age categories (0 to 4 and 5 to 14 years). A more in-depth look at the paediatric age groups (<14 years) shows that the sharp increase in antibiotic use following the easing of pandemic restrictions and the 2022 to 2023 Group A streptococcal surge has persisted (Figure 3.8a). Among children aged 0 to 4 years, antibiotic use rose by 17.0%, from 1.41 to 1.65 items per 1,000 inhabitants per day; while in those aged 5 to 14 years, it increased by 25.2%, from 0.71 to 0.88 items per 1,000 inhabitants per day. These age groups also accounted for a larger proportion of total antibiotic use in 2024 compared with 2019 (0 to 4 years: 5.6% to 6.1%; 5 to 14 years: 5.9% to 7.4%), indicating an increase in absolute prescribing and relative to overall use (Figure 3.8b). This sustained rise among younger age groups may reflect more cautious prescribing practices since the pandemic, and the resulting large GAS upsurge, or increased circulation of viral infections for which antimicrobials are prescribed. Further research, particularly into changes in clinical indications and consultation rates, would help clarify the underlying causes of this higher antibiotic prescribing in children.

Antibiotic use in 2024 remained above the 2022 surge for 5 to 14, 64 to 74, and 75 years and over. As with previous years, the rate of antibiotic use was highest amongst the oldest age groups in 2024 (2.16 and 3.49 items per 1,000 inhabitants per day in those aged 65 to 74 years and 75 years and above, respectively) (Figure 3.8a). Given the consistently high rates of antibiotic use among older adults, a focused section on this population is planned for next year's report chapter.

General practice antibiotic use by paediatric age groups

This section examines the use of the most frequently used antibiotics among paediatric age groups in response to the call to 'close the gap' in the evidence base for this specific population (92).

As shown in Figure 3.9, in 2024, the most commonly prescribed antibiotic group for children in general practice was penicillins (excluding beta-lactamase inhibitor combinations), followed by 'macrolides, lincosamides and streptogramins' (4.10 and 0.62 items per inhabitants per day, respectively, for children aged 0 to 17 years). Together, these 2 classes accounted for 89.8% of

total antibiotic use in children aged 0 to 9 years (79.7% and 10.2%, respectively), consistent with the likelihood that most antibiotic prescriptions in this age group are intended for respiratory infections (93). Tetracyclines were the third most frequently prescribed antibiotic group in paediatric general practice (5.6%). They are indicated for the treatment of acne (94), as well as respiratory infections and certain sexually transmitted infections (95). The National Institute for Health and Care Excellence (NICE) guidance advises against use of tetracyclines for children under 12 years old (96), hence, high rates of tetracycline use were observed in adolescents aged 15 to 17 years, followed by those aged 10 to 14 years (Figure 3.9) (96). The fourth most commonly used antibiotic group, 'Sulfonamides and trimethoprim', represented 6.1% of total antibiotic use in the paediatric age group 0 to 9, and 5.1% in those aged 0 to 17. Sulfonamides and trimethoprim antibiotics are commonly used for the treatment of UTIs in young children (27). Penicillins (with beta-lactamase inhibitors) accounted for a relatively small proportion of antibiotic use in paediatric age groups, ranging from 1.7% (0.018 items per 1,000 inhabitants per day in infants under one year) to 2.3% (0.019 items per 1,000 inhabitants per day in children aged 10 to 14 years).

The proportion of total antibiotic consumption comprising Access antibiotics within the 0 to 14 years was higher than that observed in the 15 to 17 year old population (In 2024, 0 to 14 years: 86.6% and 15 to 17 years: 68.4%). The relative proportion of Access antibiotic use in the youngest age groups was notably higher, decreasing with increasing age group (90.4% in infants under one year; 86.6% in one to 4 year olds; 85.5% in 5 to 9 year olds, and 79.9% in 10 to 14 year olds).

Figure 3.8. a) items per 1,000 inhabitants per day, and b) percentage of items, in general practices by age group, England, 2019 to 2024

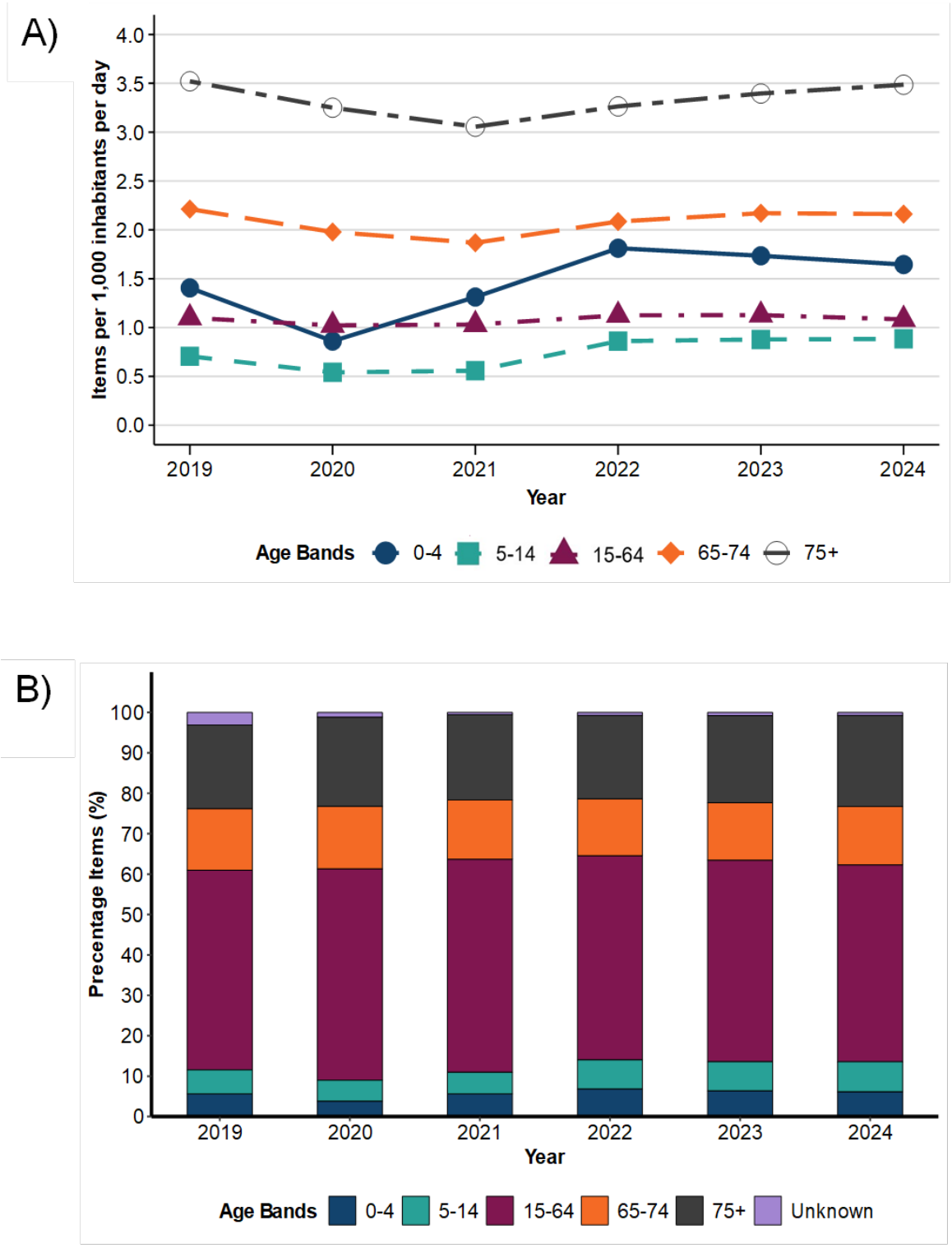
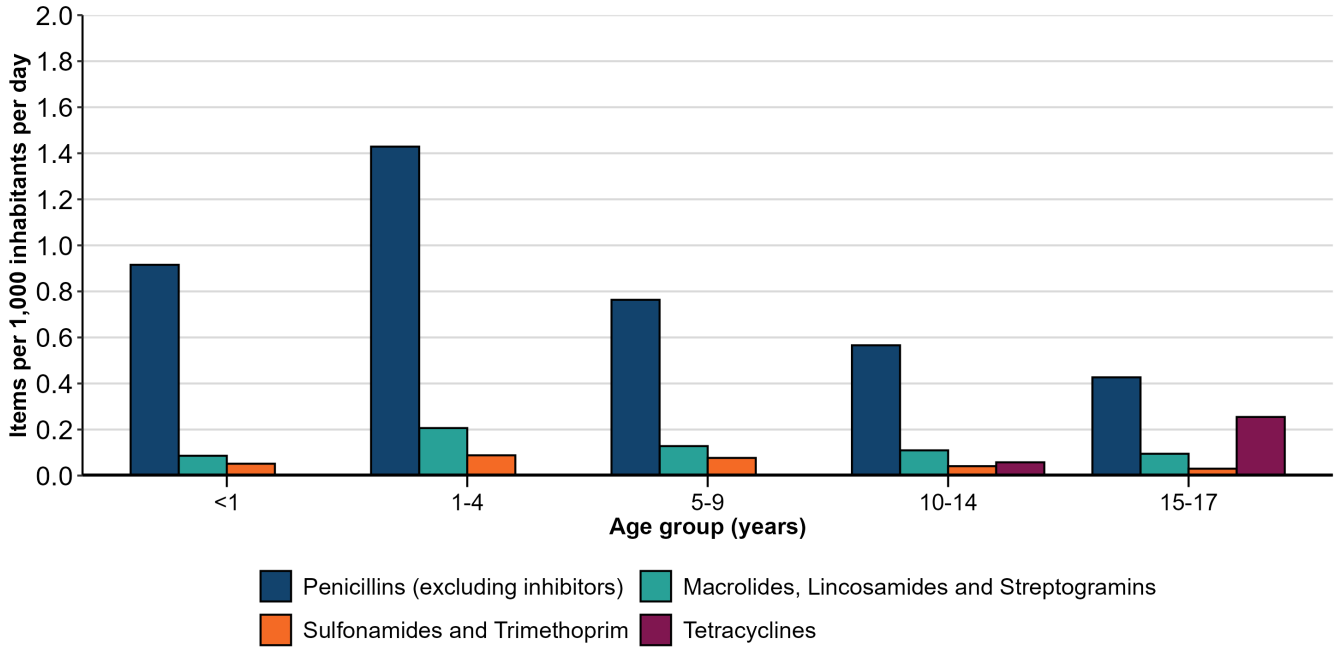


Figure 3.9. Rate of top 4 most used antibiotic groups in general practice setting by paediatric age groups, 2024



Other community use

Antibiotic consumption in ‘other community’ settings increased by 63.2% between 2019 (pre-pandemic) and 2024. Between 2023 and 2024 alone, there was a 49.1% increase in consumption (from 0.12 to 0.18 items per 1,000 inhabitants per day). Consumption in this setting surpassed 2019 levels (0.109 items per 1,000 inhabitants per day) since 2022 (0.11 items per 1,000 inhabitants per day), and has remained above since. The rise in antibiotic use observed within the ‘other community’ setting is in part related to new data being captured following the introduction of the Pharmacy First service (Box 3.5). Increases seen, both in this setting and in general practice from 2022 onwards suggests increased healthcare demands, rather than changes in the provision of services alone.

In 2024, out-of-hours primary care centres accounted for 31.4% of antibiotic consumption in the ‘other community’ setting. Usage within out-of-hours primary care centres has shown a slight decline between 2023 to 2024 (−5.0%, from 0.059 to 0.056 items per 1,000 inhabitants per day). Meanwhile, other care settings such as walk-in centres (+1.2%, +0.001 items per 1,000 inhabitants per day) and community services (+4.1%, +0.003 items per 1,000 inhabitants per day) showed slight increases in antibiotic prescribing. While levels remain low in these categories, this could be indicative of a broader rise in community demand.

Previously, out-of-hours accounted for the largest proportion of antibiotic use in the ‘other community’ setting. However, with the introduction of Pharmacy First in 2024 (Box 3.5), this has changed. Pharmacy First now accounts for 34.5% (0.061 items per 1,000 inhabitants per day) of antibiotic consumption in the ‘other community’ setting. This marks a significant change in how antibiotics are accessed in the community, highlighting the early impact of the Pharmacy First service. The introduction and rise in antibiotic use through the Pharmacy First service likely reflects shifts in patient pathways from settings such as independent sector clinics, emergency

departments, and some walk-in centres. Some antibiotics provided through alternative supply routes, such as Patient Group Directions or direct sourcing from wholesalers, may not be fully captured in prescribing data. These factors, along with natural fluctuations in infection rates, should be considered when interpreting trends (see Box 3.5 for further detail on Pharmacy First).

Dental use

Dental settings were unique in showing an increased antibiotic use in 2020, following easing of COVID-19 restrictions. Since then, a downward trend has been observed, with antibiotic use decreasing by 25% between the 2020 peak to 2024 (from 0.15 to 0.11 items per 1,000 inhabitants per day). In 2023, the rate of antibiotic use within the dental setting fell below the 2019 rate for the first time since the COVID-19 pandemic (−7.8%) (97). This decline continued between 2023 and 2024, with a further 4% reduction (from 0.12 to 0.11 items per 1,000 inhabitants per day). Comparing pre-COVID 2019 to 2024, there was an 11.5% decrease (−0.015 items per 1,000 inhabitants per day). This downward trend may partly reflect changes in healthcare-seeking behaviour and a shift in antibiotic prescribing from the public to the independent dental sector, for which data is currently unavailable.

The most commonly used antibiotics in dental care in 2024 were amoxicillin (67.2%), metronidazole (27.4%), erythromycin (1.9%), and phenoxymethylpenicillin (1.7%). All showed a decline in use compared to 2023, except for phenoxymethylpenicillin, which increased by 15.3% (from 0.0016 to 0.0019 items per 1,000 inhabitants per day). Notably, phenoxymethylpenicillin use has been rising since 2021, continuing its upward trend from 0.0004 in 2020, to 0.0013 in 2021, and reaching 0.0019 items per 1,000 inhabitants per day in 2024. This increase in phenoxymethylpenicillin use in dental care reflects a positive stewardship outcome and suggests a change in prescribing practices, favouring narrower-spectrum antibiotics over amoxicillin. This trend aligns with published recommendations that emphasise the use of narrow-spectrum agents, with phenoxymethylpenicillin recommended as the first-line antibiotic for dento-alveolar infections (98, 99).

Box 3.5. Antibiotic prescribing under Pharmacy First service

Under the Government's NHS Primary Care Recovery Plan, NHS England (NHSE) commissioned the Pharmacy First service in 2023. From 31 January 2024, pharmacies participating in the Pharmacy First service can supply prescription-only medicines (including antimicrobials) for 7 common conditions: earache, uncomplicated UTIs in women, sore throat, sinusitis, impetigo, shingles, and infected insect bites, after consultation with a community pharmacist (antimicrobial-pathway combinations are described in Table 3.6.1).

In 2024, during the first 11 months following the introduction of the Pharmacy First service in February 2024, 1,286,114 antibiotic items were supplied under the Pharmacy First service. Since the launch and increased implementation, dispensing rates have shown a steady upward trend, peaking in December 2024 at 284 items per 100,000 population (Box Figure 3.5.1).

In 2024, for antimicrobials defined within the Pharmacy First service pathways, most primary care usage occurred in the GP setting (80.3%), compared with 5.4% under the Pharmacy First service. Across all ages, the most dispensed antimicrobials under the Pharmacy First service pathways were phenoxymethylpenicillin (37.0%; 475,578 items), nitrofurantoin (36.0%; 462,832 items), flucloxacillin (12.1%; 155,856 items), and amoxicillin (7.3%; 94,452 items). Among children aged one to 17 years), phenoxymethylpenicillin accounted for the highest proportion of Pharmacy First antimicrobial use (45.5%; 119,171 items), followed by amoxicillin (35.2%; 92,065 items), and flucloxacillin (9.2%; 24,186 items)

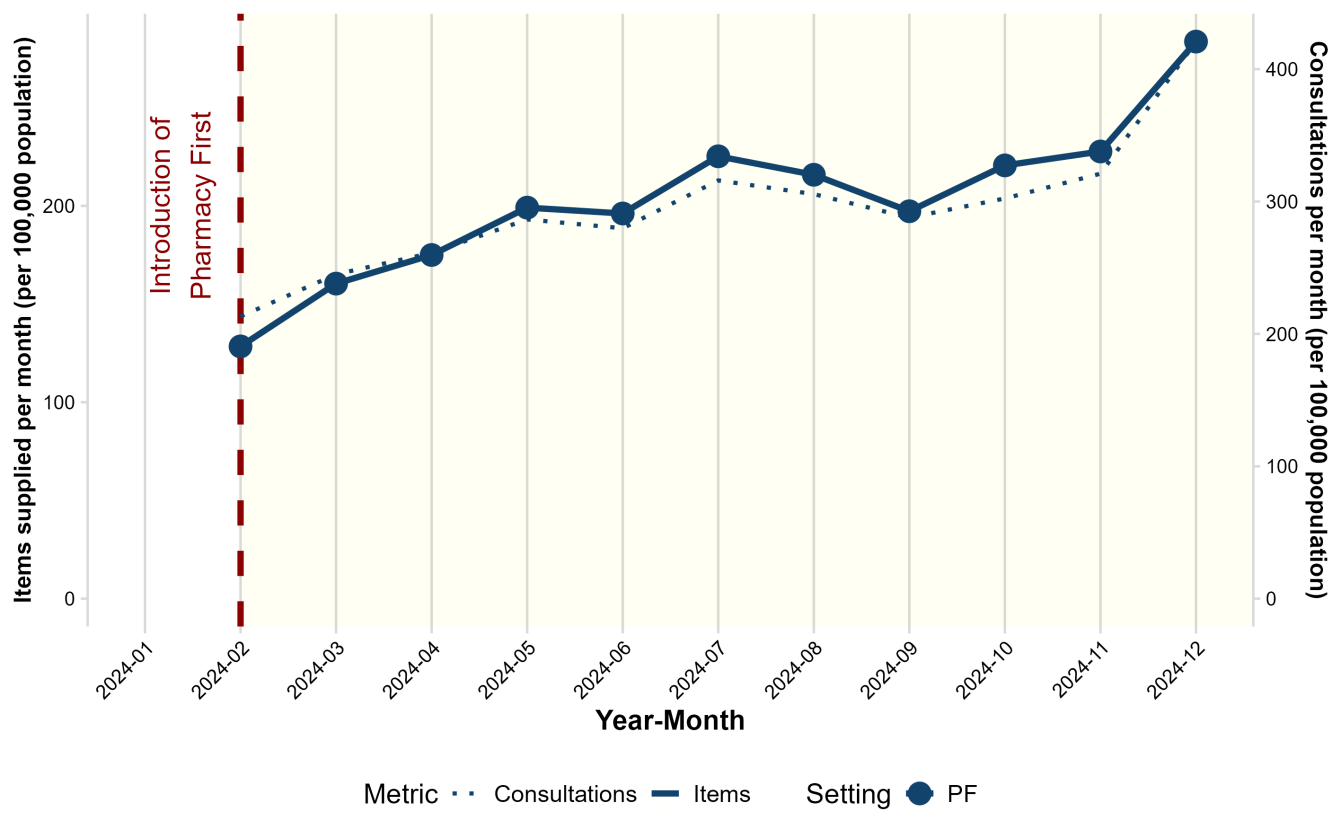
Box Table 3.5.1. Pharmacy First clinical pathways with their associated populations and antimicrobial recommendations

Clinical pathway	Population covered	Recommended antimicrobial									
		Nitrofurantoin	Aciclovir	Valaciclovir	Fusidic acid	Flucloxacillin	Clarithromycin	Erythromycin	Phenoxymethyl-penicillin	Amoxicillin	Doxycycline
Urinary tract infection	Women (16 to 64 years)	✓*									
Shingles	Adults (≥18 years)		✓*	✓							
Impetigo	Children (1 to 17 years) and adults (≥18 years)				✓*	✓*	✓	✓			
Infected insect bites	Children 1 to 17 years) and adults (≥18 years)					✓*	✓	✓			
Acute sore throat	Children (5 to 17 years) and adults (≥18 years)						✓	✓	✓*		
Acute sinusitis	Children (12 to 17 years) and adults (≥18 years)						✓	✓	✓*		✓
Acute otitis media	Children (1 to 17 years)						✓	✓		✓*	

* First-line treatment if no penicillin allergy, ineffective treatment, or other inclusion/exclusion criteria met

Note: Although not shown in the table, antibiotics are not recommended as the first-line management in some Pharmacy First pathways, including acute otitis media (AOM), impetigo, and acute sinusitis. For example, in children aged one to 17 years with AOM, analgesic or anaesthetic ear drops are recommended instead of antibiotics.

Box Figure 3.5.1. Total antimicrobial items supplied and consultations per 100,000 inhabitants per month under Pharmacy First (PF) clinical pathways in England, 2024 [note 1]



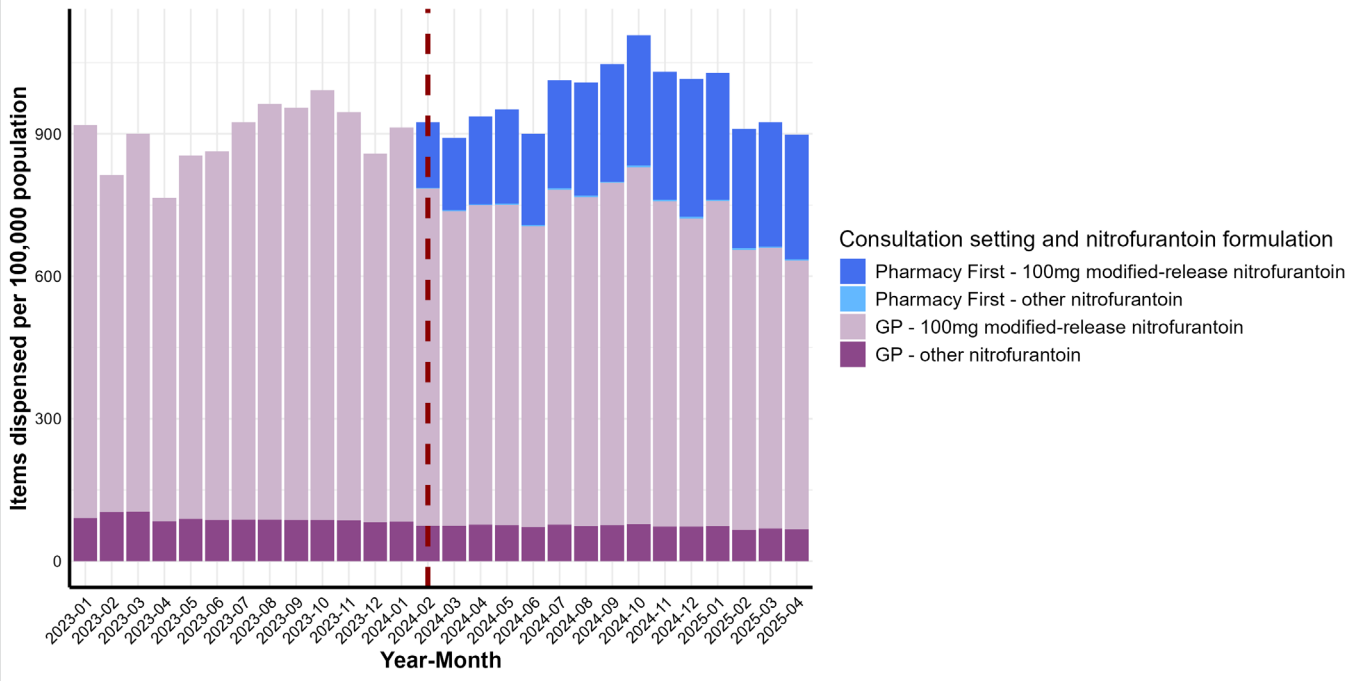
[Note 1] Total items dispensed for antibiotics covered by Pharmacy First clinical pathways have been included (nitrofurantoin, flucloxacillin, clarithromycin, erythromycin, phenoxymethylpenicillin, amoxicillin, doxycycline)

Nitrofurantoin is one of the most commonly supplied antimicrobials under Pharmacy First. Between February and December 2024, supply of 100mg modified-release nitrofurantoin to women aged 16 to 64 via Pharmacy First accounted for 22.4% of all nitrofurantoin supplied or dispensed to this demographic across Pharmacy First and GP settings (443,314 items; 219 items per 100,000 population per month). Whereas, 69.8% (1,389,057 items; 687 items per 100,000 population per month) was dispensed in GP settings (Box Figure 3.5.2)

Total nitrofurantoin consumption in this demographic across GP and Pharmacy First settings increased from 894 items per 100,000 population per month in the February to December 2023 to 984 items per 100,000 population per month in the February to December 2024 period, following the introduction of Pharmacy First. GP practice dispensing declined, for this demographic, for both 100mg modified-release nitrofurantoin (−14.6%, from 805 to 687 items per 100,000 population per month between 2023 and 2024) and other nitrofurantoin formulations (−16.5%, from 89 to 75 items per 100,000 population per month between 2023 and 2024).

The reduction in GP practice dispensing of nitrofurantoin, alongside increased supply through Pharmacy First indicates a shift in uncomplicated UTI management from GPs to community pharmacies. The overall rise in total nitrofurantoin use is potentially driven by improved treatment access, potential changes in infection rates, and increased public awareness of the new service.

Box Figure 3.5.2. Total nitrofurantoin supplied or dispensed per month in women aged 16 to 64 years by consultation setting (GP practice or Pharmacy First), England, 2023 to 2024

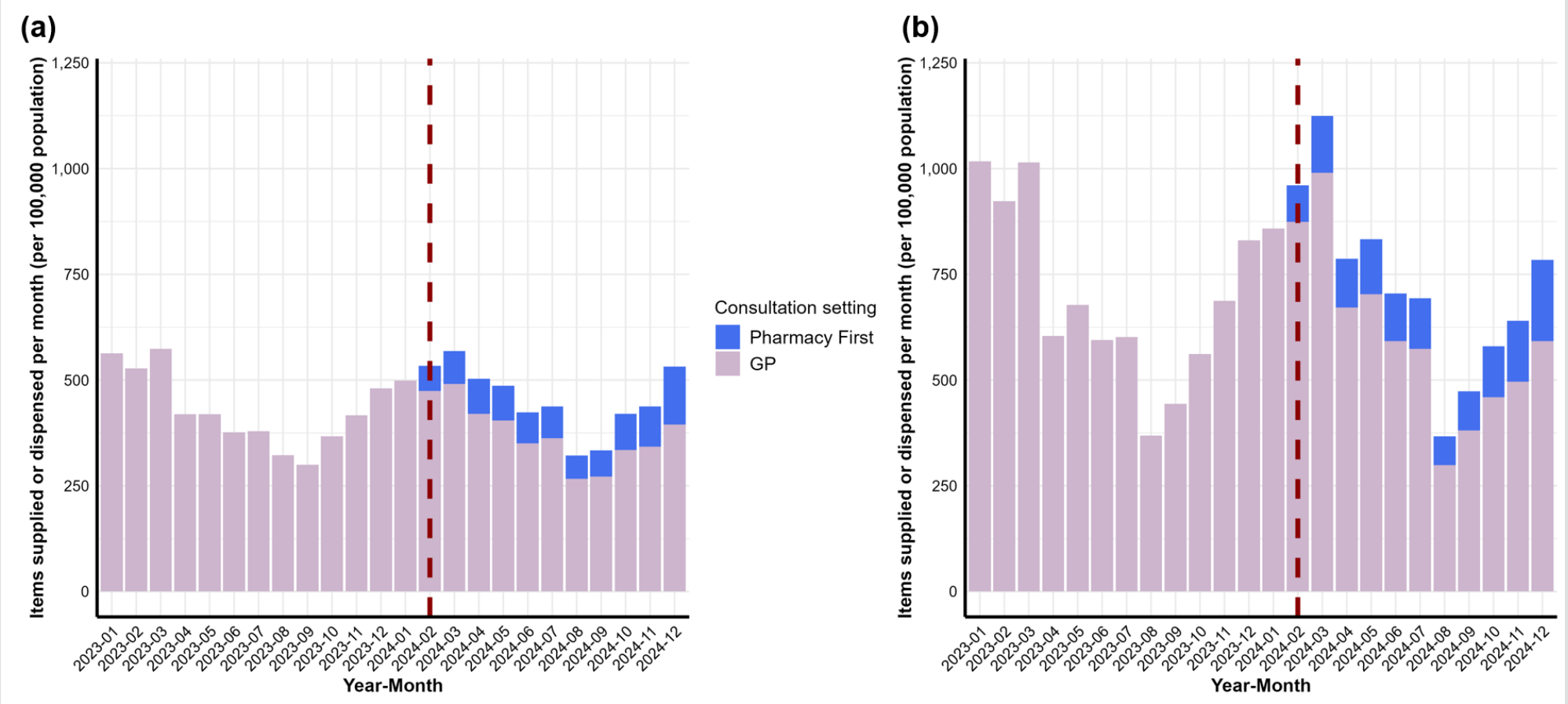


Note: 'Other nitrofurantoin' includes nitrofurantoin 50mg capsules, nitrofurantoin 100mg capsules, nitrofurantoin 25mg/5ml oral suspension sugar free, nitrofurantoin 50mg tablets, nitrofurantoin 100mg tablets, nitrofurantoin 25mg/5ml oral liquid, Furadantin 50mg tablets, nitrofurantoin 50mg/5ml oral liquid, nitrofurantoin 50mg/5ml oral suspension sugar free.

Phenoxymethylpenicillin is commonly supplied to children and young people under Pharmacy First. Between February and December 2024, supply of phenoxymethylpenicillin to those aged 5 to 17 years via Pharmacy First accounted for 16.5% of all phenoxymethylpenicillin supplied or dispensed to this demographic across Pharmacy First and GP practice settings (117,356 items; 119 items per 100,000 population per month), whereas 83.5% (*n* = 592,615 items; 603 items per 100,00 population per month) was dispensed in GP practices (Box Figure 3.5.3). Total phenoxymethylpenicillin consumption in this age group across GP practice and Pharmacy First settings increased from 664 items per 100,000 population per month in the February to December 2023 to 722 per 100,00 population per month in the same period of 2024. In contrast, total phenoxymethylpenicillin consumption in adults aged 18 years and over in GP practice and Pharmacy First settings increased from 417 per 100,000 population per month between February to December 2023 to 454 per 100,000 population per month in the same period of 2024.

While the increase in antibiotic supply through the Pharmacy First service is notable, it should be interpreted with caution and in the context of broader changes in how patients access care. The service follows established clinical protocols based on guidance from the NICE and diagnostic pathways developed by the UKHSA, supporting appropriate prescribing. The observed increase may reflect a shift in patient pathways from other settings — including independent sector medical services, emergency departments, and some walk-in or urgent treatment centres – rather than a simple increase in antibiotic demand. Although dispensing data is available for walk-in centres, supplies made under Patient Group Directions may not be fully captured, particularly where stock is sourced directly from hospitals, wholesalers, or over-labelling providers. Given these surveillance limitations, alongside seasonal and year-to-year variation in infection rates, it is important to present data from Pharmacy First alongside appropriate context and caveats.

Box Figure 3.5.3. Total phenoxymethylpenicillin supplied or dispensed per month in (a) adults (aged 18 years and over) and (b) children and young people (5 to 17 years old) by consultation setting (GP practice or Pharmacy First), England, 2023 to 2024



Box 3.6. Health equity: antibiotic consumption in primary care by level of deprivation

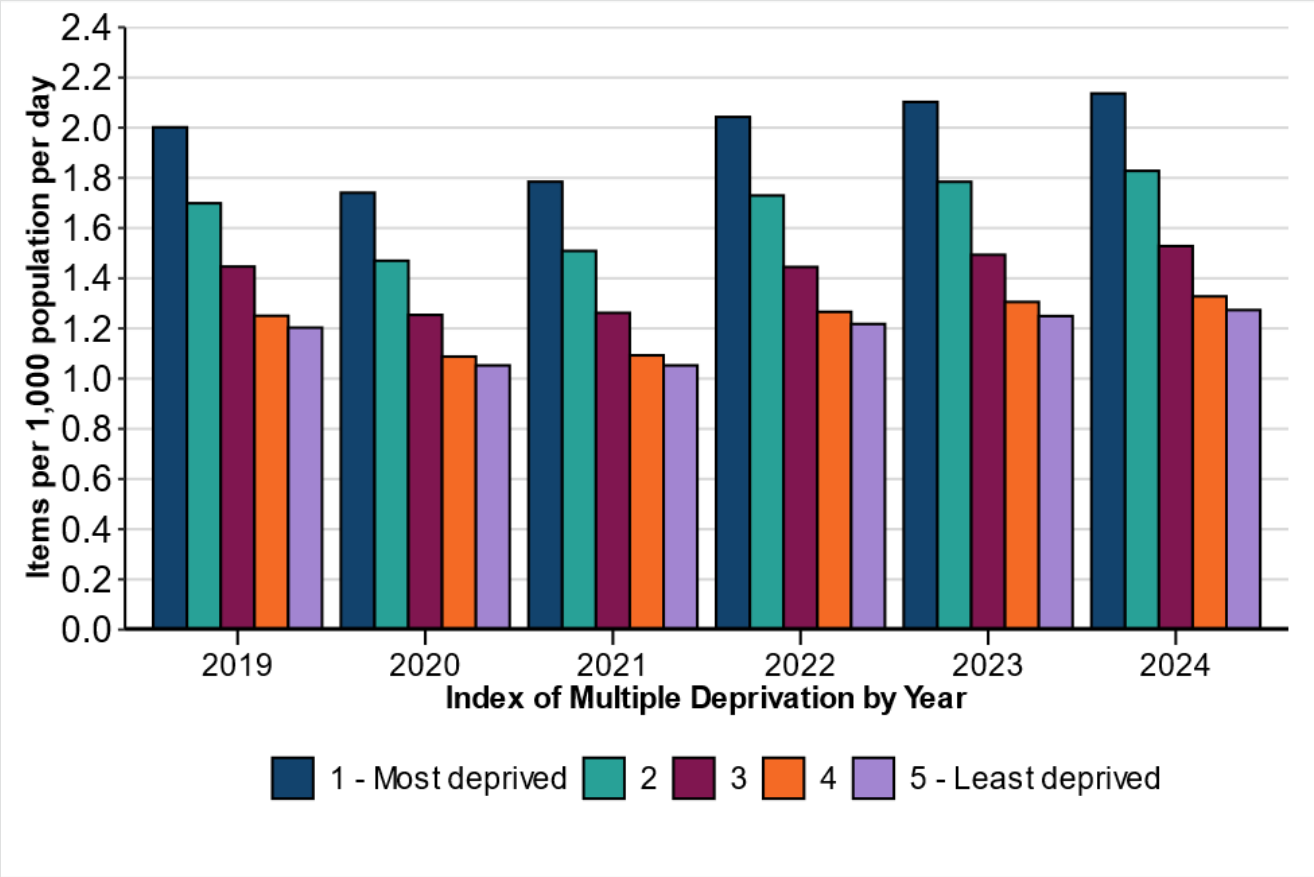
Index of Multiple Deprivation (IMD) is a measure of the relative level of deprivation calculated for each Lower-layer Super Output Area, or small areas, within England (100). Traditionally, this is presented as an index of deciles and here it has been aggregated to IMD quintiles, where IMD 1 represents primary care providers located in the 20% most deprived LSAO in England and IMD 5 the 20% least deprived. (Note: 2020 population denominator data has been used here as proxy for 2019 to 2024, as the most recent available population IMD data.)

Within the primary care setting, there is a positive association between increased level of deprivation and antibiotic usage (Box Figure 3.6.1). Antibiotic consumption in the most deprived quintile was 67.8% higher when compared to the least deprived quintile. From 2019 to 2024, antibiotic usage was increasing for every deprivation quintile, however the rate of increase was the greatest in the 2 most deprived quintiles (6.7% in IMD 1 and 7.6% in IMD 2) compared to the 2 least deprived (6.2% in IMD 4 and 5.8% in IMD 5).

In 2024, use of broad-spectrum antibiotic items per 1,000 population per day was also positively associated with increased deprivation, with the rate of usage in IMD 1 38% more for first-fourth generation cephalosporins, 25% more co-amoxiclav and 24% more quinolones when compared to the rates of usage in IMD 5. This finding is corroborated by findings in Scotland linking higher broad-spectrum antibiotic GP prescribing with increasing levels of deprivation(101). Whilst usage of quinolones decreased overall in primary care prescribing in England from 2019 to 2024, this reduction was not as pronounced for all deprivation groups, with those in IMD 1 using 24% more quinolones than IMD 5 in 2024, compared to just 18% more in 2019. The association between broad-spectrum antibiotic usage and deprivation is thought to be due to higher chance of complications from infections due to other co-morbidities or greater numbers of previous infections leading to more broad-spectrum prescribing (102).

The disparity in broad-spectrum use across quintiles has seen a slight improvement between 2019 and 2023, the increasing rate of total antibiotic use, and increasing proportion of broad-spectrum use across IMD quintiles in primary care demonstrates the ongoing need to address health equity issues.

Box Figure 3.6.1. Total antibiotic use (items per 1,000 individuals per day) in primary care by Index of Multiple Deprivation (IMD) quintile



Box 3.7. Increasing use of methenamine

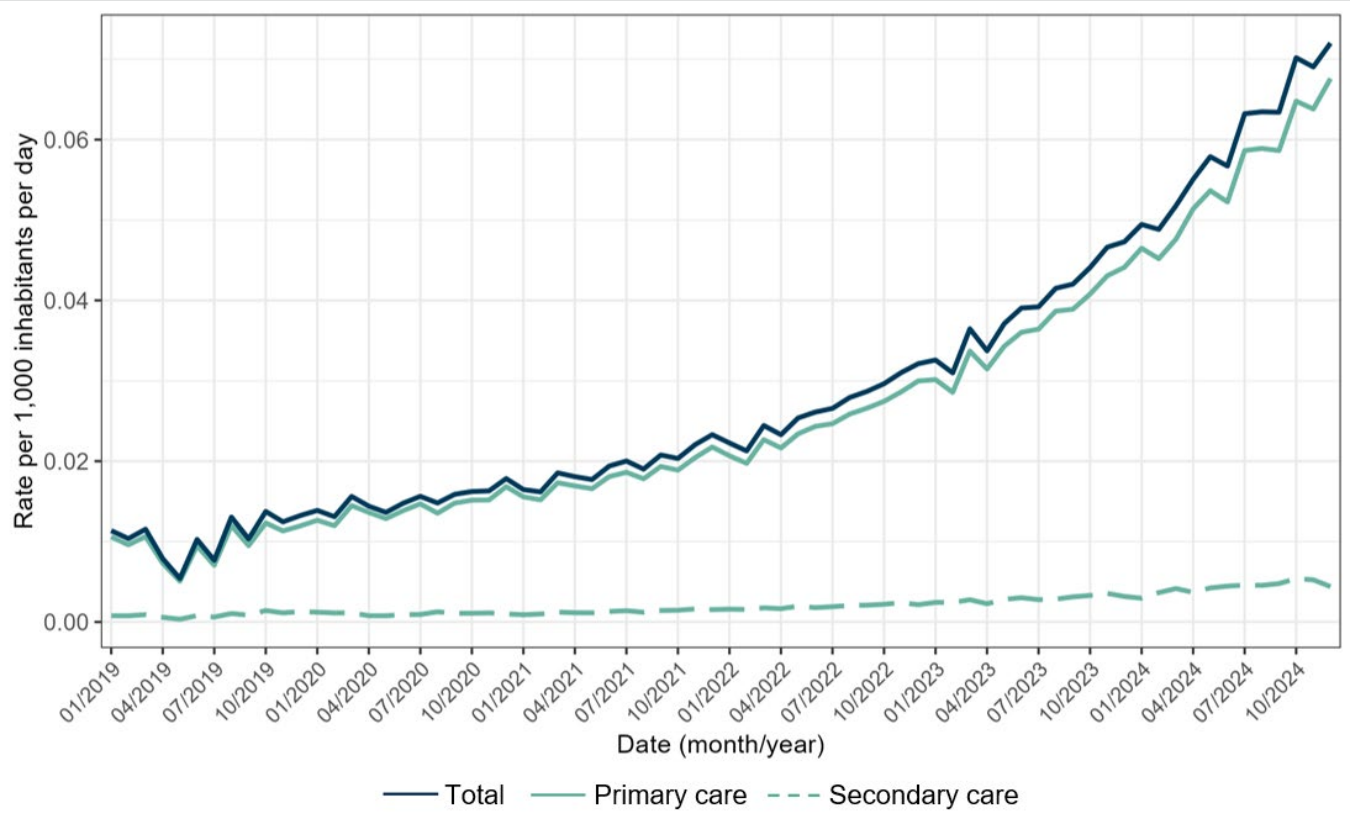
Urinary tract infections (UTIs) are a leading source of life-threatening *E. coli* bloodstream infections and significantly contribute to the burden of AMR in England (see AMR in urine isolates for further details). Over half a million women experience recurrent UTIs, with 1.8 million hospital admissions involving UTIs reported between FY 2018 to 2019 and 2022 to 2023). Methenamine hippurate is a licensed urinary antiseptic for UTI prophylaxis, with growing evidence supporting use in long-term UTI prophylaxis (103). In England, with similar trends seen internationally, methenamine hippurate use has increased rapidly across primary and secondary care, from 0.13 in 2019 to 0.72 DID in 2024 (+82%) (Box Figure 3.7.1) (103 to 105).

It is expected that use of methenamine will increase further following the recent update to national guidance, particularly in primary care, where most UTI management occurs(63). This increase is likely to result in methenamine replacing low-dose, long term prophylactic use of nitrofurantoin and trimethoprim. Future work is planned to evaluate antibiotic use for long term UTI prophylaxis and methenamine's impact on UTI prescribing trends.

Methenamine hippurate is classified within the 'Other' category in the UK adapted AWaRe classification (52). As a WHO ATC Index 'J01' antimicrobial, methanamine has historically been

included in both the total antibiotic consumption rate calculations, and the denominator for proportion Access calculations for the UK AMR. Long term prophylactic treatment courses and 28-day prescriptions will reflect proportionally higher usage measured in DDDs. UKHSA are continuing work with the antimicrobial surveillance teams from the 4 Devolved Administrations of the UK to monitor the use of methenamine in line with the antimicrobial consumption targets of the UK AMR NAP 2024 to 2029 (50).

Box Figure 3.7.1. Methenamine hippurate use in primary and secondary care, DDDs per 1,000 inhabitants per day, January 2019 to December 2024, England



Antibiotic use in secondary care (DDDs by admissions)

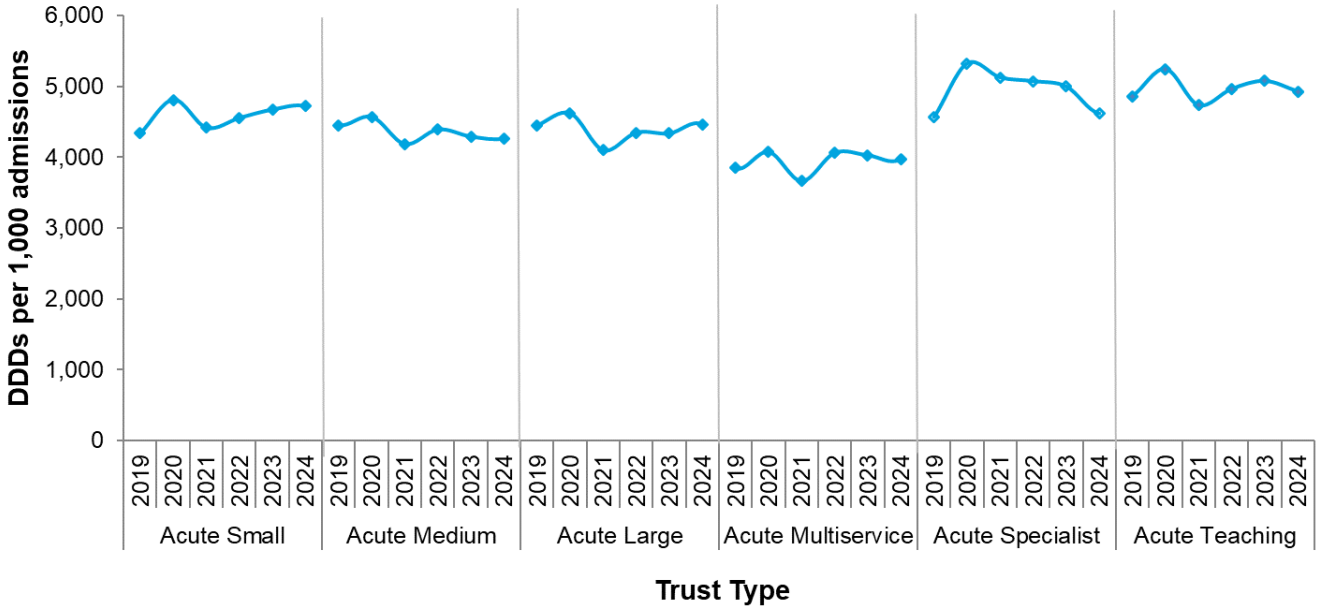
Total antibiotic use in secondary care

In 2024, antibiotic use in NHS acute hospital trusts, measured using hospital admissions as the denominator, was broadly comparable to 2019 levels, increasing by 0.6% (from 4,633 to 4,663 DDDs per 1,000 admissions). Over this period, inpatient prescribing increased by 6.9% (from 2,940 to 3,142 DDDs per 1,000 admissions), while outpatient prescribing decreased by 10.1% (from 1,693 to 1,521 DDDs per 1,000 admissions).

Between 2023 and 2024, overall antibiotic use in secondary care declined by 1.4% (from 4,728 DDDs per 1,000 admissions). Outpatient prescribing decreased by 4.2% (from 1,588 to 1,521 DDDs per 1,000 admissions), with the 2024 rate remaining below that of 2019 (1,693 DDDs per 1,000 admissions). Inpatient prescribing remained stable with a marginal increase of 0.05%

(from 3,140 to 3,142 DDDs per 1,000 admissions), however the rate in 2024 remained higher than that of 2019 (2,940 DDDs per 1,000 admissions).

Figure 3.10. Antibiotic consumption, by trust type, expressed as DDDs per 1,000 admissions, England, 2019 to 2023



The decrease in antibiotic use between 2023 and 2024 was noticeable in all acute trust types apart from acute small trusts and acute large trusts, where prescribing increased by 1.0% (from 4,672 to 4,718 DDDs per 1,000 admissions) and 2.9% (from 4,336 to 4,460 DDDs per 1,000 admissions), respectively (Figure 3.10).

Antibiotic use in acute small trusts, acute large trusts, acute multiservice trusts, acute specialist trusts, and acute teaching trusts remained above 2019 levels in 2024, whilst acute medium trust antibiotic use fell below 2019 levels. Due to missing or unreliable data between 2019 and 2024, an estimated 5.45 million DDDs and 392,000 admissions were affected across 15 trusts, resulting in either the removal of these trusts or application of proxy measures. A section providing details on data quality can be found in the Annexe.

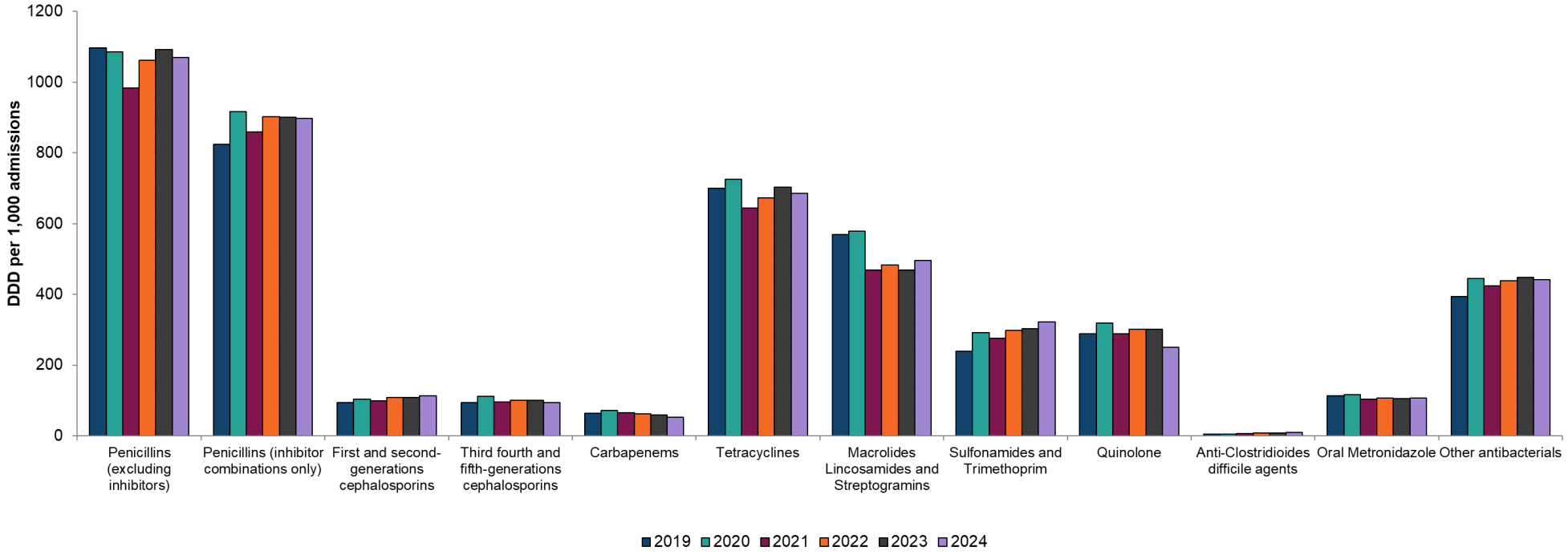
Figure 3.11 shows antibiotic usage (DDDs per 1,000 admissions) by antibiotic group from 2019 to 2024. In 2024, penicillins had the highest use in secondary care, accounting for 42% of acute trust antibiotic consumption. This was followed by tetracyclines at 15%, macrolides, lincosamides and streptogramins at 11%, other antibacterials at 9%, with the remaining groups each comprising less than 10% of all antibiotics. These proportions in prescribing groups remains relatively unchanged from 2023 and previous years.

Between 2019 and 2024, use of several antibiotics in secondary care declined (Figure 3.11). Aminoglycosides prescribing decreased by 16.1% (from 149.4 to 125.4 DDDs per 1,000 admissions), carbapenems by 18.0% (from 63.4 to 52.0 DDDs per 1,000 admissions) and quinolones by 13.6% (from 289.3 to 250.0 DDDs per 1,000 admissions). The decline in

carbapenem use was seen across all trust types and was largely driven by reductions in ertapenem and meropenem prescribing (from 10.1 to 5.4, and 52.9 to 49.6 DDDs per 1,000 admissions, respectively). In contrast, prescribing of anti-*Clostridioides difficile* agents increased during this time period by 112.4% (from 4.3 to 9.1 DDDs per 1,000 admissions), potentially reflecting rising rates of hospital-onset *C. difficile* infections. This increase also coincides with the publication of updated NICE guidelines for *C. difficile* prescribing, recommending fidaxomicin use and subsequent improvements in access (106).

Penicillins (excluding beta-lactamase inhibitors) showed a large absolute decrease between 2019 and 2024 (−26.67 DDDs per 1,000 admissions, from 1096.2 to 1069.6, −2.4%). In contrast, penicillins with beta-lactamase inhibitors showed a large increase of 73.52 DDDs per 1,000 admissions (from 824.1 to 897.6, an increase of 8.9%), alongside sulfonamides and trimethoprim, where a marked incline of 34.7% was noted (from 239.0 to 321.9 DDDs per 1,000 admissions). The increase in sulfonamides and trimethoprim use is likely linked to a rising burden of UTIs. Macrolides, lincosamides, and streptogramins declined sharply between 2019 and 2021 (17.7%, from 569.7 to 469.1 DDDs per 1,000 admissions), followed by an increase in 2024 (495.5 DDDs per 1,000 admissions), though use remains below pre-pandemic levels.

Figure 3.11. Antibiotic consumption in trusts by antibiotic group, expressed as DDDs per 1,000 admissions, England 2019 to 2023



Speciality prescribing

Consumption data for specialist groups in secondary care is presented in Table 3.2. Within the specialist groups, intensive care units (ICUs) continue to have the highest antibiotic usage, with 67.9 DDDs per ICU admission in 2023. The next highest antibiotic usage was observed in accident and emergency (A&E) and non-specified outpatient departments, with 29.5 DDDs per speciality admission.

Between 2019 and 2023, most speciality groups showed an increase in antibiotic use, with the exception of specialist surgery and 'other' specialties in which decreases of −9.0% (1.9 to 1.8 DDDs per admission) and −3.8% (5.9 to 5.7 DDDs per admission) below pre-pandemic levels were observed, respectively.

The greatest increase in antibiotic prescribing from 2022 was observed in A&E and non-specific outpatient departments (+32.1%, 22.3 to 29.5 DDDs per admission).

Table 3.2 Percentage of all antibiotic consumption attributed to piperacillin/tazobactam, carbapenems and colistin in secondary care by speciality, expressed as DDDs per speciality admission, England, 2023 to 2024

Specialist group	DDDs per admission	Piperacillin/ tazobactam	Carbapenems	Colistin [note]
Intensive Care Unit	67.6	5.0%	4.2%	0.1%
A&E/Non-specific Out-Patient Department	29.5	1.0%	0.3%	0.1%
Specialist Medicine	4.8	2.9%	2.1%	0.7%
General Surgery	3.8	2.6%	1.2%	0.0%
Geriatrics	3.5	4.7%	1.8%	0.0%
Orthopaedics	3.2	2.5%	1.4%	0.0%
Obstetrics and Gynaecology	2.5	0.6%	0.4%	0.0%
Paediatrics	2.2	1.4%	1.3%	1.0%
General Medicine	2.2	3.4%	1.5%	0.1%
Specialist Surgery	1.8	1.6%	1.3%	0.2%
Other	5.7	2.0%	1.2%	0.0%

Note: Colistin: parenteral route only, inhaled colistin was excluded.

Antimicrobial Product Subscription Model: new antimicrobials

Antimicrobial Product Subscription Model

In the UK's NAP for AMR 2019 to 2024 (50) NHS England (NHSE) committed to exploring new payment models for antimicrobial products. This initiative acknowledged the challenge faced by the pharmaceutical sector in bringing new antimicrobials to market, driven not only by

restrictions on their use, but also by their typically short treatment duration (particularly in comparison to many other medicines such as diabetes or hypertension), both of which limit potential returns on investment.

In 2020, NHSE and NICE launched a pilot scheme to trial a new payment approach for antimicrobials, using a delinked subscription model (107). The model is based on the value provided to the NHS and patients, rather than on the volume of sales. The pilot involved 2 products: cefiderocol (manufactured by Shionogi) and ceftazidime-avibactam (manufactured by Pfizer). The pilot successfully demonstrated the feasibility of measuring the value of these subscription-based payment model antimicrobials.

Building on this pilot, the 2024 to 2029 UK NAP for AMR committed to expanding the subscription model across the UK (50). In August 2024, NHSE officially launched the UK Antimicrobial Products Subscription Model, which is open to products targeting infections caused by WHO-prioritised critical pathogens (107).

Under the model, pharmaceutical companies receive a fixed annual payment, comprising point-of-sale revenue and a centrally paid top-up to ensure the full agreed amount is received. In return, companies must ensure reliable supply of their product and adhere to environmental manufacturing standards (108, 109). The evaluation method has moved from traditional Quality-adjusted life year (QUALY)-based health economic modelling, to a new scoring system using defined evaluation criteria.

In 2025, NICE will assess eligible products, with contract offers expected by Spring 2026. Currently, the model is limited to traditional antibiotic products. However, in April 2025, NICE launched a Health Technology Assessment Innovation Lab project aimed at adapting the evaluation criteria for other antimicrobial classes, such as antifungals. Results from this project are anticipated in Spring 2026.

New antimicrobials

WHO publishes analyses of the antibacterial product pipeline receiving market authorisation for human use (both preclinical and clinical pipelines of antibacterial products) (110). In recent years, several new antimicrobials have been developed and approved for use in the UK, including cefiderocol, ceftolozane with tazobactam, ceftazidime with avibactam, and eravacycline. Figure 3.12 displays the total DDDs per 1,000 population for these new antimicrobials across regions in England, in 2024.

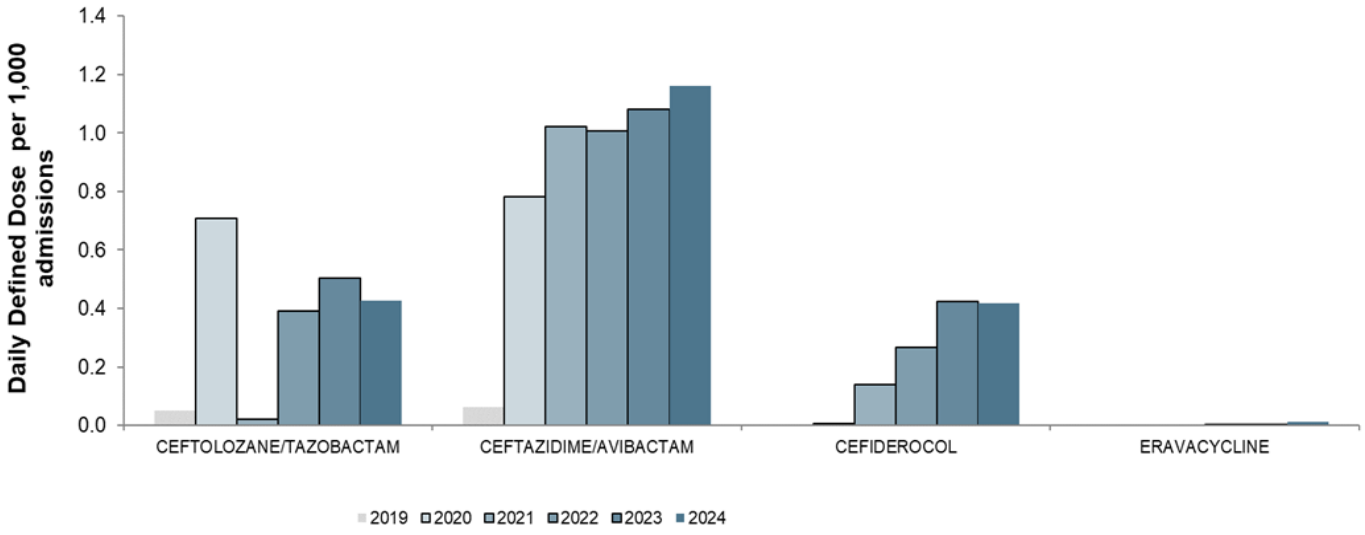
Cefiderocol, a cephalosporin antibiotic primarily used against multidrug-resistant Gram-negative bacteria, including carbapenem-resistant Enterobacteriaceae (CRE) and *Pseudomonas aeruginosa*, shows a gradual increase over the past 4 years. Between 2023 and 2024 consumption decreased by 1.7%, from 0.42 to 0.42 DDDs per 1,000 admissions (Figure 3.12). In 2024, cefiderocol was prescribed by 68.1% (92 out of 135) of NHS trusts in England.

Ceftolozane with tazobactam, a combination cephalosporin antibiotic used to treat complicated UTIs, complicated intra-abdominal infections, and hospital-acquired bacterial pneumonia, has shown fluctuations in consumption, likely related to drug shortage in 2021 (61). Between 2023 to 2024, consumption decline by 15.3% (0.50 to 0.43 DDDs per 1,000 admissions). In 2024, 48.1% (65 out of 135) of NHS trusts in England reported use of ceftolozane with tazobactam.

Ceftazidime with avibactam is a relatively new combination of a third-generation cephalosporin and a non-β-lactam β-lactamase inhibitor, used to treat complicated infections including severe drug-resistant Gram-negative bacterial infections. Between 2023 and 2024, ceftazidime with avibactam consumption increased by 7.5% (1.1 to 1.2 DDDs per 1,000 admissions), although the consumption of this antibiotic remains low. In 2024, ceftazidime with avibactam had a hospital usage of 68.1%, with 92 out of 135 of NHS trust reporting it use.

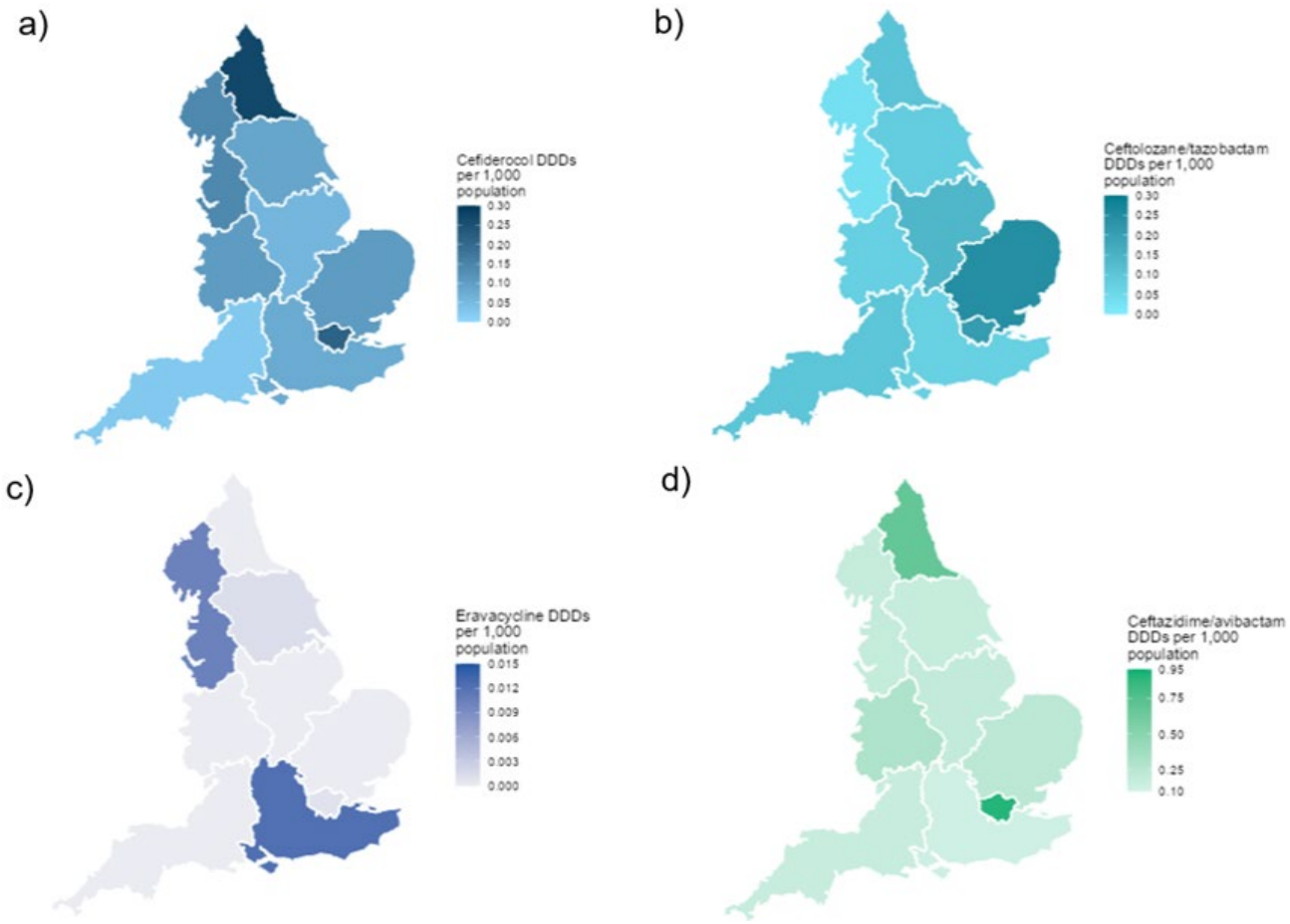
Reports of consumption of eravacycline, a novel tetracycline used to treat complicated, multidrug-resistant, intra-abdominal infections, began in May 2023, and remains low (Figure 3.12).

Figure 3.12. New antibiotic consumption, expressed as DDDs per 1,000 admissions, England, 2019 to 2024



Cefiderocol and ceftazidime with avibactam showed the highest usage across all the regions. Cefidericol use was particularly pronounced in the North East and London, whilst ceftolozane with tazobactam was highest in the East of England. London had the highest total DID, followed by the North West. Eravacycline had the lowest overall usage, with consumption observed in 4 regions: South East, London, Yorkshire and Humber, and North West (Figure 3.13).

Figure 3.13. England regional consumption, expressed as DDDs per 1,000 population, in 2024, of (a) cefiderocol (b) ceftolozane with tazobactam (c) eravacycline (d) ceftazidime with avibactam



The highest proportion of DDD per speciality admission attributed for cefiderocol, ceftazidime with avibactam, ceftolozane with tazobactam and eravacycline were in intensive care. Ceftazidime with avibactam has the highest usage 0.10% followed by cefiderocol 0.04% and ceftolozane with tazobactam with 0.03%. There are currently low usage for eravacycline.

Table 3.3. Percentage of all antibiotic consumption attributed to cefiderocol, ceftazidime with avibactam, ceftolozane with tazobactam and eravacycline in secondary care by speciality, expressed as DDDs per speciality admission, in England, 2024

Specialist group	Total DDDs per admission by specialist group	Cefiderocol	Ceftazidime /avibactam	Ceftolozane /tazobactam	Eravacycline
Intensive Care Unit	80.5	0.04%	0.10%	0.03%	
A&E/Non-specific Out-Patient Department	23.6	0.00%	0.00%	0.00%	

Specialist group	Total DDDs per admission by specialist group	Cefiderocol	Ceftazidime /avibactam	Ceftolozane /tazobactam	Eravacycline
Specialist Medicine	4.6	0.00%	0.01%	0.02%	
General Surgery	1.7	0.01%	0.03%	0.01%	
Geriatrics	3.5	0.01%	0.01%	0.00%	
Orthopaedics	3.1	0.02%	0.02%	0.01%	0.00%
Obstetrics and Gynaecology	2.1	0.00%	0.00%	0.01%	
Paediatrics	2.2	0.01%	0.04%	0.01%	
General Medicine	2.1	0.03%	0.09%	0.01%	0.00%
Specialist Surgery	1.7	0.01%	0.03%	0.01%	0.00%
Other	4.3	0.01%	0.01%	0.01%	

As surveillance of new antibiotic consumption continues to expand, there is also growing interest in the development and clinical evaluation of ‘non-traditional’ antibacterials as potential complements and alternatives to antibiotics. These include small molecule antibacterials, monoclonal antibodies, proteins or live biotherapeutics such as bacteriophages, which impact virulence indirectly or bacterial growth.

Incorporating these non-traditional agents into emerging antimicrobial surveillance, and broadening the scope to include resistance monitoring for all new antimicrobials, could support efforts to monitor their introduction and use, assess their effectiveness, detect emerging resistance, promoting responsible stewardship, understand equity in prescribing, and inform clinical decision-making on their appropriate use (111).

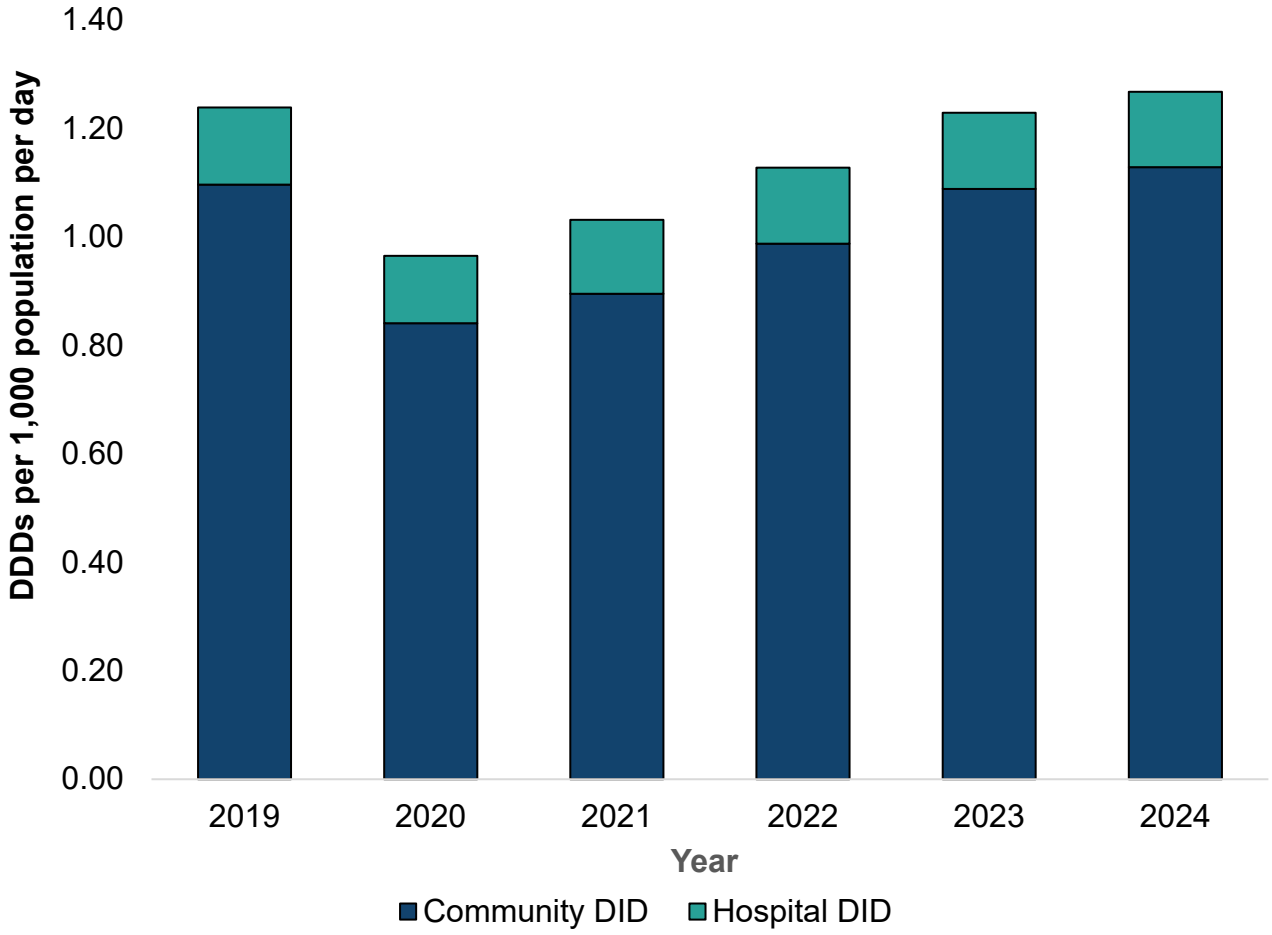
Antifungal consumption

Total antifungal consumption

Total consumption of systemic antifungals in England in 2024 was slightly higher than that seen in 2019 (+2.0%, Figure 3.14). As presented in previous ESPAUR reports, antifungal usage, expressed as DDDs per 1,000 population per day, decreased significantly in 2020, the first year of the COVID-19 pandemic. Usage has since increased to pre-pandemic levels, increasing by 30.7% from 2020 to 2024. Specifically, use of systemic antifungals in primary care and in acute NHS trusts has increased by 33.5% (0.85 to 1.13 DID) and 11.7% (0.12 to 0.14 DID) respectively between 2020 and 2024.

In 2024, 89% of systemic antifungals were used in the community setting. It is difficult to ascertain whether this is a true representation of community use as several antifungal agents may be supplied as over the counter (OTC) medicines, which are not captured in this data set.

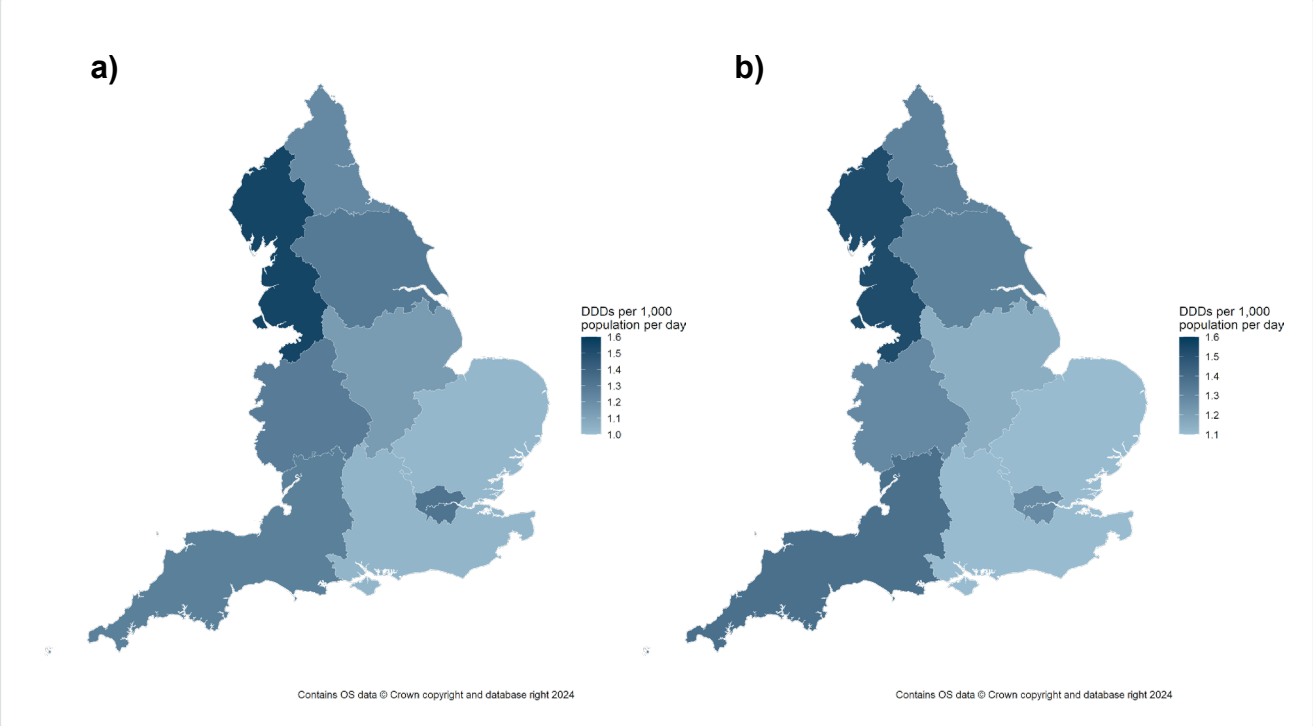
Figure 3.14. Total consumption of systemic antifungals in the community and acute hospitals in England, expressed as DDDs per 1,000 population per day (DID), 2019 to 2024



Box 3.8 Regional variation in antifungal consumption in England

There was marked regional variation in use of antifungals in England (Box Figure 3.8.1). In 2024, the North West had the highest prescribing rate (1.53 DID); this is also the region with the highest reported incidence of fungaemia (see AMR Chapter Annex). The East of England and the South East used the fewest antifungals (1.10 DID). Differences in the resident population characteristics and distribution of specialist care trusts may account for the variations seen between regions.

Box Figure 3.8.1. Total consumption (primary and secondary care) of systemic antifungals for UKHSA centres, expressed as DDDs per 1,000 inhabitants per day (a) 2019 (b) 2024



Antifungal prescribing in primary care

The total use of systemic antifungals in the community in 2024 increased in comparison to 2019 (+3.0%, from 1.102 to 1.130 DID). Figure 3.14 shows a large decrease in total systemic antifungals prescribed in the community between 2019 and 2020 (−23.2%, 1.102 to 0.846 DID). There have since been year-on-year increases from 2020 to 2024 (+33.5%, 0.846 to 1.130 DID).

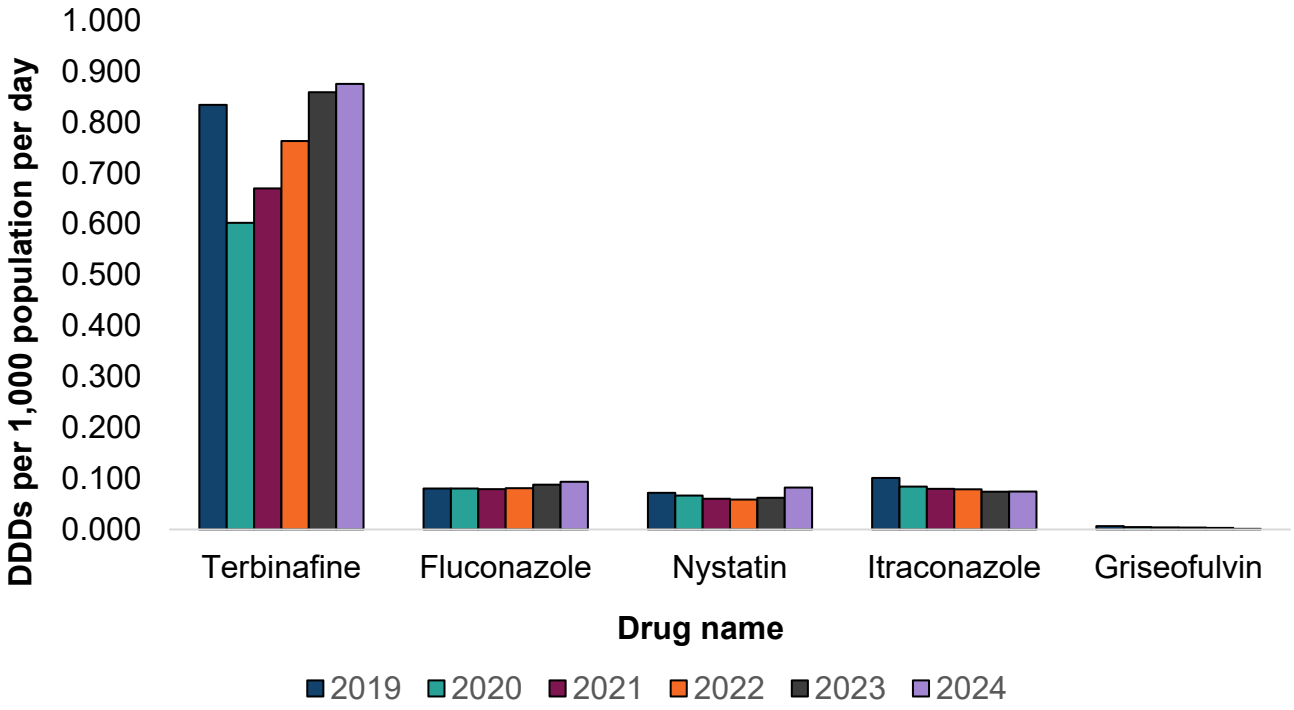
Figure 3.15 shows that the most frequently prescribed antifungal in the community was terbinafine (0.88 DID in 2024), an oral antifungal agent active against common dermatophyte infections of the skin, hair and nails. Usage of terbinafine decreased by 27.8% from 2019 to 2020 likely related to the COVID-19 pandemic 'lockdowns' where transmission of dermatophyte infections was reduced. There has been a year-on-year increase in terbinafine use between 2020 and 2024 (+45.3%, 0.6 to 0.88 DID), surpassing 2019 levels.

Fluconazole usage has increased over the last 6 years (+16.4%, 0.081 to 0.094 DID). Oral fluconazole, most often used for cutaneous and mucosal yeast infections, is available over the counter, hence the numbers presented may not reflect true use. Nystatin use decreased year-on-year from 2019 to 2022 (−18.4%, from 0.072 to 0.059 DID), with increases from 2022 to 2024 (+39.6%, from 0.059 to 0.082 DID). Itraconazole and griseofulvin usage have decreased

each year since 2019 (between 2019 and 2024, from 0.101 to 0.074 DID, and from 0.007 to 0.001 DID, respectively).

There are a limited number of drugs shown in Figure 3.15, as there are limited types of antifungals prescribed for systemic use in community settings; more variety can be seen in the hospital setting.

Figure 3.15. Total consumption of systemic antifungals in the community in England, expressed as DDDs per 1,000 population per day, 2019 to 2024



Antifungal prescribing in secondary care

As can be seen in Figure 3.16, total consumption of systemic antifungal agents in NHS acute trusts in 2024 was 180 DDDs per 1,000 admissions. This represents a 5.2% decrease in the rate of prescribing from 2023 (190 DDDs per 1,000 admissions), an 10.7% decrease from peak consumption in 2020 (201 DDDs per 1,000 admissions) and only slightly higher levels (1.3%) than in 2019 before the COVID-19 driven peak, that is a return of antifungal prescribing levels by acute trust admissions to pre-pandemic levels.

Figure 3.16. Total consumption of systemic antifungals in NHS acute hospital trusts in England, expressed as DDDs per 1,000 admissions, 2019 to 2024

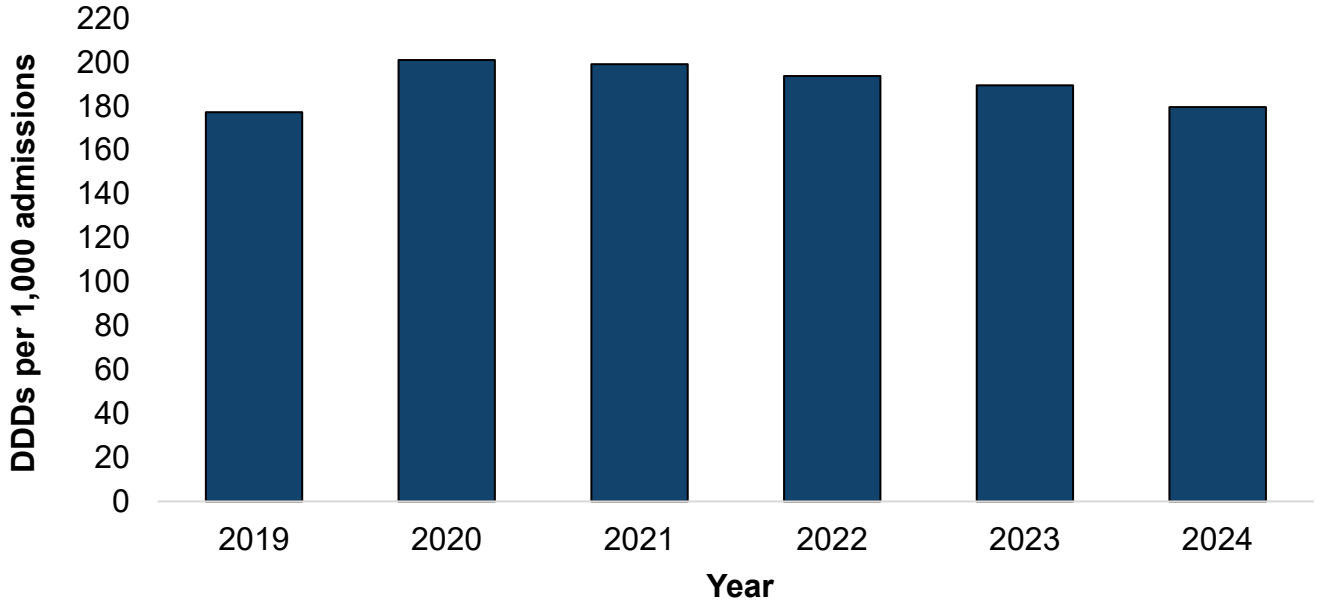


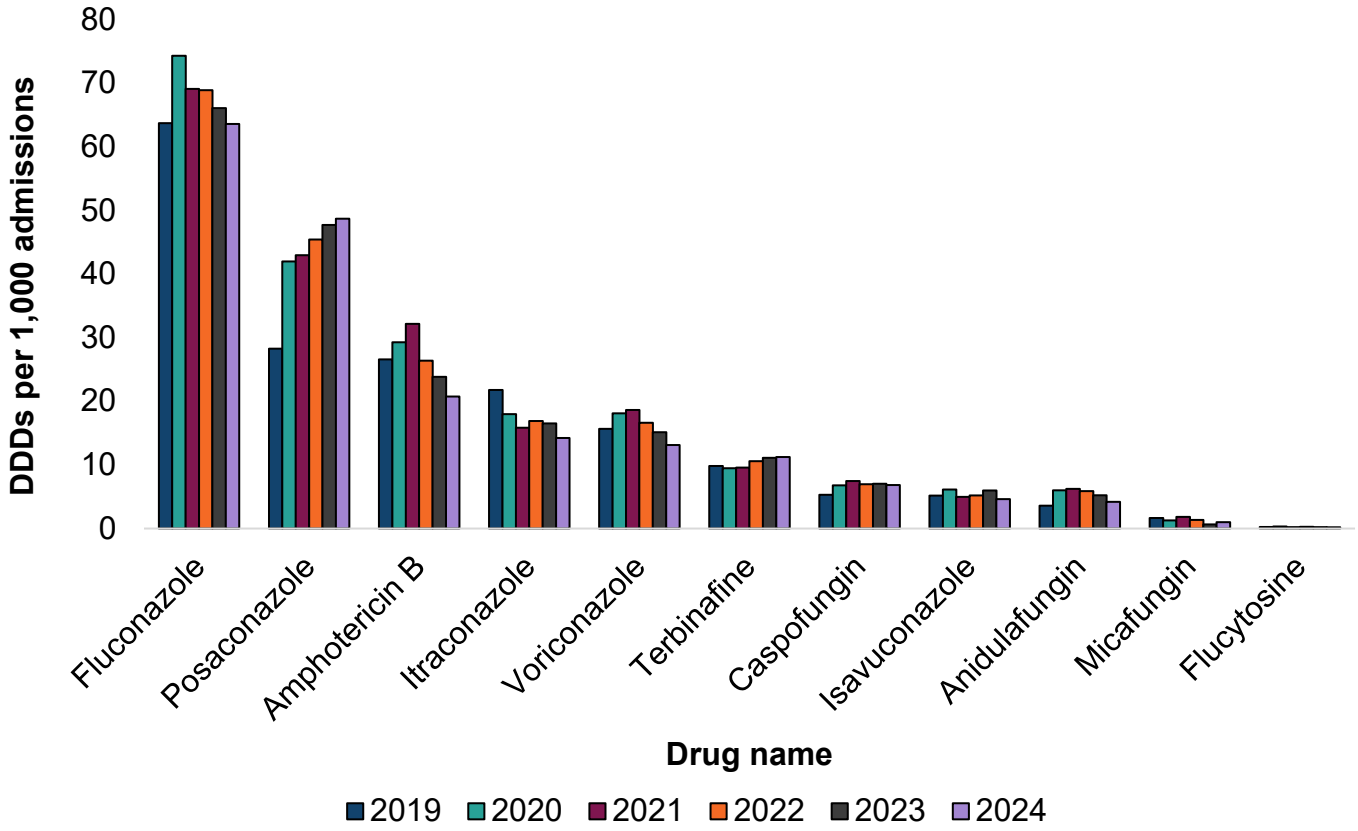
Figure 3.17 shows the prescribing of individual systemic antifungals in secondary care between 2019 and 2024. Fluconazole was the most frequently prescribed antifungal in 2024 (64 DDDs per 1,000 admissions), followed by posaconazole (49 DDDs per 1,000 admissions). Posaconazole prescribing increased markedly in 2020 (+48.5% in comparison to 2019) and remains at the increased rate in 2024, most likely due to the reduced cost of this drug following its coming off patent in 2020. Itraconazole and voriconazole usage has decreased between 2019 and 2024, with 34.6% and 16.3% reductions respectively during this time period, possibly representing a switch to posaconazole due to its broad spectrum of activity against moulds and better tolerability.

Amphotericin B is a broad-spectrum antifungal agent suitable for most invasive yeast and mould infections. Usage of the drug increased by 21.1% during the early COVID-19 pandemic period (from 27 to 32 DDDs per 1,000 admissions) 2019 to 2021. Usage has since decreased by 35.4% from 2021 to 2024 (32 to 21 DDDs per 1,000 admissions).

In 2024, usage of echinocandin antifungals was 4.2, 6.8 and 1.0 DDDs per 1,000 admissions for anidulafungin, caspofungin and micafungin, respectively. Since 2019 both anidulafungin and caspofungin usage has increased (2019 to 2024: +16.2% and +28.8% respectively), although use is still low. Micafungin usage, however, decreased by 39.4%, from 1.7 to 1.0 DDDs per 1,000 admissions between 2019 and 2024.

Flucytosine, which is not prescribed as a sole agent but often in combination with amphotericin B, has the lowest levels of prescribing at 0.2 DDDs per 1,000 admissions. Terbinafine usage decreased between 2019 and 2021 (9.8 to 9.6 DDDs per 1,000 admissions) but has since increased to 11.2 DDDs per 1,000 admissions.

Figure 3.17. Total antifungal consumption by drug in NHS acute trusts, 2019 to 2024



In 2024, the specialty with the highest systemic antifungal prescribing rate was ‘Intensive Care Medicine’ (11,886 DDDs per 1,000 admissions) followed by ‘Haematology’ (8,521 DDDs per 1,000 admissions).

Antiviral consumption

Influenza virus

Box 3.9. Use of influenza antivirals

In the time period 1 January 2019 to 31 December 2024, consumption of oseltamivir in primary and secondary care settings, influenza admissions, and influenza-like illness (ILI) primary care consultations follow a similar trend and seasonality, whereby rates begin to increase in October, peak in approximately December or January, and return to baseline levels in April. During this period, the influenza season 2022 to 2023 (03 October 2022 to 21 May 2023), had the greatest peak in all measures, occurring in December 2022. In primary care, monthly ILI consultations peaked at 91.6 per 100,000, and defined daily doses (DDDs) of oseltamivir at approximately 38,100 (Box Figure 3.9.1). In secondary care, DDDs of oseltamivir peaked at approximately 203,800, and influenza admissions at 46,500 (Box Figure 3.9.2), translating to approximately 4.4 DDDs for every influenza admission.

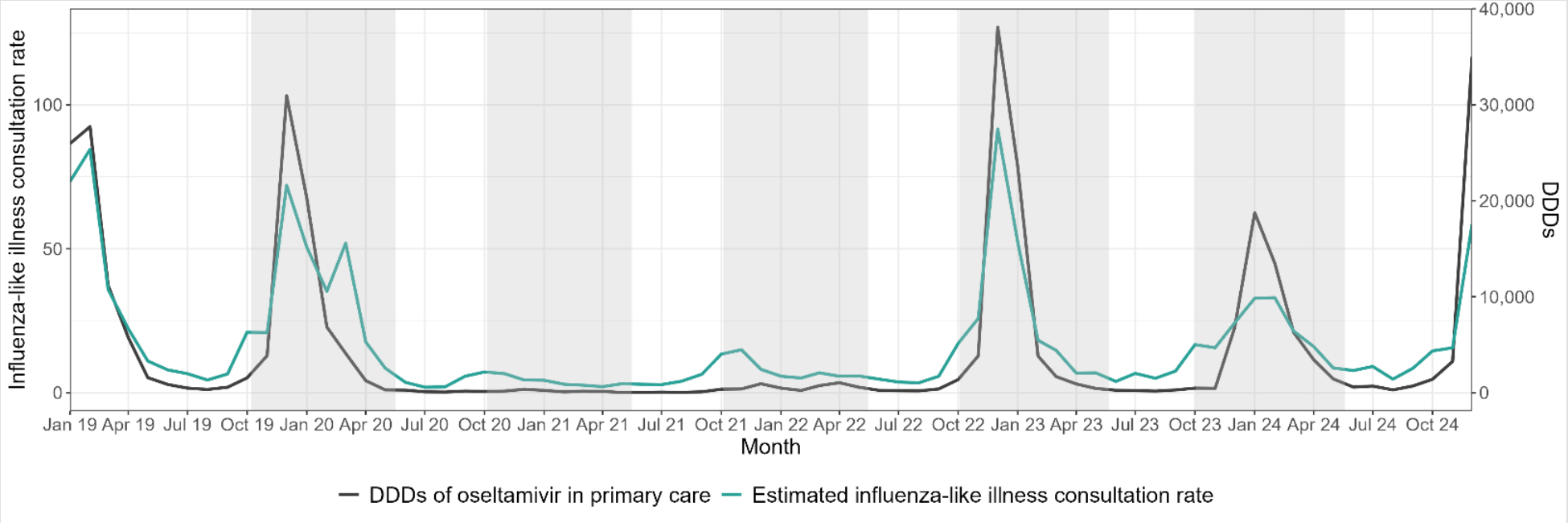
The following season, 2023 to 2024 (9 October 2023 to 19 May 2024), showed a decrease in all measures, and a decrease in comparison to pre-pandemic levels. The 2023 to 2024 season peak in primary care oseltamivir consumption occurred in January 2024 at approximately 18,800 DDDs, a 51% decrease from the 2022 to 2023 peak, and an ILI consultation rate of 32.8 per 100,000 (Box Figure 3.9.1). In secondary care, oseltamivir consumption peaked at approximately 75,000 DDDs of oseltamivir and 16,700 influenza admissions (Box Figure 3.9.2), resulting in approximately 4.5 DDDs of oseltamivir for every influenza admission. Despite differences in oseltamivir consumption between seasons, the only statistically significant differences were between season 2020 to 2021 and seasons 2019 to 2020, 2022 to 2023, and 2023 to 2024 (adjusted p-values <0.05).

Consumption of zanamivir remains low relative to consumption of oseltamivir, as it is typically a second-line treatment. Zanamivir consumption peaked in January 2019, at approximately 3,000 DDDs.

Prescriptions of influenza antivirals in primary care settings through FP10 prescriptions are permitted only after the Chief Medical Officer and Chief Pharmaceutical Officer notification to primary care providers that influenza is circulating in the community. FP10 prescriptions of oseltamivir or zanamivir in primary care were not permitted during the periods 8 May 2019 to 3 December 2019, 18 May 2020 to 24 November 2022, 9 May 2023 to 14 December 2023, and 2 May 2024 to 3 December 2024. Primary care DDDs of oseltamivir typically peak within one month of the notification being issued.

DDDs of oseltamivir in secondary care per 1,000 hospital admissions were lower in the most recent complete influenza season (2023 to 2024, 13.5 DDDs per 1,000 admissions) than both the previous season (2022 to 2023, 20.7 DDDs per 1,000 admissions) and the season immediately before the COVID-19 pandemic (2019 to 2020, 17.2 DDDs per 1,000 admissions, Box Figure 3.9.3).

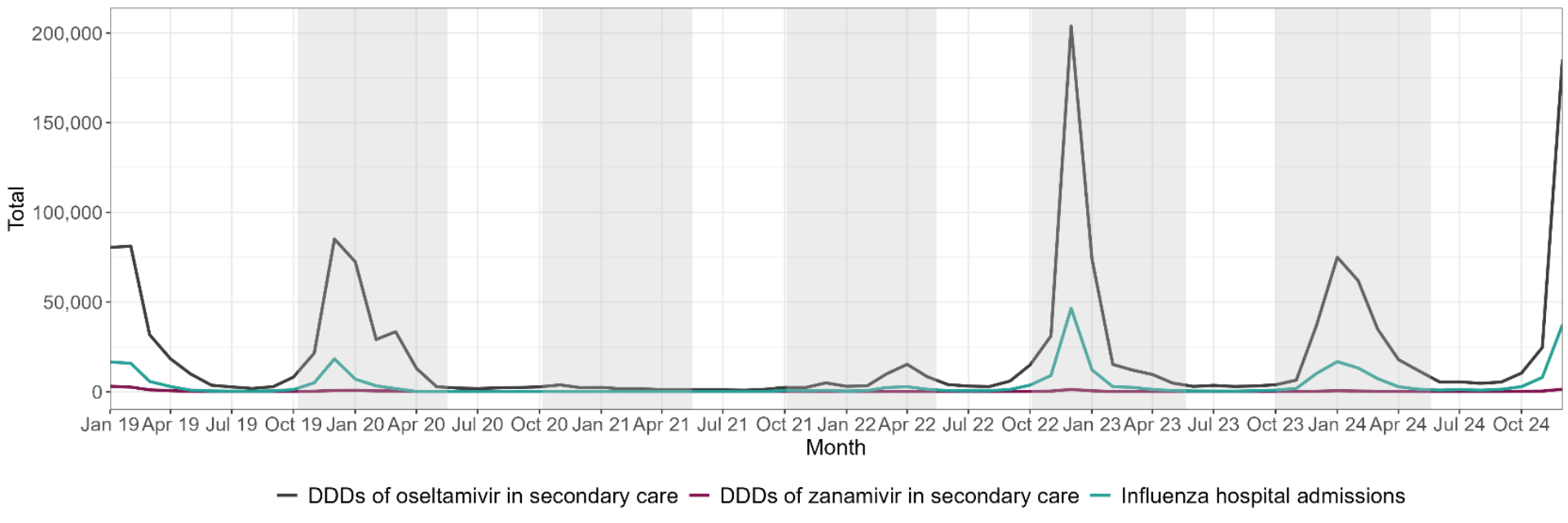
Box Figure 3.9.1. Monthly Defined daily doses of oseltamivir and estimated influenza-like illness consultation rates in primary care settings, January 2019 to December 2024



Note: Consultation rate is estimated per 100,000 population of England.

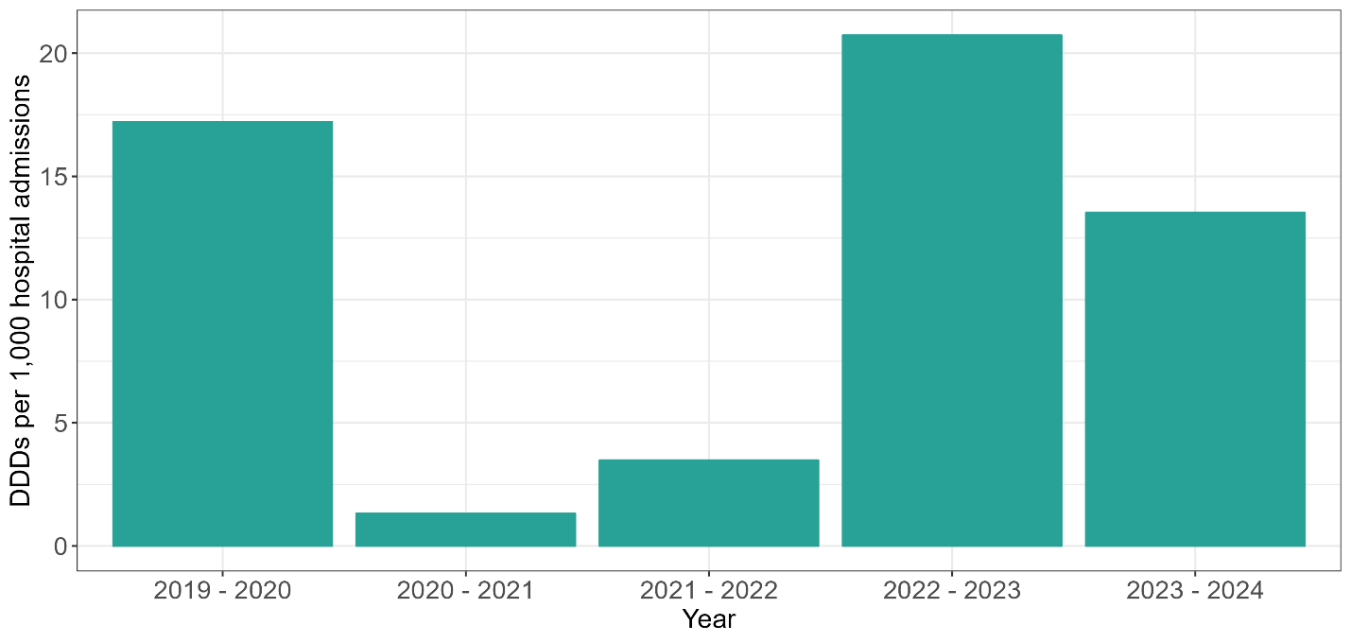
Note 2: Shading indicates the influenza seasons analysed.

Box Figure 3.9.2. Defined daily doses of oseltamivir and zanamivir in secondary care and influenza hospital admissions, 01 January 2019 to 31 December 2024, aggregated over each month



Note: Shading indicates the influenza seasons analysed.

Box Figure 3.9.3. Defined daily doses of oseltamivir in secondary care per 1,000 hospital admissions, for years running September to August, 2019 to 2020 to 2023 to 2024



SARS-CoV-2: COVID-19 therapeutics

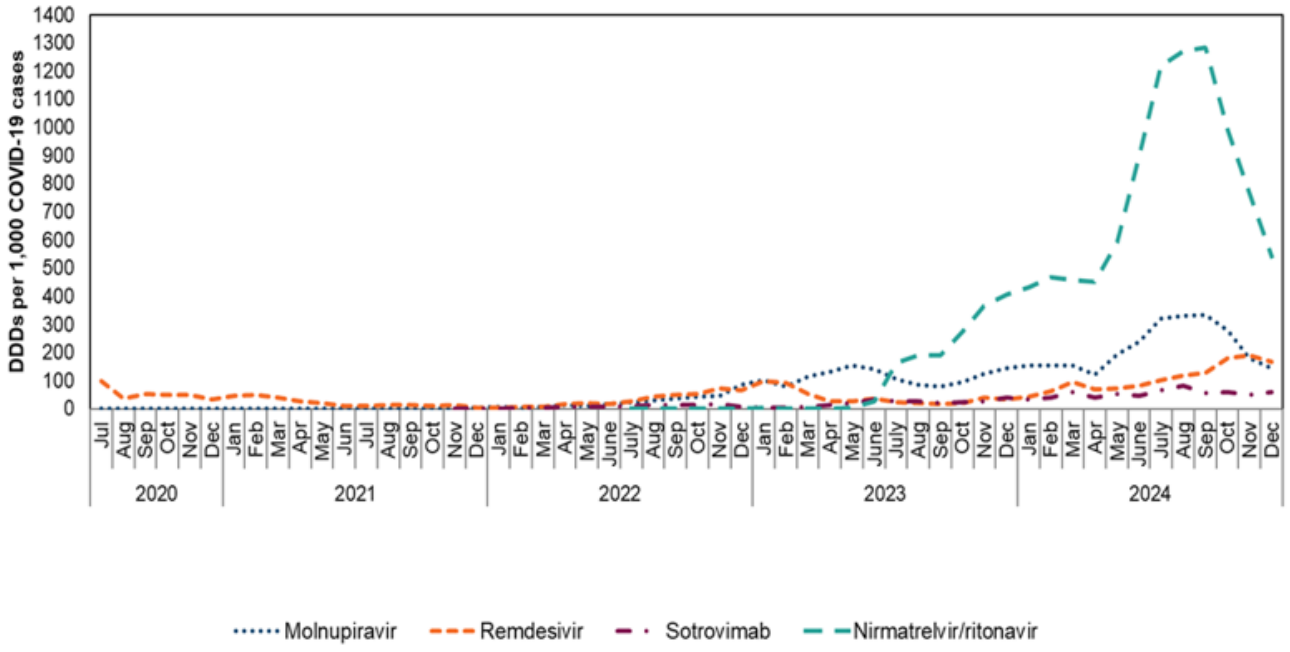
This section discusses the use of antiviral agents against SARS-CoV-2. It includes epidemiological surveillance data on 4 direct-acting antiviral COVID-19 treatments used in England from 2020 to 2024 (112). Between 2023 and 2024, the total consumption of these therapeutic agents decreased by 29.7%, from 370,711 to 260,452 DDDs. This reduction corresponds with a decline in the number of reported COVID-19 cases during the same period, from 593,963 in 2023 to 127,350 in 2024.

Figure 3.18 displays the rates, expressed as DDDs per 1,000 COVID-19 cases, in England for COVID-19 therapeutics used within both primary and the secondary care settings. As denominator data was unavailable for individuals who were eligible, were offered and accepted each treatment, the number of COVID-19 cases were used. This is considered an exploratory analysis and may not directly reflect variations between care providers.

Nirmatrelvir plus ritonavir was the most frequently dispensed therapeutic agent across both primary and secondary care settings, with the highest rate observed in December 2024 at 544 DDDs per 1,000 reported COVID-19 cases (59%) (Figure 3.18). This was followed by remdesivir at 167 DDDs per 1,000 cases (18%). Molnupiravir and sotrovimab were administered exclusively in secondary care settings, with usage rates of 167 and 60 DDDs per 1,000 cases, respectively. Between November and December 2024, a general decline in DDDs per 1,000 COVID-19 cases was observed across most agents, with the exception of remdesivir, which demonstrated a 16.1% increase in use. Consumption was higher in 2024 compared to 2020 due

to the decrease in COVID-19 cases diagnosed and recorded (and hence the denominator) (Figure 3.18).

Figure 3.18. Total consumption of COVID-19 therapeutics, expressed as DDDs per 1,000 COVID-19 cases, England, 2020 to 2024



Hepatitis B virus

Box 3.10. Antiviral prescribing for the treatment of hepatitis B virus (HBV)

Entecavir and tenofovir disoproxil are the primary recommended options for people in whom antiviral treatment is indicated. Surveillance of antiviral treatment coverage of individuals living with diagnosed chronic hepatitis B is required to monitor equity in access and outcome from treatments. The main aim of current treatment strategies is to prevent chronic liver disease progression through endpoints of long-term suppression of HBV replication with HBsAg loss being the optimal endpoint.

As treatment eligibility has historically been complex and can change over a person's life, with many people being monitored but not on treatment for years, attrition of retention in care can occur. Simplified treatment guidelines may improve patient engagement, require less specialist follow up, and expedite achievement of public health programme goals. European Association for the Study of the Liver (EASL) and WHO have recently simplified guidance on treatment eligibility to (i) those with HBV DNA >2,000 IU/ml, elevated alanine aminotransferase (ALT) and/or at least moderate histological lesions, and (ii) all cirrhotic patients with detectable HBV DNA.

Although a national comprehensive treatment surveillance system has not yet been established, IQVIA collects data on antiviral prescriptions dispensed in secondary care

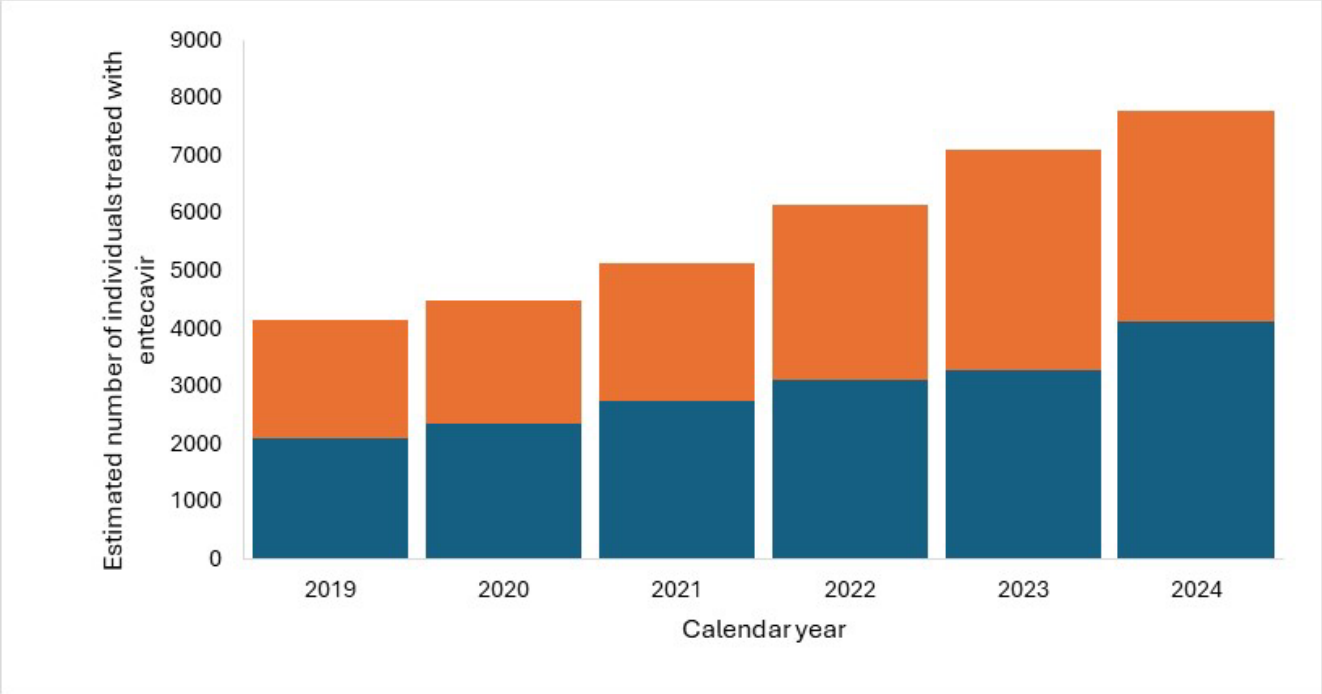
pharmacies in England. Volume data (number of packs) was extracted from IQVIA for entecavir (0.5mg or 1mg once daily) and for tenofovir disoproxil (245mg once daily) between 2019 and 2022. The number of doses was estimated by number of packs provided by IQVIA. Tenofovir, in combination with other antiretroviral drugs, is also a treatment for HIV and is recorded as a combination treatment in IQVIA. We identified any single use of tenofovir disoproxil as indicating HBV treatment.

The average number of prescriptions (which equates to packs) per year between 2019 and 2024 was 70,604 units for entecavir and 120,112 units for tenofovir disoproxil. Numbers of prescriptions increased between 2020 and 2024 from 50,621 to 94,706 units for entecavir and from 114,769 to 130,192 units for tenofovir disoproxil. Between 2019 and 2024, an estimated annual average of 5803 individuals were treated with entecavir and 9,872 individuals treated with tenofovir disoproxil (Box Figure 3.10.1). Between 2019 and 2024 the estimated number of individuals treated with entecavir increased from 4,161 to 7,784 and from 9,433 to 10,700 for tenofovir disoproxil. For London, an estimated annual average of 2846 individuals were treated with entecavir and 4,419 with tenofovir disoproxil; outside London the estimated numbers were 2957 and 5454 individuals, respectively.

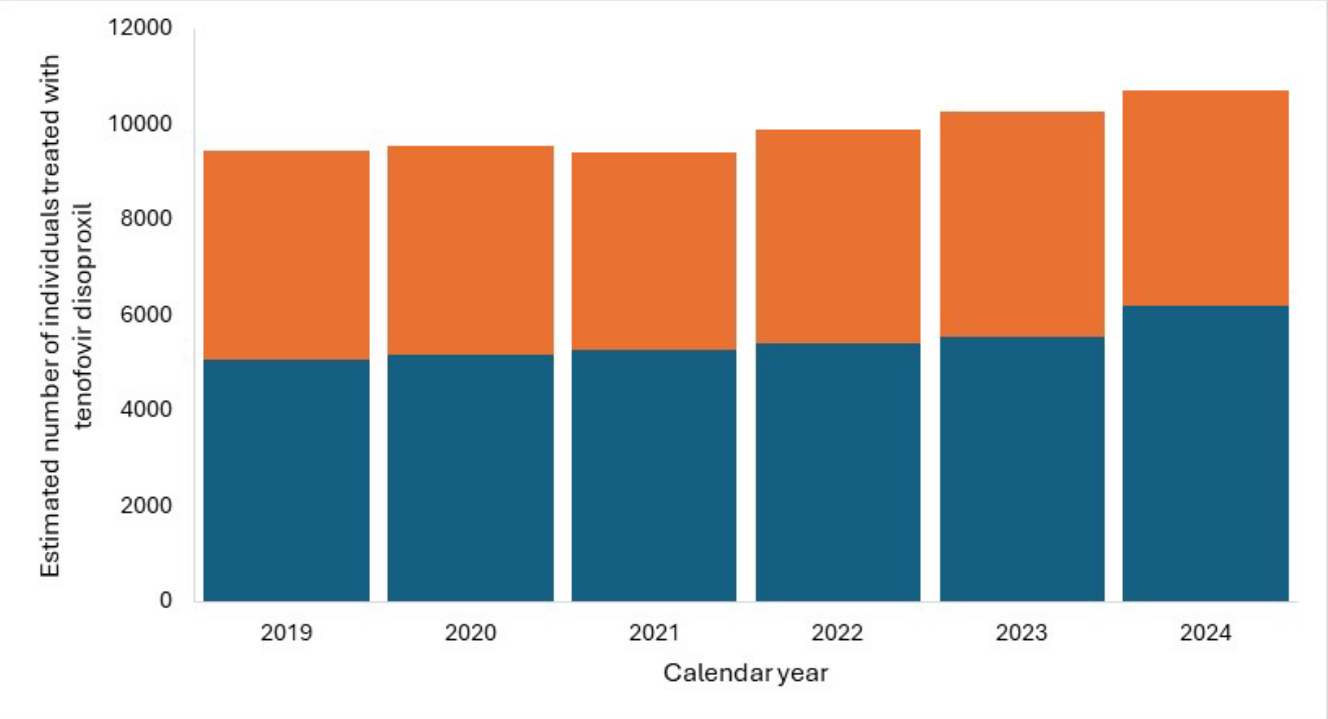
Please refer to the Hepatitis B annual report for further information.

Box Figure 3.10.1. Estimated number of individuals treated with a) entecavir and b) tenofovir disproxil in secondary care between 2019 and 2024, by treatment location

a)



b)



Hepatitis C virus

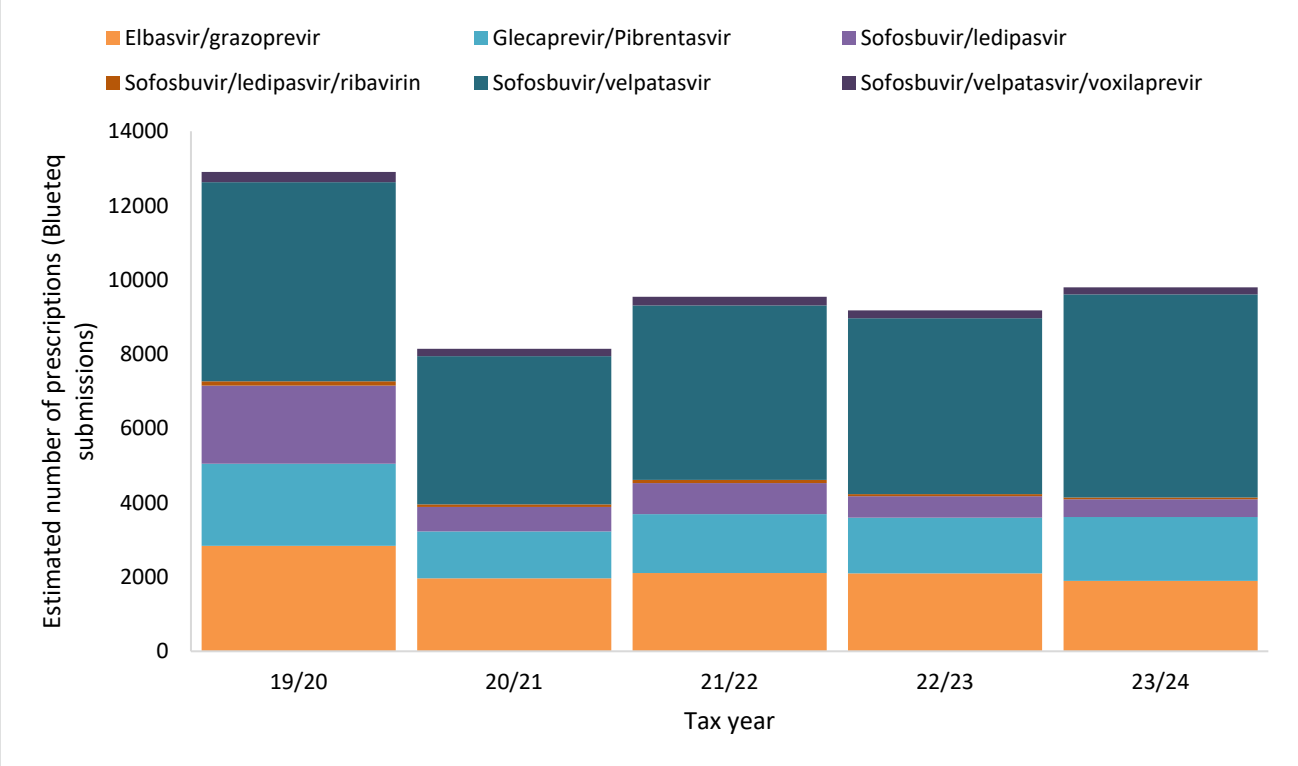
Box 3.11. Direct-acting antiviral (DAA) therapies for the treatment of hepatitis C

Highly effective and tolerable direct-acting antiviral (DAA) therapies were introduced in 2011 to 2012, which offered an all-oral, interferon free based regimen, with a shorter treatment duration, which were more effective and better tolerated for those living with chronic hepatitis C (71). Sofosbuvir was released in most Western countries in 2013 and 2014 (including the United States, 28 European member states, Australia, Canada and New Zealand), followed by approvals of other second-generation DAAs including Simepravir, and further IFN-free regimens. In 2015, the English National Health Service (NHS) funded DAA therapies for individuals with severe liver disease, with restrictions on disease stage lifted in 2017 to anyone with viraemic HCV infection eligible for treatment (113). Since the release of DAA therapy in England, the cumulative number of treatment initiations from the 2015 to 2016 tax year to the 2023 to 2024 was 87,346 (114).

Data on DAA prescribing is collated by UKHSA from NHSE's Blueteq system, a web-based software system for the approval and management of high-cost medicines. Prescriptions were counted using the Blueteq number, a unique identifier per prescription, and can represent treatment for a new case of hepatitis C, an individual who may have experienced treatment failure, or an individual who may have been previously treated and subsequently experienced a re-infection.

The average number of prescriptions (Blueteq submissions) per tax year between 2019 to 2020 and 2023 to 2024 was 9,913, with the number of prescriptions lowest in the tax year 2020 to 2021 during the SARs-CoV-2 pandemic where there was considerable disruption to health care services. During this period, 6 different treatment regimens were prescribed between the tax year 2019 to 2020 and 2023 to 2024. The highest average number of prescriptions was for Sofosbuvir/Velpatasvir (SOF/VEL) with 4850, followed by Elbasvir/Grazoprevir (EBR/GZR) with an average of 2,180 prescriptions, and Glecaprevir/Pibrentasvir (GLE/PIB) with 1,656. SOF/Ledipasvir (LDV) had an average of 931 prescriptions between the tax year 2019 to 2020 and 2023 to 2024, SOF/VEL/Voxilaprevir (VOX) had on average 220 prescriptions, and SOF/LDV + ribavirin (RBV) had on average 74 prescriptions. Whilst for most of the treatment regimens the number of prescriptions per tax year have remained consistent, a decrease was observed in SOF/LDV from 2,101 prescriptions in the tax year 2019 to 2020 to 481 prescriptions in the tax year 2023 to 2024 (Box Figure 3.11.1).

Box figure 3.11.1. Estimated number of prescriptions reported to blueteq by treatment regime between the tax year 2019 to 2020 and 2023 to 2024



Antiparasitic consumption

Assessment of the consumption of antiparasitic drugs is included below and includes antimalarial and anthelmintic drugs. The addition of antiparasitic use within the independent sector is a new addition to the ESPAUR report this year. Consumption data is provided for the antiparasitics used in England, for which DDDs are available according to the WHO. Data is presented as DIDs, combined for NHS primary and secondary care, and across independent sector settings, further details of which are provided in the Annexe (115).

Antimalarial consumption

The UKHSA has reported a recent rise in travel-acquired malaria, with the number of imported cases diagnosed in 2023 exceeding 2000 cases for the first time in over 20 years (116). The rise is linked to an increase in overseas travel following removal of COVID-19 pandemic restrictions, combined with a global resurgence of malaria cases beyond pre-pandemic levels(117). Provisional data for 2024 indicates that cases remain elevated, with 753 imported cases of malaria to the UK in the period from January to June 2024. The UKHSA Malaria Expert Advisory Group (previously known as the Advisory Committee on Malaria Prevention) has subsequently published updated Malaria prevention guidelines for travellers from the UK.

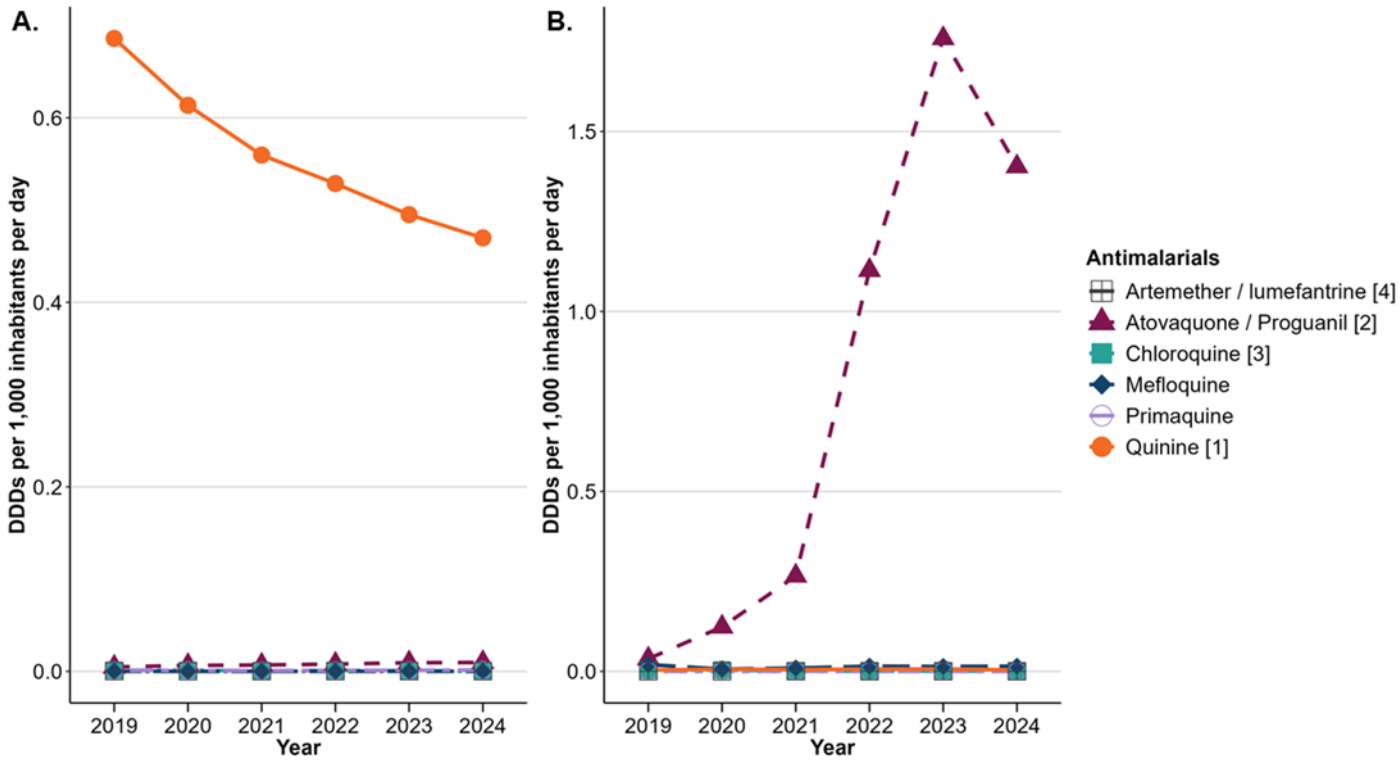
Antimalarial consumption is reported for the treatment and prophylaxis against malaria (Figure 3.19a and b).

Consumption of atovaquone-proguanil (A-P; commonly known as Malarone) within the NHS showed an overall increase between 2019 and 2024 (from 0.005 to 0.010 DID, +106.4%). A-P is used in both the prevention and treatment of malaria, but as Artemisinin Combination Therapies (ACTs) are the first line for malaria treatment in the UK, most scripts for A-P are likely to be for chemoprophylaxis, especially in the community, as malaria is predominantly treated in secondary care. A-P is typically prescribed privately, since the NHS does not fund its cost for chemoprophylaxis. Inclusion of the independent sector usage data in ESPAUR this year indicates that A-P is the most frequently used antimalarial drug across the combined NHS and independent sectors, with the independent sector comprising 99.3% of A-P use in 2024 (1.40 DIDs in the independent sector alone) (Figure 3.19a and b). It is most likely that the increase in A-P prescribing is a result of the increase in international travel post-pandemic.

Quinine is the mostly frequently used antimalarial drug in the NHS (0.470 DID in 2024). Consumption of quinine has seen a steady decline over the past 6 years (31.5% decrease in DIDs between 2019 and 2024) in contrast to the observed increase in travel-acquired malaria cases. This is likely to be due to the change from quinine to ACT as first line antimalarial therapy in the UK. Not all quinine prescribing can be attributed to malaria treatment and may include prescribing for other conditions, although the only indication for quinine apart from malaria listed in the British National Formulary is nocturnal night cramps.

Whilst some antimalarial drugs are also used to treat other conditions, or as chemoprophylaxis, ACT is only used in the treatment of malaria. Oral ACT is the first line treatment for *P. falciparum*, with severe or complicated cases receiving intravenous artesunate prior to oral ACT. Consumption data indicates that artemisinin compound prescriptions have remained stable over the 6 years to 2024, (0.0004 DIDs, combined NHS and independent sector use), except for an observed decrease to 0.0002 DIDs, coinciding with the COVID-19 pandemic in 2020.

Figure 3.19 Antimalarial use in A. NHS and B. independent sector, DDDs per 1,000 inhabitants per day, England, 2019 to 2024 [note 1] [note 2] [note 3] [note 4]

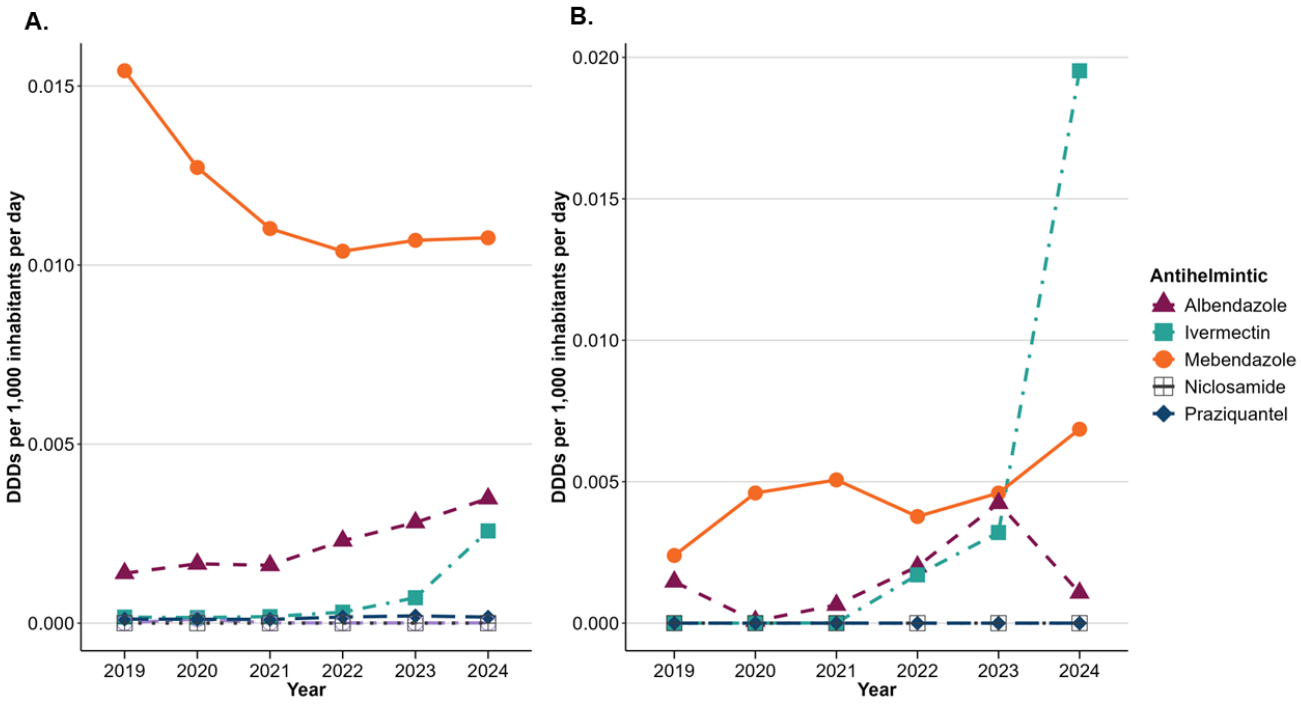


[Note 1] Quinine includes: quinine bisulfate, quinine dihydrochloride, quinine sulfate.
[Note 2] Atovaquone/proguanil includes: proguanil, proguanil/atovaquone, atovaquone. (Atovaquone alongside use as antimalarial may also be used for treatment of Pneumocystis pneumonia).
[Note 3] Chloroquine includes: chloroquine chloroquine/proguanil and chloroquine phosphate.
[Note 4] Artemisinin compounds includes: artemether/lumefantrine, artesunate, piperaquine phosphate/artenimol.

Anthelmintic consumption

Consumption of anthelmintics can be seen in Figure 20a and b. The data indicates that ivermectin use has been steadily increasing in both the NHS and independent sectors since 2019, with the largest proportional increases seen between 2023 and 2024 (from 0.004 to 0.022 (+465%), combined NHS and independent sector use. Ivermectin is indicated for use in travel-associated helminth infections such as strongyloidiasis, as well as oral treatment of ectoparasitic infections, including pediculosis (lice infestation) and scabies (mite infestation). A national increase in scabies cases was reported in 2024, with observed incidence rates above the 5-year average in 2024 (118). National shortages of the 2 main topical treatment options (permethrin and malathion) may have resulted in an increase in consumption of systemic oral ivermectin, which was licensed for scabies by the MHRA in 2023. Oral ivermectin subsequently became available in the UK for scabies in March 2024, and the NICE guidelines were updated accordingly (119, 120).

Figure 3.20. Anthelmintic use in A. NHS and B. independent sector, DDDs per 1,000 inhabitants per day, England, 2019 to 2024



Mebendazole consistently remains one of the most frequently used anthelmintic drugs in England (0.018 DID in 2024, combined NHS and independent sector consumption). The rate of mebendazole consumption within the NHS decreased over the previous 6 years (by 0.005 DIDs (−30.0%) between 2019 and 2024, whilst use in the independent sector has increased by the equivalent rate (0.005 DIDs, +49.1%) in the same period. Mebendazole is indicated for the treatment of several helminth infections, including threadworm.

Mebendazole is available as an over the counter (OTC) medication (following a public consultation in 2018), without prescription, for certain indications, such as threadworm (*Enterobius vermicularis*), the most common parasitic worm infection in the UK, particularly in children aged between 4 to 11 years old (NICE, 2023). Whilst the data includes community pharmacy consumption, it does not capture anthelmintics dispensed OTC. The data is therefore likely to underestimate mebendazole consumption. Mebendazole is also indicated for the treatment of whipworm (trichuriasis), hookworm and roundworm (ascariasis) and, whilst these infections are not endemic to England, previous reports by the UKHSA suggest that helminth infections may affect up to 20% of migrants from endemic countries (OHID, 2021). Unfortunately, as with the antimalarial data, it is not possible to distinguish prescribing by indication in the presented anthelmintic consumption data.

Consumption of albendazole within the NHS and independent sectors was relatively stable between 2019 and 2021 and, following a notable increase of 75% DID between 2021 and 2023 (from 0.004 to 0.007 DIDs), declined in 2024 (0.004 DIDs). Praziquantel consumption, indicated for the travel-associated helminth infection schistosomiasis, increased from 2019 to 2024 (from

0.0001 to 0.0002 DIDs, +48%), but continues to contribute only a small proportion of the overall anthelmintic DIDs.

Current UK collaboration (4 nations) and participation in international surveillance

Consumption data for England continues to be monitored and collated alongside those of the devolved administrations (Northern Ireland, Scotland, and Wales) to understand the UK-wide picture of total primary and secondary care consumption and progress made towards the UK AMR 5-year NAP for antimicrobial reduction targets (50).

England, in collaboration with the other UK administrations, submits and validates data to the WHO Global AMR and Use Surveillance System (GLASS) antimicrobial consumption module (GLASS-AMC). Recent submissions have been for England and Scotland data, for the years covering 2016 to 2024.

Future actions

Improved data granularity and linkage: Patient-level prescribing data is now available in primary care, with secondary care data expected. This enables linkage between prescribing records, hospital admissions, and other datasets, to better understand patient pathways. Increased granularity, particularly clinical indication, will expand epidemiological research and improve insights into patient groups, risk factors and prescribing appropriateness.

Understanding independent sector antibiotic use: Access to independent sector prescribing data has improved and is presented in this report. This supports understanding of the independent sector contribution to national prescribing trends and provides a more accurate picture of total antimicrobial consumption across the country. Prescribing within independent dental practices remains indistinct within broader independent primary care data. Further work is ongoing to address this.

Epidemiological projects

Ongoing work is exploring how sustained high levels of remote versus face-to-face consultations affects antibiotic prescribing trends in general practice. Additionally, patient-level data is being utilised to understand the impact of primary care antibiotic use as a risk factor to CDI.

Future work is also planned to expand on the variations seen in antimicrobial consumption across the country, exploring regional differences in antimicrobial use and possible correlations with AMR profiles and sociodemographic characteristics, particularly by level of deprivation, which has been associated with higher prescribing and healthcare seeking behaviour, in more deprived areas (121 to 123).

Pharmacy First Service

2024 saw the introduction of the Pharmacy First scheme. The UKHSA continues to monitor the impact of Pharmacy First on trends in antimicrobial use in the community in England and is involved in the evaluation of the scheme with academic partners.

Expansion of international surveillance

Antifungal use data was included in the UK submission to the WHO GLASS antimicrobial consumption module for the first time in 2024. The UKHSA re-established the ESPAUR antifungal sub-group, hence future antifungal collaboration should inform antifungal prescribing and resistance surveillance. The subgroup performed a survey of NHS acute trusts to determine the extent to which antifungal stewardship (AFS) is embedded in clinical practice and barriers to increasing AFS in secondary care. A summary of the results can be found in the AMS chapter.

International collaborations

We plan to build on previous collaborative work between the UKHSA and the Transatlantic Taskforce on Antimicrobial Resistance (TATFAR). We will also continue to develop international relations through our Global AMR Surveillance workstream.

Knowledge mobilisation

UKHSA routinely publishes national antimicrobial surveillance data through a public-facing dashboard, Fingertips: AMR local indicators, which presents and makes available geographically granular data to support local monitoring and action. Ongoing work aims to improve the timeliness of data publication and review of published metrics with decision-making stakeholders, alongside the development of a new UKHSA dashboard designed to enhance presentation of surveillance insights.

New antimicrobial surveillance workstream

Continue monitoring the use of newer antimicrobials (as detailed in the Antimicrobial Product Subscription Model section and COVID-19 therapeutics) and expand surveillance to include repurposed and ‘non-traditional’ antibacterials and antibiotic alternatives (for example monoclonal antibodies, bacteriophages) in England. This includes assessing their introduction, consumption trends, clinical indications, and resistance patterns to inform clinical guidance and the national rollout of stewardship interventions. A workstream strategy is currently being developed to support this effort. As part of the UKHSA’s pandemic preparedness planning, monitoring of antivirals for the treatment of respiratory infections will be extended.

One Health

Work on the fourth Joint UK One Health Report on antibiotic use, antibiotic sales and antibiotic resistance is ongoing. The report is expected to be published at the beginning of 2026.

Chapter 4. Antimicrobial stewardship

Main messages

TARGET (Treat Antibiotics Responsibly, Guidance, Education and Tools) antibiotics toolkit
Research with primary care staff identified the need for a consistent, whole-practice approach to antimicrobial stewardship (AMS) when improving prescribing behaviours. As a result, the TARGET Cycle of AMS infographic was developed to illustrate AMS as a continuous process, highlighting key steps along the way. TARGET also published a new set of resources to support primary care staff in the prevention and management of recurrent urinary tract infections. The resources are evidence-based and align with national guidance and add to the TARGET 'How-to…?' series for reviewing patients on long-term or repeat antibiotics for complex conditions.

Evaluation of UKHSA AMS tools to support secondary care in England
The evaluation highlighted widespread use of UKHSA AMS tools with web analytics showing an average of 71,588 visits to tool host websites over a 4-year period. Seven of the 12 tools identified had evidence of use in secondary care both within England and the devolved nations. Eleven tools had evidence of impact in the UK, such as impact on guidance from UK national organisations, references in UK AMR action plans and NICE guidance and showed an impact in national media, with the ESPAUR report specifically named or used in 50 mainstream media news items since 2019. The Start Smart, then Focus Toolkit, Antibiotic Guardian campaign, ESPAUR report, and the Antimicrobial Stewardship Prescribing Competencies were also found to have had international impact.

Knowledge mobilisation of the new UK-adapted AWaRe categories in primary and secondary care
Evidence of immediate utilisation of the UK-adapted AWaRe categories has been seen with the gov.uk website receiving 1,130 unique visits in the first 2 months after publication. Social media activity to support awareness of the publication on Facebook, LinkedIn, Instagram, and X had 84,577 total impressions, 3,456 engagements with a 4.1% engagement rate, and 83 shares. Knowledge mobilisation activities have included publication of a press release and subsequent articles in trade journals, Fingertips news webpage update, presentation at ESPAUR Oversight Group, a news article included in the Antibiotic Guardian newsletter, email dissemination with key individuals and stakeholders, and sharing by ESPAUR Oversight Group stakeholder organisations with their membership.

What indicators are used to estimate or measure appropriateness of antibiotic prescribing high-income countries? A rapid systematic review
Most of the articles (*n* = 119) described patient-level indicators for appropriateness that considered one or more factors relating to indication, drug and/or patient characteristics

(Figure 4.8). Around a quarter of the articles (*n* = 35) described proxy-indicators that estimated appropriateness based on population-level data, such as antibiotic consumption data, prescription information, prescriptions linked to diagnosis coding, and those that require information relating to prescription, diagnosis and patient demographics. Initial findings highlight the complexity of defining appropriateness of antibiotic prescribing and the required knowledge of the drug and diagnosis to be able to correctly determine appropriateness of prescribing.

What roles have pharmacy professional had in the preparedness, prevention, response, and recovery to non-COVID-19 outbreaks? A rapid systematic review

The review showed several roles for pharmacists within outbreaks, prevention and preparedness, including among others supply of patient advice at micro-level, collaborating with regional partners for vaccinations at meso-level and development of national treatment guidance at macro-level. Fewer roles in recovery were identified with examples including organisational level root cause analyses and research to learn from previous outbreaks.

Antifungal Stewardship Survey in 2024

Eighty-seven percent of Trusts with an antifungal stewardship (AFS) programme had access to fungal guidelines compared to 76% in 2016. However, guidelines were more likely to be unavailable for paediatric populations. Use of fungal biomarkers to guide care of patients with invasive fungal disease (IFD) reduced by 3% between 2016 and 2024. However, the availability of fungal biomarkers had increased for all tests since 2016. The main barriers to AFS, lack of staff time and competing priorities, remained the same as 2016.

Introduction to Chapter 4

Tackling antimicrobial resistance (AMR) requires action on multiple fronts to optimise antimicrobial use (AMU) and reduce the emergence and transmission of resistance. An important element of this approach is the implementation of antimicrobial stewardship (AMS) interventions. AMS enables healthcare workers to choose the most appropriate drug, dosage and duration of treatment, whilst limiting the microbe's ability to develop or acquire resistance. Optimising prescribing in this way is a focus of the UK's 5-year National Action Plan (NAP) on tackling AMR (50) which includes a target to reduce total antibiotic use in human populations by 5% from the 2019 baseline and to achieve 70% of total use of antibiotics from the Access category (new UK category) across the human healthcare system.

In this chapter we provide a summary of national primary and secondary care AMS interventions led by the UKHSA between April 2024 and March 2025. This year's AMS chapter features multiple projects that span both primary and secondary care and therefore an 'AMS across sectors' section features in this year's chapter. In addition, we also outline ongoing work to tackle health inequalities associated with AMR and antimicrobial prescribing.

Professional and public education and training is an important part of AMS. Further information about World AMR Awareness Week (WAAW) AMS resources, such as the Antibiotic awareness toolkit for healthcare professionals in England, is available in the Professional and Public Education and Training (PPET) chapter (Chapter 6).

Primary care AMS

TARGET antibiotics toolkit

AMR is linked to antimicrobial prescribing and with 80% of antibiotics being prescribed in primary care (Chapter 3), it is crucial that we provide evidence-based resources to support our primary care workforce. The TARGET (Treat Antibiotics Responsibly, Guidance, Education and Tools) Antibiotics Toolkit aims to support a practice-based approach to AMS. All TARGET resources are designed using behavioural theory and in collaboration with primary care staff and patients, to support responsible antibiotic use. By providing information and resources for both patients and healthcare staff, TARGET facilitates shared decision making for AMU and supports the 2024 to 2029 AMR NAP by prioritising a well-resourced workforce to address AMR.

Optimising antibiotic use

The TARGET toolkit comprises a suite of resources to support clinicians on all aspects of AMS, including training tools, patient information leaflets, clinical audits, diagnostic guidance, antibiotic prescribing summary tables, self-assessment checklist, and materials for clinical waiting rooms. The resources can be used flexibly, either as standalone materials or as part of an integrated package. They can be downloaded for free from the Royal College of General Practitioners (RCGP) website and adapted for local use.

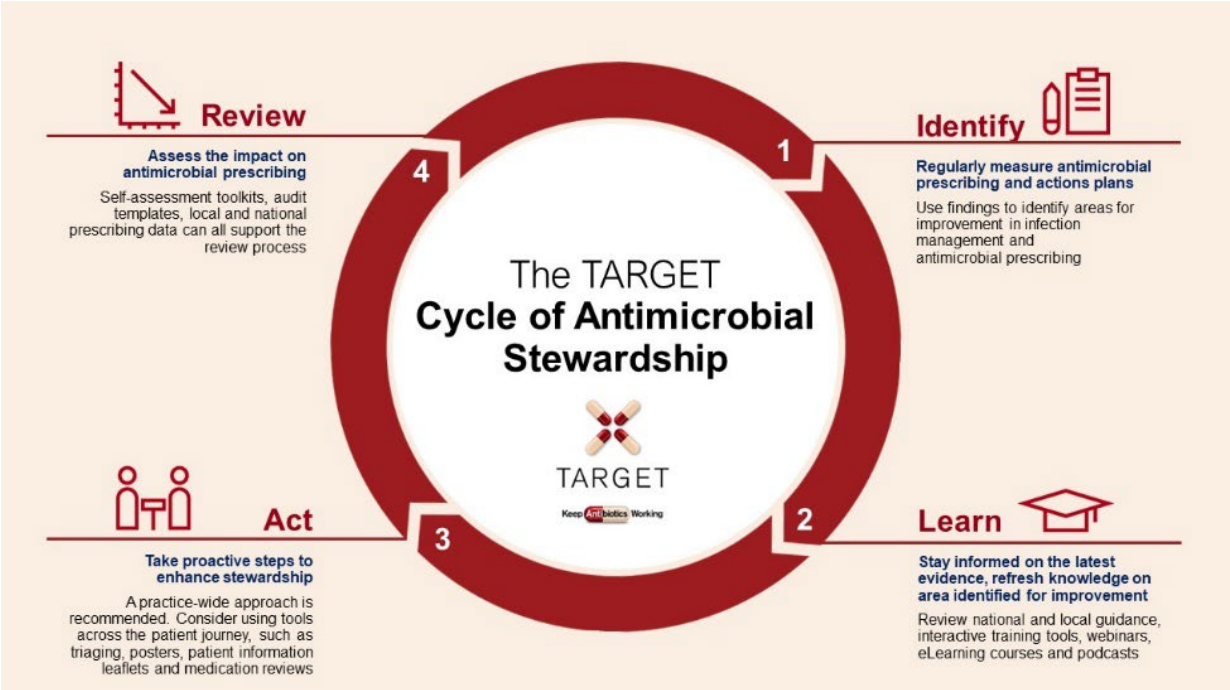
TARGET Cycle of Antimicrobial Stewardship

The TARGET resources are designed to support primary care providers in planning, implementing and reviewing AMS activities. These resources align with the antimicrobial prescribing and stewardship competency framework (124), offering practical tools to embed AMS into routine practice.

To support the implementation of AMS interventions, UKHSA conducted a series of focus groups involving 19 staff members from 3 general practice settings. Participants represented a range of professional roles, providing diverse insights into their current AMS approach and the feasibility of adopting a cyclical model for implementing AMS in practice. The research revealed that, while teams often approach AMS as a linear process, clear steps were evident in practice. However, despite motivation to adopt a continuous and proactive cycle, time and resource constraints often meant that teams respond reactively to issues, with some steps being missed. Participants also highlighted the key role of administrative staff and the growing diversity of non-GP prescribers in delivering AMS messaging. However, there is a need for tailored AMS training and resources to support these professionals. A consistent, whole-practice approach to AMS was seen as essential to managing patient expectations and reducing unnecessary antibiotic prescribing.

In response to these findings, the TARGET Cycle of Antimicrobial Stewardship infographic was iteratively designed (Figure 4.1). This implementation framework illustrates a cyclical 4-step process: Identify, Learn, Act and Review. This tool is designed for use within primary care teams, supporting a whole-practice approach and demonstrating how the TARGET toolkit can facilitate the implementation of a stewardship cycle. The framework highlights that AMS activities are continuous and should not end once an intervention has been implemented.

Figure 4.1. TARGET Cycle of Antimicrobial Stewardship infographic



Text version of Figure 4.1

The TARGET Cycle of Antimicrobial Stewardship outlines the following cyclical steps that should be taken to encourage antimicrobial stewardship within primary care:

1. Identify – regularly measure antimicrobial prescribing and action plans. Use findings to identify areas for improvement in infection management and antimicrobial prescribing.
2. Learn – stay informed on the latest evidence, refresh knowledge on area identified for improvement. Review national and local guidance, interactive training tools, webinars, e-learning courses and podcasts.
3. Act – take proactive steps to enhance stewardship. A practice-wide approach is recommended. Consider using tools across the patient journey, such as triaging, posters, patient information leaflets and medication reviews.
4. Review – assess the impact on antimicrobial prescribing. Self-assessment toolkits, audit templates, local and national prescribing data can all support the review process.

End of text version.

New resource development: Recurrent UTI ‘How to…?’ tools

Regular and structured clinical reviews of patients receiving repeated acute courses or long-term prophylactic antibiotics are essential AMS interventions that align with both the 2024 to 2029 AMR NAP and the NHS Long Term Plan (50, 125).

The TARGET recurrent UTI (rUTI) ‘How to…?’ tools, developed in collaboration with NHS England (NHSE), aim to support primary care staff in reviewing patients on long-term or repeat antibiotics for rUTI. These resources include a clinical review booklet, providing recommendations for conducting a review which align with national guidelines, a worked examples slide deck, which uses clinical scenarios to illustrate key points and decision-making processes, and quick-reference checklists, which provide succinct step-by-step guidance which follows the structure of the booklet.

These resources add to the TARGET ‘How to…?’ series, which support primary care staff to review the appropriate use of antimicrobials in the treatment and prevention of complex conditions.

Updated TARGET resources: patient information leaflets

TARGET resources reflect the latest evidence base in antimicrobial prescribing and AMS, therefore it is essential that the tools are reviewed and updated to ensure they reflect current guidance and that the design and usability of the leaflets remain fit for purpose.

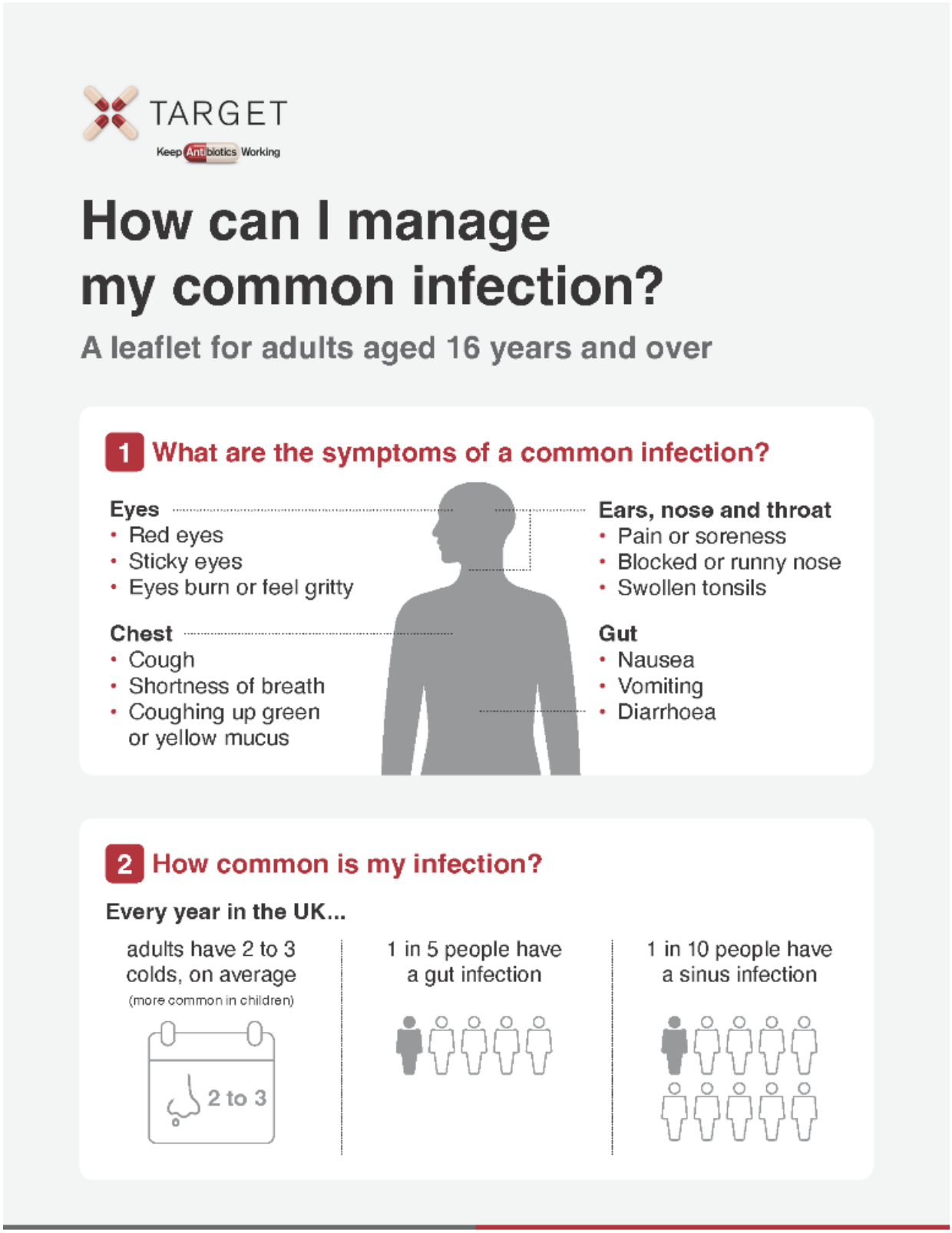
The TARGET patient information leaflets underwent a comprehensive review throughout 2024. This included an examination of the latest literature and national guidelines, as well as a user

testing phase to gather public feedback on the design and content. Nineteen participants were recruited through the UKHSA's market research panel, The People's Pulse, and each was allocated 2 leaflets to review.

Overall, participants found the leaflets to be helpful in supporting patient self-care and in guiding decisions about when to seek further medical advice. Feedback highlighted the need for minor improvements to enhance clarity and accessibility, such as simplifying medical terminology and reducing the density of text. In response, the leaflets underwent a plain language review and were awarded the Crystal Mark, confirming their clarity and readability for a broad audience. As part of the review, the leaflet previously targeted at older adults with UTIs was replaced with a new leaflet for all adults, which contains relevant information for older adults.

In November 2024, 5 revised leaflets were published to the TARGET toolkit: self-care for common infections, respiratory tract infections (RTI), RTI pictorial, UTI for women under 65 years and UTI for all adults. An example of one of the updated leaflets is shown in Figure 4.2. The leaflets are fully accessible as a website page, PDF or editable document and have been translated into 32 languages.

Figure 4.2. Front page of the revised TARGET patient leaflet on common infections following the 2024 review



Text version of Figure 4.2

Image showing the front page of the revised TARGET patient leaflet on common infections titled ‘How can I manage my common infection? A leaflet for adults aged 16 years and over’.

Underneath the title there is the silhouette of a person from the waist up with the question: ‘What are the symptoms of a common infection?’ and the following text:

- eyes – red eyes, sticky eyes, eyes burn of feel gritty
- ears, nose and thoat – pain or soreness, blocked or runny nose, swollen tonsils
- chest – cough, shortness of breath, coughing up green or yellow mucus
- gut – nausea, vomiting, diarrhoea

Underneath this is a second question: ‘How common is my infection?’ and the following text.

Every year in the UK:

- adults have 2 to 3 colds on average (more common in children)
- one in 5 people have a gut infection
- one in 10 people have a sinus infection

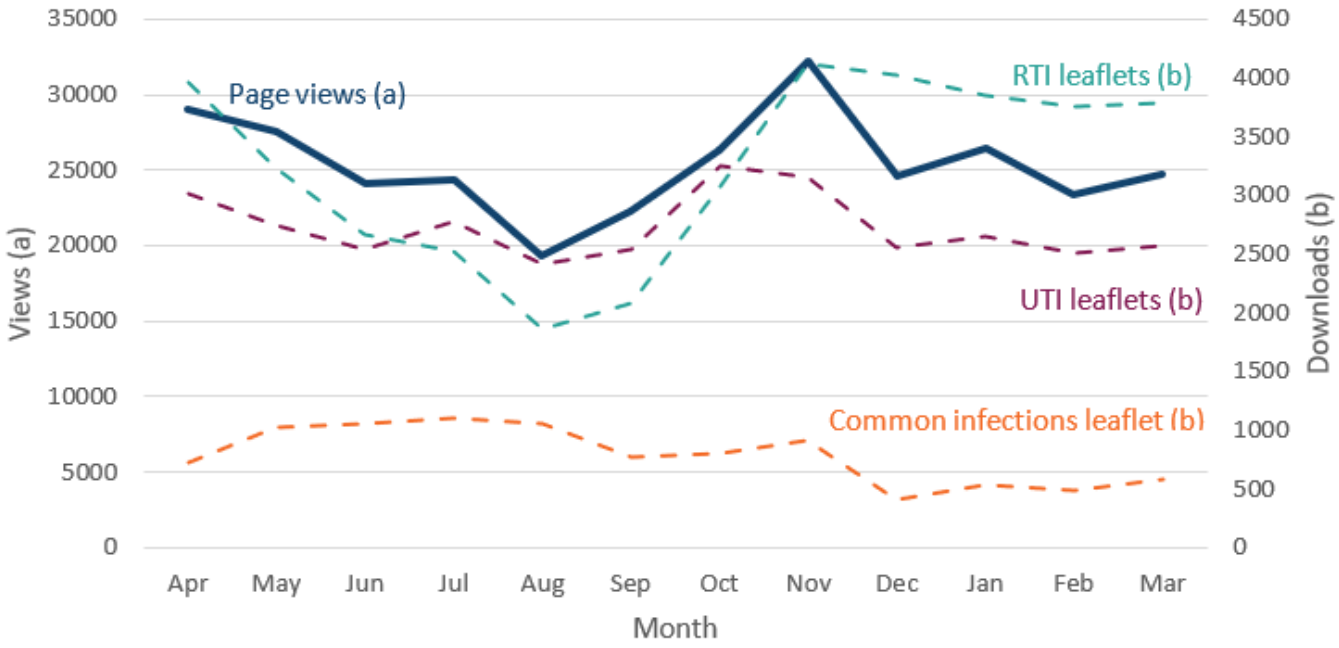
End of accesible text

TARGET website and resource usage

During the financial year (FY) from April 2024 to March 2025, the TARGET toolkit received a total of 304,047 website views (Figure 4.3). The highest engagement was in November 2024 at 32,267 views, during the TARGET and RCGP campaign for WAAW (see Chapter 6) and the publication of the updated patient information leaflets. Engagement was reduced during the summer period and at its lowest in August 2024, with 19,267 views.

TARGET leaflets were the most accessed resource on the toolkit, with a total of 81,050 downloads over the FY. The RTI leaflet was the most downloaded leaflet, making up 31,784 (39%) of the total leaflet downloads but reducing during the summer months of June to September (Figure 4.3). The most common format in which the leaflets were accessed was PDF (54,933 downloads), followed by HTML (23,673 downloads) and Word (15,485 downloads). TARGET leaflets are available in 32 languages, with Welsh being the most accessed translation (428 downloads), followed by Arabic (95 downloads).

Figure 4.3. Monthly page views of the TARGET antibiotics toolkit (a) and downloads of the TARGET patient information leaflets (b) between April 2024 and March 2025



AccuRx develop software which facilitates digital communication between patients and healthcare professionals and have integrated the 5 TARGET patient information leaflets into SMS templates. During the FY, a total of 9,682 leaflets were shared with patients using AccuRx, with the UTI leaflet for women under 65 years of age being the most used (32%). Additionally, the TARGET UTI Florey questionnaire, aligned with UKHSA diagnostic guidance, was issued over 191,000 times, peaking in October (18,403 issues). This supports clinicians in the management of prescribing antibiotics for UTI by providing them with an overview of the patient's condition prior to the consultation, informing management options early and saving consultation times.

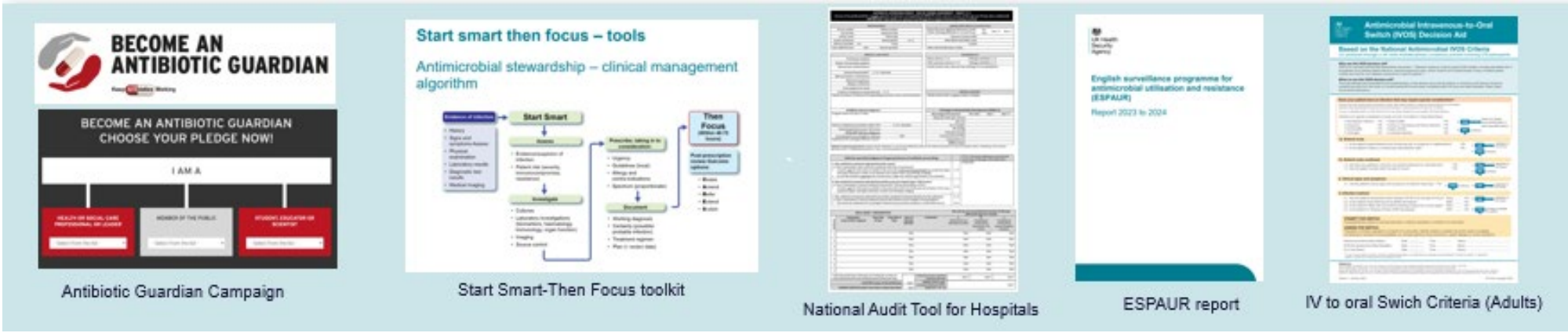
Secondary care AMS

Evaluation of UKHSA AMS tools to support secondary care in England

AMR is recognised nationally and internationally as a major risk to public health. Inappropriate use of antibiotics is a driver, and good AMS is a key factor in mitigating this risk. Since 2011, UKHSA and its predecessor organisations have developed national tools to support AMS through various research-focused methods (Figure 4.4). These include secondary care-specific tools for example 'Start smart then focus' (SSTF) toolkit, as well as tools that support AMS across multiple sectors for example Antibiotic Guardian Campaign (126, 127).

An evaluation was conducted to determine the extent to which the national AMS tools developed by UKHSA for use in secondary care are being used and implemented to support AMS activities in secondary care in England, and the wider impact of the tools, as well as the barriers and facilitators to their use.

Figure 4.4. Examples of the AMS tools evaluated



Text version of Figure 4.4

The image shows examples of 5 AMS tools. From left to right these are:

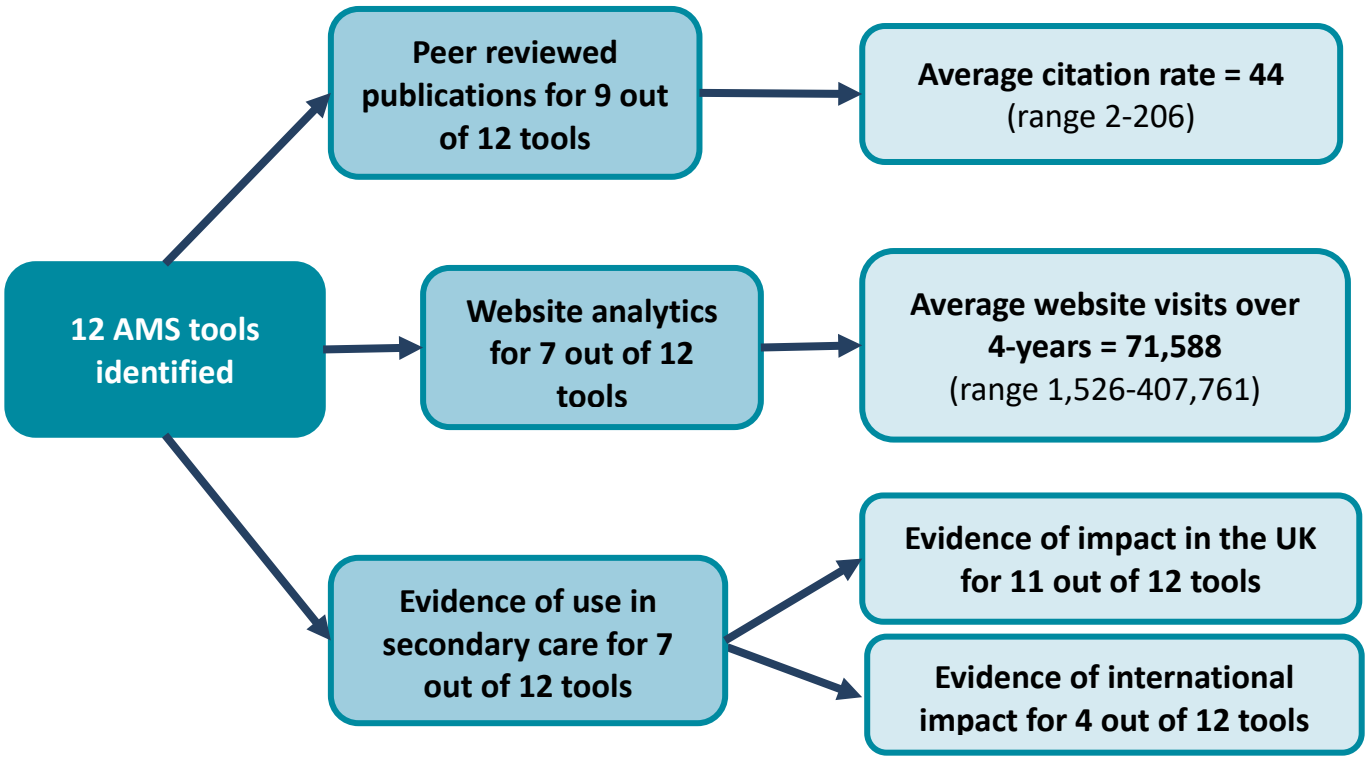
- a screenshot of the pledge section of the Antibiotic Guardian website
- screenshot of the Start Smart then Focus clinical management algorithm taken from the Start Smart then Focus toolkit
- a screen shot of the national audit tool for hospitals
- a screenshot of the front page of the 2023 to 2024 ESPAUR report
- a screen shot of the intravenous to oral switch criteria for adults

End of accessible text

The first phase of the evaluation, carried out between October and November 2024, comprised of a scoping review. Literature database (PubMed), grey literature search (Policy Commons), ESPAUR reports (2014 to 2024), UK AMR Strategy (2013 to 2018), National Action Plan (2019 to 2024 and 2024 to 2029), UK 20-year AMR vision, NICE guidelines and NHSE policy documents were reviewed. Data was collected on the number of citations of papers on tool development, number of views of the host webpage (2020 to 2024), evidence of use in the UK, and reference to the tool internationally.

Twelve tools were identified including tools developed specifically to support secondary care, such as intravenous to oral switch checklist, as well as some that support across a range of settings, such as the ESPAUR report and Antibiotic Guardian campaign. There was evidence of widespread use of the tools (Figure 4.5). Peer-reviewed publications for development were available for 9 of the 12 tools, with an average citation rate of 44 (range: 2 to 206). Website analytics were available for the host website of 7 tools, with an average of 71,588 visits in a 4-year period (range: 1,526 to 407,761). Seven tools had evidence of use in secondary care in England and the devolved nations. Eleven tools had evidence of impact in the UK, including evidence of impact on guidance from UK national organisations such as Royal Colleges and charities, references in UK AMR action plans and NICE guidance and impact in national media, with the ESPAUR report specifically named or used in 50 mainstream media news items since 2019. There was also evidence of international impact for the Start Smart, then Focus Toolkit, Antibiotic Guardian campaign, ESPAUR report, and the Antimicrobial Stewardship Prescribing Competencies.

Figure 4.5. Summary of findings from scoping review



Text version of Figure 4.5

The image shows a flow diagram outlining findings from an evaluation of UKHSA AMS tools to support secondary care in England. A box on the far left contains the text 12 AMS tools identified. Three arrows extend from this box linking to a second column of 3 boxes. The top arrow links to a box containing the text Peer reviewed publications for 9 out of 12 tools. An arrow links this to a box in the top right of the image containing the text Average citation rate equals 44 (range 2 to 206). The middle arrow that extends from the far left box links to a box containing the text Website analytics for 7 out of 12 tools. This links to another box with the text Average website visits over 4 years = 71588 (range 1,526 to 407,761). The third arrow

extending from the initial far left box links to a box with the text Evidence of use in secondary care for 7 out of 12 tools. This links to 2 final boxes containing the text Evidence of impact in the UK for 11 out of 12 tools and Evidence of international impact for 4 out of 12 tools.

End of accessible text.

The evaluation showed that some tools have more evidence of impact than others, particularly those that are available on websites, with the Start Smart Then Focus Toolkit and the Antibiotic Guardian Campaign showing most evidence of impact. The outcomes of the first phase of the evaluation have been shared via a conference poster at BSAC in November 2024 (128).

Antimicrobial stewardship across sectors

This year's AMS chapter features multiple projects that span both primary and secondary care.

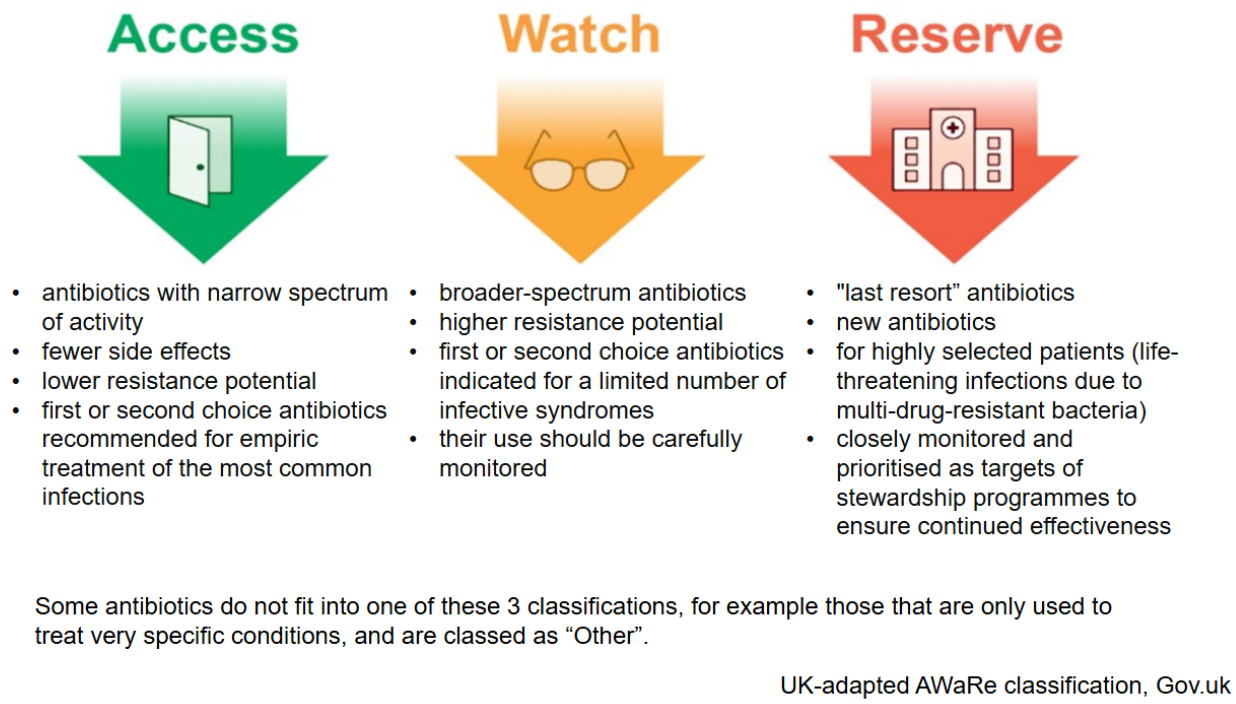
Publication of new UK-adapted AWaRe categories and subsequent knowledge mobilisation in primary and secondary care

The Expert Advisory Committee on Antimicrobial Prescribing, Resistance and Healthcare Associated Infection (APRHAI) commissioned UKHSA/ESPAUR to a develop UK-wide classification following the update of WHO AWaRe categories in 2023. The method for Delphi consensus process (52) was published as a peer reviewed article in January 2025 and the updated UK-wide AWaRe categories were also published on .gov.uk website in January 2025 (3).

The new classification system directly supports Target 4b of the 2024 to 2029 NAP (50), which aims to achieve 70% of total antibiotic use from the Access category across human healthcare (Figure 4.6). The most significant change within the adapted 2024 classification compared to the England-adapted 2019 classification (129) is the move of first generation cephalosporins (cefadroxil, cefalexin, cefazolin and cefradine) from the Watch category to the Access category.

There are also some differences to the WHO 2023 categories, including co-amoxiclav as Watch as opposed to Access.

Figure 4.6. Summary of the Access, Watch and Reserve categories



Text version of Figure 4.6

The image outlines the access, watch and reserve categories. On the left of the image there is the word Access which is coloured green. Underneath this, a green arrow contains the image of a door and there is the following text underneath as bullet points:

- antibiotics with narrow spectrum of action
- fewer side effects
- lower resistance potential
- first or second choice of antibiotics recommended for empiric treatment of the most common infections

In the middle of the image is the word Watch in orange. Underneath this, an orange arrow contains an image of a pair of glasses and there is the following text underneath as bullet points:

- broader spectrum antibiotics
- higher resistance potential
- first or second choice antibiotics indicated for a limited number of infective syndromes
- their use should be carefully monitored

On the right of the image is the word Reserve in red. Underneath this a red arrow contains the image of a hospital and there is the following text underneath as bullet points:

- 'last resort' antibiotics

- new antibiotics
- for highly selected patients (life-threatening infections due to multi-drug-resistant bacteria)
- closely monitored and prioritised as targets of stewardship programmes to ensure continued effectiveness

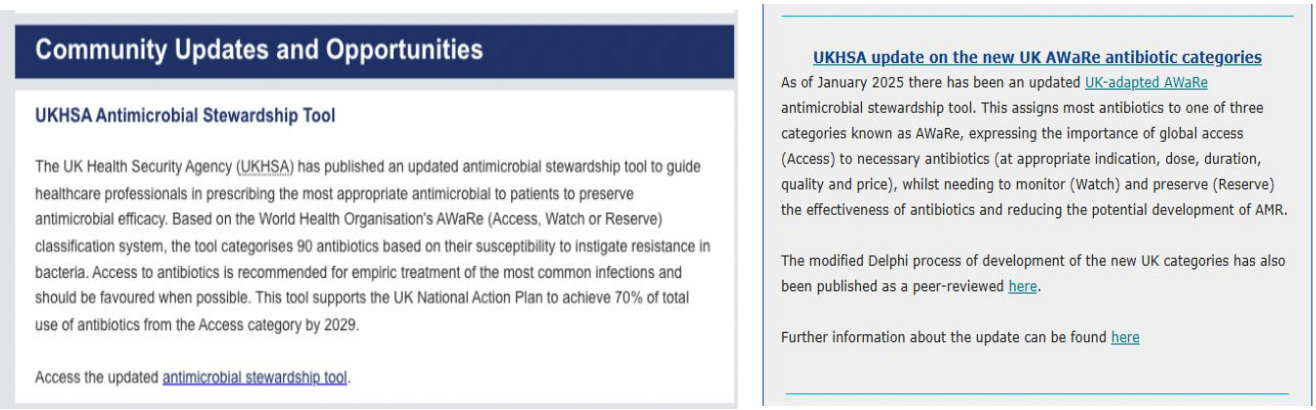
At the bottom of the image is the following text: “Some antibiotics do not fit into one of these 3 classifications, for example those that are only used to treat very specific conditions and are classed as ‘Other’”.

End of accessible text.

Evidence of immediate utilisation of the updated UK-wide AWaRe categories has been seen, with the gov.uk website receiving 1,130 unique visits in the first 2 months after publication. Social media activity to support awareness of the publication on Facebook, LinkedIn, Instagram, and X had 84,577 total impressions, 3,456 engagements with a 4.1% engagement rate, and 83 shares.

Additional knowledge mobilisation work has included the publication of a press release and subsequent articles in trade journals (January to February 2025), Fingertips news webpage update (Feb 2025), presentation at ESPAUR Oversight Group (Feb 2025), news article included in Antibiotic Guardian newsletter (March 2025), email dissemination with key individuals and stakeholders (March to April 2025) with ongoing work planned. Of the stakeholder organisations within the ESPUAR Oversight Group who were contacted a number have shared amongst their membership, including in newsletters (Figure 4.7).

Figure 4.7. Examples of newsletter inclusion from Microbiology Society and British Association for Sexual Health and HIV



Text version of Figure 4.7

The image contains 2 screenshots showing examples of newsletter inclusion from Microbiology Society and British Association for Sexual Health and HIV

End of accessible text.

Following publication of the updated UK-AWaRe categories, queries have been raised across the 4 nations regarding the impact of methenamine hippurate on achievement of the NAP targets, especially achievement of the 70% Access target. This is due to its classification as 'Other' and inclusion in the denominator for this target, as well as recent changes to NICE guidance (63) that may increase its use; NICE antimicrobial prescribing guidance now recommends that methenamine hippurate is considered for prevention of recurrent UTIs in women, trans men and non-binary people with a female urinary system. Discussions are ongoing at a UK-wide level for its placement in the context of national calculation of the NAP targets (Box 3.7).

What indicators are used to estimate or measure appropriateness of antibiotic prescribing high-income countries? A rapid systematic review

AMS aims to ensure that antimicrobials are prescribed appropriately. Defining and measuring 'appropriate' use is therefore vital to determine prescribing quality and optimise antimicrobial use.

UKHSA colleagues led on a collaboration with colleagues from the European Society of Clinical Microbiology and Infectious Diseases (ESCMID) Antimicrobial Stewardship Group (ESGAP) to conduct a rapid systematic review to identify indicators used to estimate or measure the appropriateness of antibiotic prescribing in high-income countries.

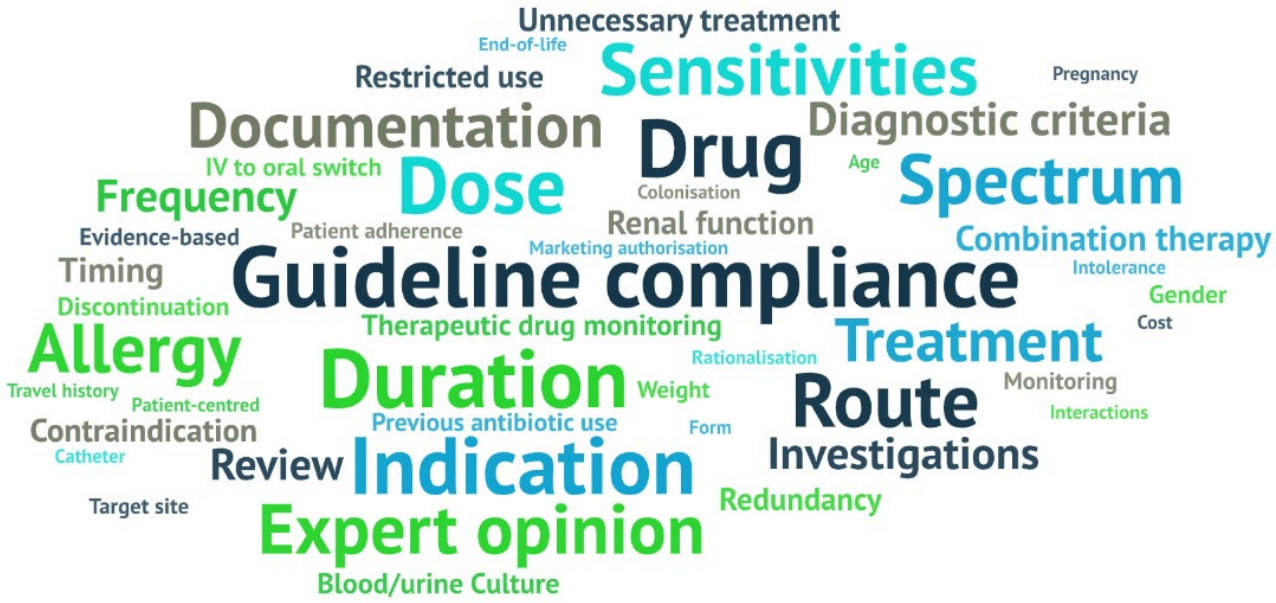
Electronic bibliographic databases Embase, Medline and Cochrane were searched. Articles discussing indicators to estimate or measure appropriateness of antibiotic prescribing of systemic antibiotic treatment or prophylaxis in high income countries published from 2014 onwards were included. Other antimicrobials were excluded. High income countries were defined as the 38 belonging to the Organization for Economic Co-operation and Development (OECD). Each article was screened and extracted by one reviewer, with 10% reviewed by a second reviewer. The method was published on PROSPERO (130).

The interim results have been presented at ESCMID Global conference, with in-depth results planned for publication in autumn 2025.

Initial database searches identified 1,155 articles for screening after de-duplication, and of those 154 are included in the initial results. 22 out of the 38 OECD countries were represented, with the highest number of papers from the United States (*n* = 30) followed by France (*n* = 16), Australia (*n* = 15), and the United Kingdom (*n* = 13). Indicators to determine the appropriateness of antibiotic prescribing in a wide variety of settings, infections, and patient groups were described. Most of the articles described hospital settings (93), and did not restrict the patient group, infection or drug that was the focus.

Most of the articles (*n* = 119) described patient-level indicators for appropriateness that considered one or more factors relating to indication, drug and/or patient characteristics (Figure 4.8). Around a quarter of the articles (*n* = 35) described proxy-indicators that estimated appropriateness based on population-level data, such as antibiotic consumption data, prescription information, prescriptions linked to diagnosis coding, and those that require information relating to prescription, diagnosis and patient demographics.

Figure 4.8. Word cloud of themed factors assessed as part of patient-level indicators (larger words were more frequently used)



Text version of Figure 4.8

The image contains a word cloud made up of the following words: unnecessary treatment, end-of-life, restricted use, sensitivities, pregnancy, documentation, drug, diagnostic criteria, IV to oral switch, age, frequency, dose, colonisations, spectrum, evidence-based, patient adherence, renal function, marketing authorisation, combination therapy, timing discontinuation, guideline compliance, intolerance, gender, cost, allergy, therapeutic drug monitoring, rationalisation, treatment, travel history, patient centred, duration, weight, route, monitoring, interaction, contraindication, previous antibiotic use, form catheter, review, indication, investigations, target site, expert opinion, redundancy, blood/urine culture.

End of accessible text.

The initial findings from this rapid systematic review show that defining the appropriateness of antibiotic prescribing is complex and published literature has used indicators that include multiple factors assessed at a patient level. Indicators used to assess appropriateness across countries, settings, and diagnoses are often consistent, with one or more factors relating to the indication, the drug and the patient. Guideline compliance, drug choice appropriate for the indication, correct dose and appropriate duration based on the drug and the indication are common indicators used. Population-level indicators relating to antibiotic consumption,

prescription information or diagnostic coding are described in around a quarter of published articles. These initial findings also suggest that most indicators require knowledge of the drug and the diagnosis to determine appropriateness of prescribing.

What roles have pharmacy professionals had in the preparedness, prevention, response, and recovery to non-COVID-19 outbreaks? A rapid systematic review

The World Health Organization (WHO) defines disease outbreaks as the occurrence of cases in excess of normal expectancy. They are usually due to infectious diseases, although may occur following exposure to chemicals or radioactive materials (131). Examples of non-COVID-19 outbreaks include widespread outbreaks such as H1N1 influenza, ebola, and local outbreaks, such as measles in a school. Infectious disease outbreaks and subsequent high use of antimicrobial treatment can be a driver for AMR. Pharmacy professionals are well placed to undertake pharmaceutical public health roles in the management of outbreaks as part of the WHO emergency cycle of prevention, preparedness, response, and recovery (132). They can also have a significant role to play in AMS activities. These activities can be at a micro- (individual or patient-facing), meso- (regional or organisational) or macro- (national) level (133).

A rapid systematic review was conducted, led by colleagues within UKHSA to identify pharmacy professionals' contribution to the management of non-COVID-19 outbreaks, classifying their roles according to the WHO emergency cycle and level of intervention.

Bibliographic databases Embase, Medline, and SCOPUS were searched. Articles discussing pharmacy professionals' contributions or roles in the management of non-COVID-19 outbreaks from 2014 onwards were included. Following screening, data was extracted and included papers were assessed for risk of bias by one reviewer, with a minimum of 10% of decisions checked by a second reviewer. The protocol for the review was published on PROSPERO (134). Interim results are reported here, with in-depth results planned for publication in autumn 2025.

Initial database searches identified 1,489 articles after de-duplication, and 248 were screened for their title and abstract. Full text assessment was conducted on 168; most of the papers were narrative commentaries or descriptive case studies. Outbreaks were identified across 53 countries, with the highest number of papers from the US (55 out of 168) followed by multi-nation papers (23 out of 168) and China (9 out of 168).

Specific disease outbreaks were reported in 97 papers, covering over 30 diseases including influenza (n = 23), mpox (n = 16), ebola (n = 13), zika (n = 6), poisonings (n = 4) and AMR, biohazards, measles and tuberculosis (n = 3 each). A third of the papers (54 out of 168) reported roles in non-disease specific general outbreaks, pandemics, and epidemics. Outbreaks due to contamination of pharmaceutical products were reported in 17 papers.

Most of the reported roles for pharmacy professionals were themed within the response phase of the WHO emergency cycle. Examples included supply of patient advice such as the appropriate use of antibiotics at micro-level, collaborating with regional partners for vaccinations at meso-level and development of national treatment guidance at macro-level. Examples of roles themed as prevention included vaccinating, contributing to organisational infection prevention and AMS guidance, and employment within national health protection organisations. Preparedness examples included undertaking learning, organisational stock management of vaccines, and pandemic preparedness research. Fewer roles reported could be themed as part of recovery. Examples included long-term management of poisonings, organisational level root cause analyses, and research to learn from previous outbreaks.

The initial findings from this rapid systematic review show that pharmacy professionals have contributed to the management of outbreaks within multiple countries. When themed within the phases of the WHO emergency cycle, most of the roles were related to response, followed by prevention and preparedness, fewer roles were themed within the recovery phase and most of the reported interventions were at the micro-level. However, the pharmaceutical public health expertise of pharmacy professionals at meso-and macro-levels, as well as the recovery phase of the WHO emergency cycle, appear to be under-utilised.

Stewardship of antifungals

The English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Antifungal Stewardship Survey in 2024: a comparison with the 2016 survey

Invasive fungal diseases (IFDs) are increasing with global cases currently estimated at 6.5 million and at-risk populations expected to rise. Additionally, antifungal resistance is increasingly reported worldwide. Antifungals are mostly prescribed for empirical treatment, with poor access and long turnaround times (TATs) limiting diagnostic test utility, which is unlikely to improve prescribing practice and consequently antifungal stewardship (AFS).

This work aimed to explore the current status of AFS initiatives across England, the challenges faced, ways to improve current AFS programmes and compare results to baseline data collected in 2016.

A web-based survey containing 40 questions was developed in Microsoft Forms and piloted by 3 antimicrobial pharmacists for face validity. The survey was disseminated to NHS hospital trusts in May 2024 through UKHSA and NHSE networks. Conclusive responses were agreed for trusts with multiple responses. Results were analysed using Microsoft Excel.

Forty-three trusts (28%) responded to the survey, compared to 30% in 2016; these were predominantly from London (17 out of 40, 43%). Respondents comprised antimicrobial

pharmacists (34 out of 43; 79%), microbiologists (7 out of 43; 16%) and infectious disease physicians (2 out of 43; 5%), while in 2016 most were microbiologists (37 out of 54, 68%).

All respondents had an AMS programme (98% in 2016), with 35% (15 out of 43) also having an AFS programme (54% in 2016). Leadership and education were lacking from most AFS programmes (33%). Eighty-seven percent of trusts with an AFS programme had access to fungal guidelines (either prophylaxis, treatment or both) compared to 76% in 2016. However, guidelines were more likely to be unavailable for paediatric than for adult populations (Figure 4.9).

Use of fungal biomarkers to guide care of patients with IFD reduced slightly between 2016 and 2024 (94% to 91% respectively). However, the availability of fungal biomarkers had increased for all tests since 2016. Galactomannan-EIA, Beta-D-glucan and PCR for Pneumocystis pneumonia were available to all respondents in 2024 (Figure 4.10a), these were available to 94%, 77% and 87% of respondents respectively in 2016 (Figure 4.10b). However, there was an increase in the proportion of Trusts reporting TAT of over 96 hours for all tests in comparison to 2016 (3 to 19 percentage points).

Respondents whose hospital did not carry out AFS cited lack of staff time (22 out of 28; 79%), competing priorities (17 out of 28; 61%) and low fungal infection numbers (11 out of 28; 39%) as barriers. They reported that more staff time, financial incentives, and improved digital capabilities would support them to carry out AFS. This has not changed since 2016 when staff time (14 out of 21; 67%) and competing priorities (10 out of 21; 48%) were the main reasons given for the lack of an AFS programme.

The availability of rapid fungal diagnostics remains challenging. Availability of fungal biomarkers to guide treatment decisions has improved, but not turnaround times. The perception that fungal infection numbers were low is concerning when evidence suggests increasing patient populations at risk of IFD and highlights the need for the development and deployment of robust diagnostic strategies for IFD. Fewer organisations had guidelines for paediatrics compared to adults, potentially creating a health inequality, which needs to be urgently addressed.

Figure 4.9. Healthcare professionals ability to access guidelines for canidaemia and/or invasive aspergillosis for adults and paediatric populations

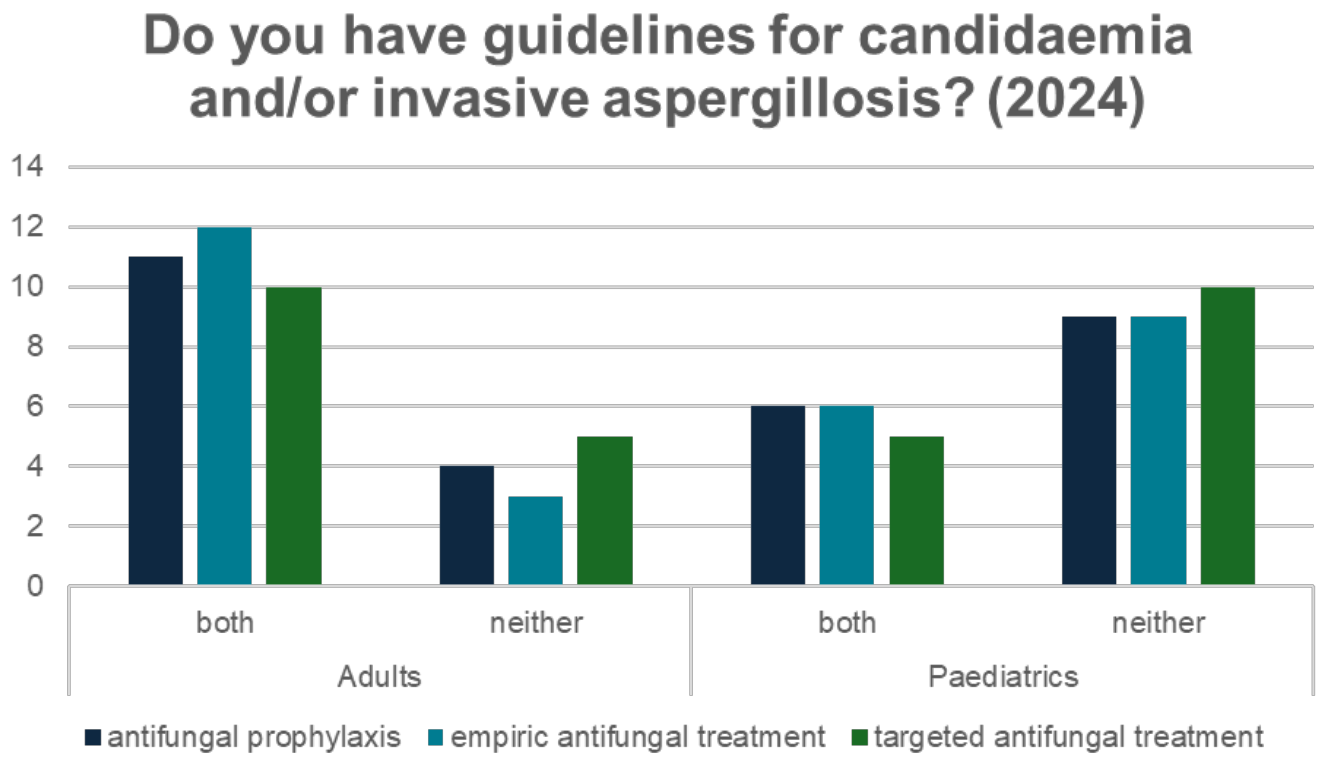
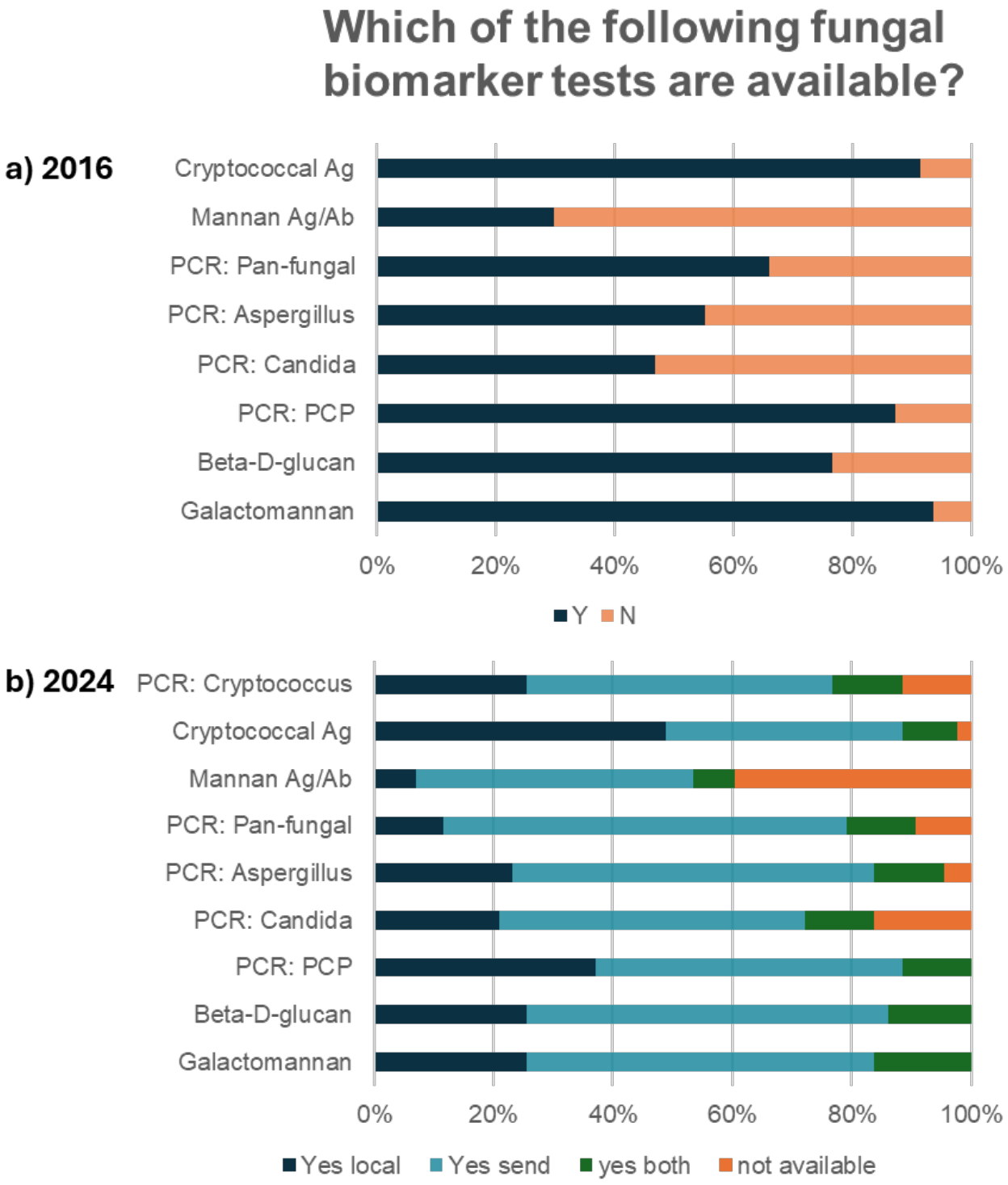


Figure 4.10a. Fungal biomarker availability in 2016, Figure 4.10b. Fungal biomarker availability in 2024



Health inequalities associated with AMR infections and prescribing

The impact of resistant infections may be particularly significant for those in vulnerable populations who often experience barriers to healthcare access and disparities in health

outcomes. Inclusion health groups include people who experience homelessness, drug and alcohol dependence, vulnerable migrants, Gypsy, Roma and Traveller communities, sex workers, people in contact with the justice system, and victims of modern slavery.

A series of reviews are being undertaken to understand the risks and potential actions that can be undertaken to support these groups. The reviews aim to systematically identify and assess the levels of antimicrobial-resistant infections and AMU focusing on specific inclusion health groups and adult social care populations. This information will inform and guide the development of effective, targeted interventions to reduce AMR and optimise AMU among these populations.

We acknowledge that individuals in these groups may overlap and therefore AMR prevalence may be due to experiences when an individual was a member of a former group (for example individuals experiencing homelessness may become a prisoner). However, the populations will be assessed separately. This is because the interventions are likely to differ depending on the population they are a member of (for example, access to prison healthcare, versus using night shelters).

A rapid systematic review to assess antimicrobial use, antimicrobial resistance and relevant antimicrobial stewardship interventions in people who use drugs

AMR is a growing global threat, with an increasing number of global deaths associated with or attributable to AMR (135). Current understanding of how factors associated with health inequalities may impact on AMR is limited. Although protected characteristics (including age, sex, ethnicity and index of multiple deprivation) are now included in routine AMR reporting in England (136), how specific marginalised populations may be impacted is unclear. It is well established that people who use, and particularly inject, drugs are at increased risk of blood-borne virus acquisition, sexually transmitted infections, and serious bacterial infections (137 to 139). However, how this may impact on the development of AMR is currently poorly understood.

Therefore a rapid systematic review is ongoing to evaluate AMU, AMR and relevant AMS interventions in people who use drugs.

A comprehensive search was conducted across PubMed, Scopus and Embase databases, employing relevant keywords and MeSH terms. Eligible publications were restricted to those from 2010 or later, published in English and based in middle- or high-income countries (as per World Bank criteria).

Prospective and retrospective studies were included. Randomised controlled trials (RCTs), observational studies and surveillance focusing on antimicrobial usage, AMR or AMS interventions in people who use drugs were included. Case reports or series, animal studies, modelling studies and qualitative studies were excluded.

A total of 1,765 abstracts were independently screened in duplicate, identifying 103 articles for full text review. Following full text review, 47 papers were eligible for inclusion. Meta-analyses and systematic reviews are currently being screened to identify any relevant additional papers, with synthesis of findings ongoing.

Future actions

TARGET antibiotics toolkit

Research

TARGET are developing a tool for care home staff to aid recognition and communication around suspected UTI, improve adherence to national guidelines on AMS and UTI, and promote self-care. Following an initial pilot in 2024, the tool has been adapted to integrate into care homes' digital reporting systems and a subsequent pilot will take place during 2025 to test the usability of the tool in this format and to inform a larger evaluation of the tool.

Resources and website

TARGET are planning to develop several new AMS resources, including:

- a digital diary for individuals with recurrent UTIs that will help users track symptoms, identify potential triggers and communicate more effectively with their clinicians
- patient information leaflets to support the collection of urine samples
- investigating the need for adapted TARGET resources for treatment of common infections in Accident and Emergency (A&E) settings
- development of a shared decision aid for paediatric RTIs in primary care, in collaboration with NHSE

In addition to these new resources, TARGET also plan to update the following existing materials in their toolkit:

- posters for clinical and waiting areas will be reviewed and updated
- a digital version of the TARGET Antibiotic checklist for community pharmacy settings has been translated into 25 languages and will be promoted in 2025 to 2026

Evaluation of UKHSA AMS tools to support secondary care in England

The next phase of the evaluation is due to be carried out in May to July 2025 and will include surveying the AMS workforce to determine which tools are used in secondary care. Furthermore, as a result of the initial phase of this evaluation, changes are planned to some GOV.UK resource pages to enable easy access to some of the less frequently used resources. Further knowledge mobilisation activities of the tools are also planned. This includes a survey of

Non-Medical Prescribing university course leads to raise awareness and determine the use of the national Antimicrobial Prescribing and Stewardship Competency Framework (124).

What indicators are used to estimate or measure appropriateness of antibiotic prescribing high-income countries? A rapid systematic review

Ongoing work is planned to finalise the review, which will be published in a peer-reviewed journal, and will inform policy implications, and ascertain whether the outcomes from the review could be reviewed and adapted (possibly by expert consensus) to give greater clarity and consistency for measuring appropriateness across the UK.

What roles have pharmacy professional had in the preparedness, prevention, response, and recovery to non-COVID-19 outbreaks? A rapid systematic review

Ongoing work is planned to finalise the review, which will be published in a peer reviewed journal. Work is also being undertaken to understand the UK context, including the implications for the management of outbreaks in the UK and for the AMS agenda.

Health inequalities

In addition to the 4 near-complete reviews, additional reviews for victims of modern slavery and Gypsy, Roma and Traveller communities will be commenced.

Furthermore, to support local and regional UKHSA teams, NHS colleagues and public health teams identify and address health inequalities in access, infection incidence, clinical outcomes, vaccine uptake and antimicrobial exposure, a toolkit will be collated and published. Interventions to tackle AMR in inclusion health groups and adult social care will also be identified.

In addition to this work which supports Commitment 8.2 and 8.3 of the 2024 to 2029 National Action Plan work is ongoing to further improve reporting on infection incidence and AMR by age, sex, ethnicity, deprivation, geography, and high-risk settings including adult social care and prisons.

Chapter 5. NHS England: improvement and assurance schemes

Main messages

NHS England (NHSE) designs and administers improvement and assurance schemes to incentivise prudent use of antimicrobials across the Integrated Care Systems (ICSs), to optimise patient outcomes, minimise avoidable exposure to antimicrobials and reduce selection pressure for antimicrobial resistance (AMR). Key areas of focus for the financial year (FY) 2024 to 2025 are shown in Figure 5.1 and include:

NHS Oversight Framework: The number of Integrated Care Boards (ICBs) meeting the national target for total primary care prescribing of antibiotics 'at or less than 0.871 items per STAR-PU' was 17 out of 42 (40%), an improvement from 24% in the previous year, and the number of ICBs meeting the national target for primary care proportion broad-spectrum antibiotic prescribing 'at or less than 10%' was the same at 41 out of 42 (98%). There was a decrease of 1,221,553 general practice antibiotic prescriptions in the 12 months to 31 March 2025 compared to the previous 12 months.

National Medicines Optimisation Opportunities: There was an absolute increase of 12% in the proportion of 5-day prescriptions for amoxicillin 500mg capsules between March 2024 and March 2025, and continued year-on-year increase to 69% at March 2025, demonstrating improvement beyond the national 60% target. This was achieved alongside a reduction of 103,473 total number of amoxicillin 500mg capsules items.

Pharmacy First: For the first time national data is available linking the supply of antimicrobials and antibiotic-sparing medicines with a standardised diagnosis for 7 common infections. For the 12 months April 2024 to March 2025 a total of 2,339,908 consultations were delivered in English community pharmacies to 2,252,359 patients for the 7 infection pathways. An antimicrobial was supplied in 45% to 85% of consultations (including urinary tract infection (UTI)). An antibiotic-sparing medicine was supplied in 25% to 36% of 3 relevant infection pathways.

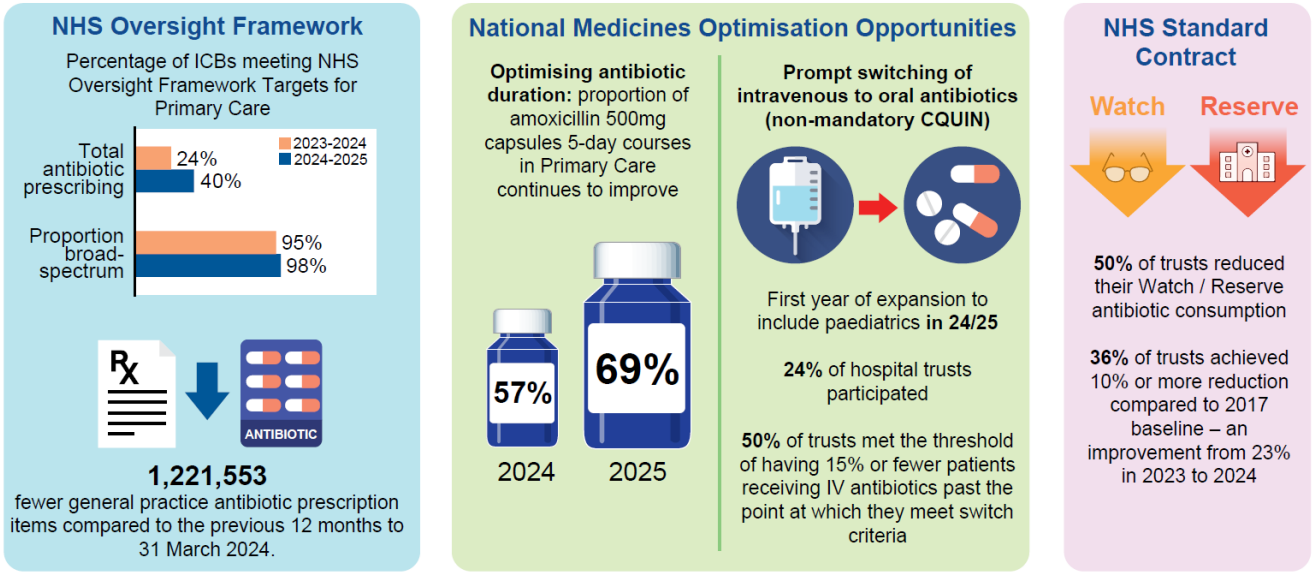
NHS Standard Contract: A requirement for Providers (NHS trusts and NHS foundation trusts) to use reasonable endeavours to reduce prescribing of broad-spectrum antibiotics was stated but no numerical target for improvement was set for 2024 to 2025. Forty-eight of 132 (36%) trusts achieved a 10% or more reduction in their 'Watch' and 'Reserve' antibiotic DDD per 1,000 admissions from the 2017 baseline, up from 30 trusts (23%) in the previous FY2023 to 2024. Consumption of antibiotics from the 'Watch' and 'Reserve' categories across England at FY end was 2,275 DDD per 1,000 admissions which is similar to the new National Action Plan 2024 to 2029 (using a 2019 to 2020 baseline) but reflects a decrease of 1.4% DDD per 1,000 admissions compared to the preceding FY 2023 to 2024.

National Blood Culture Pathway: The NHS national audit received data from 104 providers. Compliance with audit standards were low, with 26% of providers (regional range 16 to 38%) having the correct blood volume and 61% of providers (regional range 52 to 74%) placing the bottles in the analyser within the recommended 4-hour period.

NHS Commissioning for Quality and Innovation (CQUIN) non-mandatory scheme: The non-mandatory CQUIN 'Prompt switching of intravenous to oral antibiotic' was extended to paediatric patients. Overall, 33 of 135 (24%) NHS hospital trusts participated and submitted 9,595 audit cases, of which 541 (6%) were for paediatrics. Sixteen trusts met the 15% or lower threshold by Q4. Across England, 18% of cases were receiving IV antibiotics past the point at which they meet switch criteria. For paediatrics, this was 12% (67 of 541) of cases.

National initiatives to support system improvement: NHSE also provides system leadership and support through engagement with stakeholders, co-producing and co-ordinating implementation of a number of initiatives, designed as enablers, for health care commissioners and providers to enhance prudent antimicrobial use. These include optimising antimicrobial duration resources, recurrent infection resources, and supporting implementation of MHRA drug safety updates relating to fluoroquinolone prescribing.

Figure 5.1. Overview of NHS England improvement and assurance schemes and antibiotic prescribing performance for financial year 2024 to 2025



Text version of Figure 5.1

The image provides an overview of NHSE improvement and assurance schemes from 2024 to 2025. On the far left a box is titles NHS oversight Framework. A graph shows that in 2024 to 2025 40% and 98% of integrated care boards (ICBs) met the NHS Oversight Framework targets for total antibiotic prescribing and proportion of broad spectrum prescriptions in primary care respectively compared to 24% and 95% in 2023 to 2024. There were 1,221,553 fewer general practice antibiotic prescription items compared to the previous 12 months to March 2024. The middle box contains the title National Medicines Optimisation Opportunities. The

proportion of amoxicillin 500mg capsules 5-day courses in Primary Care increased from 57% in 2024 to 69% in 2025. In the first year of expanding IV to Oral Switch to include paediatrics 24% of trusts participated and 50% of trusts met the threshold of having 15% or fewer patients receiving IV antibiotics past the point at which they meet the switch criteria. On the right is a box titles NHS Standard Contract. This shows that 50% of trusts reduced their Watch/Reserve antibiotic consumption and 36% of trusts achieved a 10% or more reduction compared to a 2017 baseline. An improvement from 23% of trusts achieving this in 2023 to 2024.

End of accessible text.

National policies and commissioning

This section covers policies and initiatives for achieving the 2 human health antimicrobial stewardship targets in the UK National Action Plan – Confronting antimicrobial resistance 2024 to 2029:

- target 4a – by 2029, we aim to reduce total antibiotic use in human populations by 5% from the 2019 baseline
- target 4b – by 2029, we aim to achieve 70% of total use of antibiotics from the Access category (new UK category) across the human healthcare system

NHS Oversight Framework

The NHS Oversight Framework (NOF) aims to ensure the alignment of priorities across the NHS with wider healthcare system partners. It provides clarity to Integrated Care Boards (ICBs) and NHS providers on how NHS England (NHSE) will work with and through ICBs to monitor performance, based on objective measures of system performance and quality of care outcomes, and supports the ICBs' and NHS providers' goals.

The NOF contains 2 AMR-related indicators with targets for ICBs that have been used in NHS improvement and assurance schemes since 2015. The metrics and associated national targets are set out in Table 5.1, together with the percentage of ICBs achieving the targets. The number of ICBs meeting both targets continue to increase year on year and was 17 out of 42 (40%) for the 12 months to 31 March 2025. Data for financial year (FY) 2024 to 2025 excludes antimicrobials supplied via the Pharmacy First service for 7 common infection pathways that was launched on 31 January 2024, see Pharmacy First subsection later in this chapter for further information.

Table 5.1. NHS oversight framework targets for antibiotic prescribing and ICB performance

Code	AMR metric description	Target	Number of ICBs meeting target		
			FY 2022 to 2023	FY 2023 to 2024	FY 2024 to 2025
SO44a	AMR: total prescribing of antibiotics in primary care. The number of antibiotic (antibacterial) items prescribed in primary care, divided by the item-based Specific Therapeutic group Age-Sex Related Prescribing Unit (STAR-PU) per annum.	At or less than 0.871 items per STAR-PU	7 of 42 (17%)	10 of 42 (24%)	17 of 42 (40%)
SO44b	AMR: proportion of broad-spectrum antibiotic prescribing in primary care. The number of broad-spectrum antibiotic (antibacterial) items from co-amoxiclav, cephalosporin class and fluoroquinolone class drugs as a percentage of the total number of antibacterial items prescribed in primary care.	At or less than 10%	41 of 42 (98%)	40 of 42 (95%)	41 of 42 (98%)

For England as a whole, the NOF reported a reduction in total primary care antibiotic prescribing for the 12 months to 31 March 2025 to 0.893 antibacterial items per STAR-PU, from 0.938 for the preceding 12 months. At the final year of the UK AMR National Action Plan (NAP) 2019 to 2024 this scheme was associated with a reduction to 23% below the 2013 baseline, almost reaching the target to reduce by 25% to 0.871 antibacterial items per STAR-PU. There were 1,221,553 fewer general practice antibiotic prescription items in the 12 months to 31 March 2025 compared to the previous 12 months to 31 March 2024.

For the 12 months to 31 March 2025 in England, primary care prescribing of broad-spectrum antibiotics as a proportion of total antibiotics continues to meet the target of ‘at or less than 10%’ with 7.7% of prescriptions being for broad-spectrum agents, with a reduction of 129,625 broad-spectrum antibiotic prescriptions compared to the previous 12 months to 31 March 2024. This reduction is greater than the 84,000 broad-spectrum prescription reduction previously achieved for 2022 to 2023.

The data is available in the NHSE AMR NOF 2024 to 2025 dashboard that is published within the AMR Programme FutureNHS workspace. These are produced by NHSE in collaboration with the NHS BSA as monthly reports of ICB and sub-ICB location (SICBL) performance to monitor antibiotic prescribing in primary care and report ICB progress towards the NOF targets.

National Medicines Optimisation Opportunities

The second year of the National Medicines Optimisation Opportunities continued to provide guidance on 16 optimisation opportunities for ICBs with signposting to resources to help with their implementation. ICBs were invited to select at least 5 medicines optimisation opportunities to focus and deliver on, alongside any local medicines optimisation priorities.

For 2024 to 2025, there continued to be 2 AMR-related opportunities which were:

- reducing course length of antimicrobial prescribing – where success was defined as, by March 2025 nationally, 60% or more of the amoxicillin prescriptions as 5-day courses
- switching intravenous antibiotics to oral – where success was defined as all acute trusts meeting a target of 15% (or fewer) of patients still receiving IV antibiotics past the point at which they meet switch criteria

In March 2025, there was an absolute increase of 12% in the proportion of amoxicillin 500 mg capsule 5-day prescriptions in England, from 57% in March 2024 to 69% in March 2025, demonstrating improvement beyond the national 60% target. This was achieved alongside a reduction of 103,473 in the total number of amoxicillin 500mg capsules items (from 532,032 items in March 2024 to 428,559 items in March 2025) and an accompanying reduction in amoxicillin 500mg capsule 7-day courses (198,755 items in March 2024 to 106,459 items in March 2025). Data is available via the PrescQIPP Optimising Antimicrobial Use Dashboard.

Performance for the national medicines optimisation opportunity on switching intravenous antibiotics to oral is reported in the subsection NHS Commissioning for Quality and Innovation Scheme of this chapter.

Pharmacy First – Antimicrobial Stewardship

As part of the Delivery Plan for Recovering Access to Primary Care, NHSE launched the Pharmacy First service on 31 January 2024, which builds on the NHS Community Pharmacist Consultation Service established in October 2019. The Pharmacy First service aims to free up GP appointments for patients who need them most and give people quick and convenient access to safe and high-quality healthcare.

The Pharmacy First service comprises 3 elements enabling patients to present at or be referred to community pharmacy for. These are:

- minor illness management
- urgent repeat medicines supply
- clinical assessment using national protocols for 7 common infection pathways – main outcomes are provision of self-management advice, use of over-the-counter

medicine and/or supply of antimicrobials (antibiotics and antivirals) and/or antimicrobial-sparing medicines via a Patient Group Direction (PGD) where the choice of medicine, dose and duration is based on national guidance for each infection, non-urgent onward referral to general practice or other provider, urgent same-day referral

This report is focused on the Pharmacy First AMS associated with the 7 common infection pathways.

A National Institute of Health Research (NIHR) funded evaluation is underway to answer:

- How is Pharmacy First being implemented?
- What explains this pattern?
- What are its impacts on volume of prescribing, case mix of GP consultations, accident and emergency and hospital use, equity of access and cost for different groups of patients in different contexts?

For the first time national data is available linking the supply of antimicrobials with a standardised diagnosis for 7 common infections. This includes antimicrobial and antimicrobial-sparing medicines supply. The NHS BSA ePACT2 Antimicrobial Stewardship – Pharmacy First dashboard reports consultation activity by ICB based on where the person is registered with an NHS General Practice, providing ICBs with insight into their population use of the Pharmacy First service. The dashboard supports clinicians and NHS integrated care systems to monitor patient access to infection pathways and exposure to medicines including antimicrobials for defined populations.

For the 12 months from April 2024 to March 2025:

- a total of 2,339,908 consultations were delivered in English community pharmacies to 2,252,359 patients for the 7 infection pathways
- a supply of an antimicrobial or antimicrobial-sparing medicine, where applicable for the infection pathway, were the most common outcomes and varied by infection pathway Table 5.2
- face-to-face consultations accounted for 97% or greater for all infection pathways, with all acute otitis media consultations required to occur face-to-face
- children aged 0 to 14 years had 490,576 consultations, accounting for 21% of all consultations, with little variation by gender, supporting the importance of this cohort for targeted stewardship interventions
- females accounted for 64% of consultations for the 5 infection pathways that adults of both genders were able to access, signalling potential gender differences in incidence of infection or health-seeking behaviour

Each infection pathway has a defined population eligible to access care, and the population rate of access (number of people consulting out of the population within scope for the infection

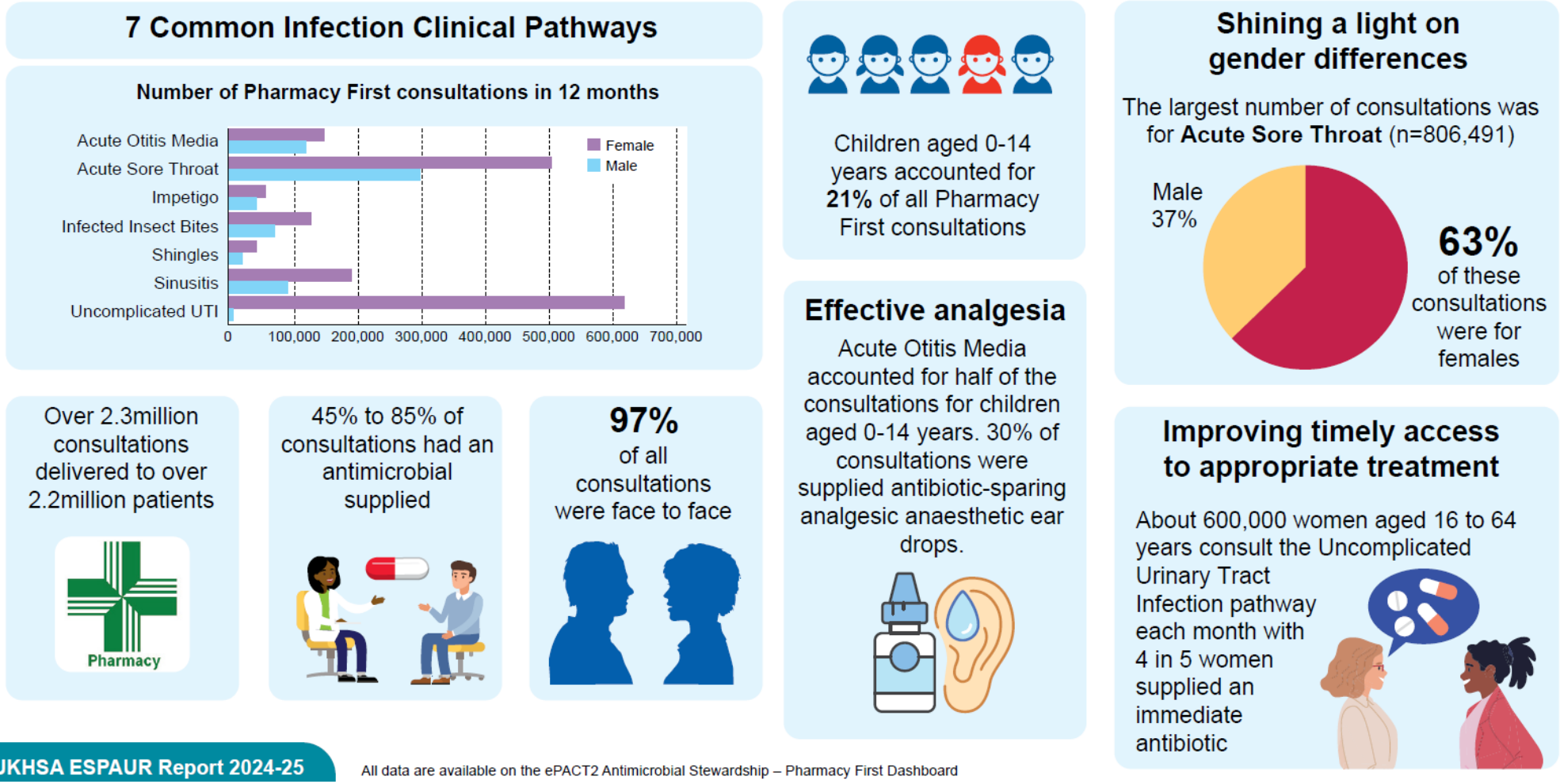
pathway) was greatest for uncomplicated UTI, followed by acute otitis media and then acute sore throat, Table 5.2. There is no equivalent data available for general practice to enable comparisons to be made. From a service level perspective, the largest number of consultations was for acute sore throat (*n* = 754,402), and the smallest number of consultations was for shingles (*n* = 57,523). The number of consultations varied by month for 6 of the 7 infection pathways, reflecting seasonal variations associated with the type of infections, for example, infected insect bites reported the largest seasonal variation with 67% of consultations occurring between June and September 2024. The infection pathways with the largest rate of urgent referrals were uncomplicated urinary tract infection (4% of consultations) and shingles (4% of consultations) followed by acute otitis media (2% of consultations). Figure 5.2 shows an overview of the Pharmacy First service in England for 12 months from April 2024 to March 2025.

Table 5.2 Population insights from the Antimicrobial Stewardship – Pharmacy First dashboard

Pharmacy First Infection Pathway	Number of consultations April 2024 to March 2025 Total = 2,339,908	Number of patients April 2024 to March 2025 Total = 2,252,359	Number of unique people consulting per 100,000 population (greatest monthly rate)	Percentage of consultations with: (aligned to greatest monthly rate)		
				Advice only provided	Antimicrobial supplied	Antimicrobial-sparing medicine supplied
Acute otitis media (for children aged one to 17 years)	269,308 (11.5%)	259,316 (11.5%)	250 (December)	19%	45%	30%
Acute sinusitis (for adults and children aged 12 years and over)	278,684 (11.9%)	266,445 (11.8%)	64 (March)	13%	47%	36%
Acute sore throat (for adults and children aged 5 years and over)	806,491 (34.5%)	774,092 (34.4%)	166 (March)	29%	65%	Non available
Impetigo (non-bullous impetigo for adults and children aged one year and over)	99,223 (4.2%)	95,653 (4.2%)	16 (March)	4%	68%	25%
Infected insect bites (for adults and children aged one year and over)	200,023 (8.5%)	195,299 (8.7%)	67 (August)	13%	83%	Non available

Pharmacy First Infection Pathway	Number of consultations April 2024 to March 2025 Total = 2,339,908	Number of patients April 2024 to March 2025 Total = 2,252,359	Number of unique people consulting per 100,000 population (greatest monthly rate)	Percentage of consultations with: (aligned to greatest monthly rate)		
				Advice only provided	Antimicrobial supplied	Antimicrobial-sparing medicine supplied
Shingles (for adults aged 18 years and over)	59,684 (2.6%)	58,628 (2.6%)	10 (no seasonal variation)	10%	82%	Non available
Uncomplicated urinary tract infection (for women aged 16 to 64 years with suspected lower UTI)	626,495 (26.8%)	604,926 (26.9%)	281 (December)	7%	85%	Non available

Figure 5.2 Overview of Pharmacy First service in England during 12 months April 2024 to March 2025



Text version of Figure 5.2

The image highlights key findings from an evaluation of Pharmacy First from April 2024 to March 2025. A graph on the top left shows the number of Pharmacy First consultations in 12 months for 7 common infection clinical pathways, split by gender. Females saw the highest number of consultations for uncomplicated urinary tract infection (UTI) (over 600,000) with 4 in 5 supplied an immediate antibiotic. Overall, the largest number of consultations were for acute sore throat (n=806,491) with 63% of these consultations for females and 37% for males. The lowest number of consultations in females were for shingles and for males were uncomplicated UTI. Over 2.3 million consultations were delivered to over 2.2 million patients with 45 to 85% of consultations having an antimicrobial supplied. 97% of consultations were face to face. Children aged 0 to 14 years accounted for 21% of all consultations and acute otitis media accounted for half of the consultations in this age group. 30% of these consultations were supplied antibiotic-sparing analgesic anaesthetic ear drops.

End of accessible text.

NHS Standard Contract

The NHS Standard Contract 2024 to 2025 retained a requirement for acute hospital trusts to use reasonable endeavours to reduce the use of broad-spectrum antimicrobials aligned with the new UK national action plan: Confronting Antimicrobial Resistance 2024 to 2029. Unlike preceding years, no specific numerical reduction target was set for acute providers due to publication of the NHS Standard Contract in advance of the 2024 to 2029 UK NAP for AMR (50). Performance is therefore reported against the NHS Standard Contract 2023 to 2024 ambition to achieve a 10% reduction in defined daily doses (DDDs) per 1,000 admissions for antibiotics from the WHO ‘Watch’ and ‘Reserve’ categories (adapted for use in England) against 2 baselines: FY 2019 to 2020 to align with the present UK AMR NAP and CY2017 to facilitate interpretation of progress against the ambitions of the previous NAP. NHS Standard Contact final performance data by trust is available on the NHS England AMR Programme FutureNHS workspace.

For the FY 2024 to 2025, the number of trusts that achieved a 10% reduction or more in their ‘Watch’ and ‘Reserve’ antibiotic consumption improved from 30 (20%) to 39 (20%) against the CY2017 baseline (Table 5.3). Applying the new NAP FY2019 to 2020 baseline year, 41 of 130 (30%) Trusts achieved a 10% reduction in Watch/Reserve prescribing per admission. Averaged across all acute provider Trusts for England, there was little change in the antibiotic consumption value compared to the FY 2019 to 2020 baseline (0.4% absolute decrease in DDD per 1,000 admissions) but a decrease of 1.4% DDD per 1,000 admissions compared to the preceding FY 2023 to 2024.

Table 5.3. Trust-level antibiotic consumption targets and achievement, 2023 to 2025

NHS Standard Contract	Target reduction in antibiotic consumption	Number of trusts that achieved 10% reduction or more in 'Watch' and 'Reserve' categories	Antibiotic consumption value at year end – 'Watch' and 'Reserve' categories DDD per 1,000 admissions
2023 to 2024 (UK NAP 2019 to 2024)	10% cumulative reduction in DDD per 1,000 admissions for antibiotics from the WHO 'Watch' and 'Reserve' categories (adapted for use in England) (compared with 2017)	30/132 (23%)	2,307
2024 to 2025 (UK NAP 2024 to 2029)	No numerical reduction target. Based on 10% reduction in DDD per 1,000 admissions for antibiotics from the WHO 'Watch' and 'Reserve' categories (adapted for use in England) (i) 2017 as baseline (ii) FY 2019 to 2020 as baseline	(i) 48 of 132 (36%) (ii) 41 of 130[a] (32%)	2,275 compared with (i) 2,297 (ii) 2,241

Note: Adjusted for additional trust merger.

National Blood Culture Pathway

Blood cultures are used for diagnosing bloodstream infections and this has not been replaced by newer, innovative technology. A 2018 blood culture survey reported a lack of adherence to the standard microbiological investigation (SMI)/syndromic 12 guidelines for the blood culture pre-analytical pathway (BCP). NHSE published 5 key recommendations NHS England » Improving the blood culture pathway – executive summary. Poor methodology will produce false negative or false positive results and users should meet the key performance indicators in the SMI/syndromic 12 guidance:

- that the correct volume of blood is placed into the blood culture bottle (8 to 10ml)
- that bottles are placed in the incubator within 4 hours of collection
- that 2 sets of blood culture bottles (one set = an aerobic and anaerobic bottle) are collected
- that the reporting time for neonatal blood culture negative results is <36 hours from sample collection

The programme undertook audit of the key performance indicators (KPIs) at NHS-trust level, combined with amendment to the standard contract to include BCP KPIs, a letter to regional medical directors, a bespoke training package with BSAC and working with CQC and UKAS to

include BCP KPIs within laboratory accreditation. The NHS audit of adult received data from 104 providers across all regions nationally (collected 2023 to 2024). Analysis to establish compliance with blood volume added to the bottles and the time taken for placement within the analyser indicated improvement is needed as less than 40% (regional range 16 to 38%) bottles surveyed had the appropriate volume added, and less than 75% were (regional range 52 to 74%) placed on the analyser within the recommended 4-hour period (Figure 5.3). NHS England is working with trusts with further improvement anticipated nationally. In the Midlands region, the proportion placed on the analyser within the recommended 4-hour period increased from 65% (range 39 to 86%) in 2023 to 80% (range 41 to 93%) in 2025, and the proportion with appropriate blood volume increased from 30% (range 0 to 72%) in 2023 to 39% (range 28 to 72%) in 2025. Notably, a single trust reported improvement in appropriate blood volume compliance from 11% to 71% with phlebotomist support. Audit guidance and processes are being reviewed to enable improved monitoring and compliance. Blood culture KPIs will be included in the NHS 2026 to 2027 Standard Contract Service Department and Improvement Plan (SDIP).

Figure 5.3. Percentage of blood culture sample that meet the minimum fill level (8 to 10ml), left; percentage of blood cultures loaded within 4 hours of sample collection, right

AMR01 : % of blood culture samples that meet the minimum fill level of 8ml - 10ml
The analysis of blood culture is the primary diagnostic test available to detect bacterial infections in the bloodstream. It helps identify the cause of the infection and determine the most suitable antimicrobial treatment. The volume of blood collected is a crucial factor that affects the accuracy of the test. UKAS and CQC have included BCP metrics in their inspection criteria to monitor compliance with national guidelines and NHS England's report. The goal is to achieve 100 percent compliance in blood culture practice to enhance patient outcomes and reduce antimicrobial resistance

AMR02 : % of blood cultures loaded within 4 hours of sample collection
In an optimised blood culture pathway, the most significant positive cultures will be detected within 12 hours of collection. For every hour delay between collection and loading on the analyser, there is a loss of positivity rate. The data will inform targeted improvement to address health inequalities, reduce antimicrobial resistance and improve patient outcomes.

NHS Commissioning for Quality and Innovation (CQUIN) non-mandatory scheme – CQUIN03 prompt switching of intravenous antimicrobial treatment to the oral route of administration as soon as patients meet switch criteria

This evidence-based quality improvement scheme aimed to promote timely intravenous-to-oral switch (IVOS) and was intended to improve a range of patient outcomes and resource utilisations including: reducing healthcare-associated infections, reducing length-of-stay, reducing exposure to broad-spectrum antibiotics, increasing nursing workforce capacity, reducing drug expenditure, and reducing carbon footprint of medicines. Leadership from the NHSE AMR programme was available to support the implementation of the non-mandatory CQUIN scheme via dedicated resources on the AMR Programme FutureNHS workspace.

For the FY 2024 to 2025, the non-mandatory CQUIN 'Prompt switching of intravenous to oral antibiotic' was extended to paediatric patients in alignment with the UK PAS paediatric antimicrobial intravenous-to-oral switch (IVOS) decision aid. The suggested thresholds were 15% (or fewer) patients still receiving IV antibiotics past the point at which they meet switch criteria.

For the FY 2024 to 2025, 33 of 135 (24%) NHS hospital trusts providing acute care services participated in the non-mandatory scheme. A total of 9,595 audit cases were submitted, of which 541 (6%) were for paediatrics. Seventeen trusts submitted audit data for all 4 quarters. All submitted data was included in the analysis. Overall, 16 (48% of 33) met the 15% or lower threshold by Q4 and the remainder reported a range between 16% and 48% of cases receiving IV antibiotics past the point at which they meet switch criteria. Across England, 18% of cases were receiving IV antibiotics past the point at which they meet switch criteria (472 of 2590 cases submitted at Q4). Of the 33 participating trusts, 26 (79%) submitted data for at least one paediatric case. Twenty-one trusts (64% of 33) met the 15% or lower threshold by Q4 and the remainder reported a range of between 17% and 67% of paediatric cases receiving IV antibiotics past the point at which they meet switch criteria. Nationally, this was 12% (67 of 541) of paediatric cases.

National guidance and implementation resources

This section highlights selected NHSE resources and enablers, developed during FY 2024 to 2025, to support health care commissioners and providers with achieving the ambitions of the UK National Action Plan – Confronting antimicrobial resistance 2024 to 2029.

Recurrent infection resources

The ‘How to…?’ series hosted on the Royal College of General Practitioners website aims to support primary care teams to review the appropriateness of antimicrobials in the evidence-based prevention and management of infective exacerbations of COPD, recurrent UTI and acne. The resources have been updated to include worked examples designed to be used with the ‘How to…’ guides and checklists to be used during patient consultations. Overall, 1,004 practitioners registered for the launch webinar for the recurrent UTI resources, 355 individuals attended the live event and 151 provided feedback. The webinar was rated on average 8.9 out of 10 and was the highest performing webinar across all RCGP learning projects to date. From feedback, 98% reported improved understanding of the impact of recurrent UTIs on patients and improved awareness of national management guidance updates. 95% said they intend to use TARGET resources when managing common infections in the future.

Guidance for ICBs and providers on OPAT

Guidance was published by NHSE for integrated care boards and providers on developing outpatient parenteral antimicrobial therapy (OPAT) services, which treat patients with IV antimicrobials in out-of-hospital settings. The guidance outlines how these services can increase NHS productivity, describing different service models and providing advice on implementing and expanding services. Supporting tools were provided on FutureNHS, including a business case template and service specifications.

Antibiotic prescribing improvement schemes

NHSE worked with colleagues in ICB medicines optimisation teams and general practitioners to develop a set of antibiotic prescribing improvement schemes. The aim is to support AMS in ICBs by applying a ‘do once’ approach of sharing a suite of 6 antibiotic prescribing improvement schemes for local adaptation and use.

NHS Model Health System

The NHS Model Health System antimicrobial dashboard reports multiple population metrics at ICB-level, relating to infection by pathway, and the dashboard now includes additional metrics supporting the 2024 to 2029 AMR NAP ambitions including acute trust antibiotic utilisation metrics that are also reported on Fingertips.

Digital Vision for AMS in England

NHSE published guidance co-produced with front line clinicians, which outlines the functionalities that clinical digital systems need to support optimal AMS within primary and secondary care. Additionally, a supporting framework document describes best practice in using information technology systems in the management of AMS, which is relevant to digital and clinical leadership teams and commissioners in all healthcare settings. Work is ongoing with Optum UK and FDB health to develop pop-up messaging at the point-of-prescribing in GP

practices to promote AMS including fluroquinolone patient safety messaging and appropriate course length prescribing messages. An antibiotic formulary was also developed for health and justice settings to upload to SystmOne (the prescribing system used in all England health and justice settings), with safety messaging for fluroquinolone prescribing and appropriate course length durations.

AMR Programme FutureNHS workspace

The NHSE AMR Programme workspace on FutureNHS continues to be a thriving collaborative space for NHS staff with an interest in AMR and AMS. The workspace provides local, regional and national colleagues with access to a wide range of AMS resources including national improvement and quality assurance performance data. Other resources include AMS toolkits for specific infections, adaptable antibiotic prescribing improvement schemes for ICBs, infographics and digital assets for promoting AMS, evidence bundles and summaries of key research from the AMS Evidence Observatory, and updates on antimicrobial issues and management. At the end of March 2025, the AMR workspace had around 1,400 registered members of which 90% actively use the workspace. Overall, members visited the site 5,834 times or approximately 500 visits per month.

Optimising antibiotic durations

PrescQIPP publishes the Optimising Antimicrobial Use Dashboard which reports metrics that demonstrate variation and support optimisation of duration of antibiotic prescriptions in primary care. Optimising antimicrobial duration metrics are now available for amoxicillin 500mg capsules, doxycycline 100mg capsules, flucloxacillin 500mg capsules, lymecycline 408mg capsules and phenoxymethylpenicillin 250mg tablets to support delivery of the second UK AMR national action plan. Additional resources to support optimisation of antibiotic durations include evidence bundle, infographics and case studies available on the FutureNHS AMR workspace.

Intravenous to oral switch

A number of resources were developed and promoted to support the expanded non-mandatory CQUIN for IVOS, including a webinar, slide deck for ICB and hospital staff on quality improvement approaches, benefits of IVOS summary, financial benefits, business case resources, posters and infographics and case studies.

Watch and Reserve antibiotic consumption

NHSE carried out a series of semi-structured interviews with 34 staff from 15 trusts between August and November 2024 to gather insights and identify a set of successful real-world ‘Watch’ and ‘Reserve’ antibiotic consumption reduction strategies, that take into consideration contextual facilitators and barriers, that could be shared and considered for adoption by hospital providers. Preliminary findings were presented in a webinar during World AMR Awareness Week (WAAW) in November 2024 with 207 registrations, 131 in attendance, and a further 62 downloads of the webinar recordings.

Data insights to support implementation of MHRA Drug Safety Updates relating to fluoroquinolone antibiotic prescribing

Fluoroquinolone antibiotics have been reported to cause serious side effects and the MHRA has published a number of Drug Safety Updates advising fluoroquinolones must now only be prescribed when other commonly recommended antibiotics are inappropriate. Twelve-month population exposure to systemic fluoroquinolones via FP10 prescription has reduced by 14% between December 2022 and November 2024. A larger reduction of 18% was reported for females, who have a population rate of exposure of 3.48 people per 1,000 female population compared to an 11% reduction in the number of males, who have a higher population rate of exposure of 4.64 people per 1,000 male population. Systemic fluoroquinolone use in primary care accounted for 2.2% of England use in CY2024 (0.385 DDDs per 1,000 population per day [DID]). In English hospital trusts, the number of fluoroquinolone DDDs reduced by 10% in the 12 months to November 2024 compared to the previous 12 months to November 2023. Implementation of the MHRA Drug Safety Updates across the NHS in England is ongoing. Data and resources to support improvement can be accessed via the Antimicrobial Resistance Programme – FutureNHS Collaboration Platform.

ePACT2 Antimicrobial Stewardship – urinary tract infection dashboard

NHSE in collaboration with the NHS Business Services Authority published the ePACT2 Antimicrobial Stewardship UTI dashboard which includes 6 comparators relating to the prescribing of antibiotics routinely prescribed in primary and community care to treat acute and recurrent lower UTIs, and for the first time reports the count and population rate of people prescribed urinary continence devices. Comparators report both prescription item and people counts, and population rates, with filters enabling reporting by selected antibiotic, age band and gender. Presented at organisational levels from GP practice to national (England), the data will support clinicians and ICSs in monitoring population exposure to antibiotics and use of urinary continence devices. It will also enable ICSs to identify opportunities to improve the management of urinary tract infections, and monitor the implementation of NICE guideline NG112 Urinary tract infection (recurrent): antimicrobial prescribing.

World Antimicrobial Resistance Awareness Week 2024

NHSE delivered a programme of work that included a joint letter with the UKHSA to further raise the profile of AMR and request facilitative actions by chief executives and senior managers of NHS organisations across the healthcare sector. Five webinars received a total of 1388 registrations with 857 in attendance. During WAAW, the site was accessed over 670 times with data showing people accessed a variety of WAAW recordings and resources, (including the newly created WAAW digital assets) and signposting to existing resources. In addition, the webinar recordings and slidesets were accessed a further 269 times on FutureNHS. Some of the feedback received from the webinars include:

- “I thought the speakers were brilliant”
- “fantastic to have expertise from other countries”

- “some good ideas to take away and try to implement”
- “ran out of time – would have been good to have allowed additional allocated time for Q&A”

The Chief Pharmaceutical Officer and the AMR National Clinical Lead also visited several sites in the East of England at their WAAW launch event to find out first-hand about the work being done in the region to help reduce the burden of AMR.

Adoption and spread of TARGET training across ICBs

TARGET training directly supports the UK AMR NAP and has been shown to impact positively on the optimisation of antimicrobial prescribing. The training equips primary care clinicians to reduce inappropriate prescribing, optimising care and outcomes for patients. Over the last 3 years, NHSE has funded training for specific ICBs to support inequalities in prescribing, initially targeting higher prescribing areas, but then moving to any interested areas, noting that engagement in uptake of training would impact positively. TARGET materials also support ICBs to achieve goals set out in national incentive and assurance schemes. All organisations additionally funded to deliver TARGET training have shown improvements in antimicrobial prescribing.

AMS pharmacy technician workforce survey

The first national NHSE AMS pharmacy technician workforce survey showed that pharmacy technicians are a committed but underutilised workforce for AMS, with variation of roles and Agenda for Change banding between settings. Findings from over 170 respondents across a variety of healthcare settings reveal the types and extent of the specific AMS tasks carried out by pharmacy technicians and indicate that broader AMS roles remain underdeveloped. The findings support a need for AMS specialist education, structured career pathways, and integration with specialist teams.

ICB antimicrobial stewardship self-assessment toolkit

NHSE published a self-assessment toolkit for ICBs to allow them to examine their approach to AMS. The toolkit is intended to help assess the governance, workforce and reporting for AMS and identify any areas that require focus, along with links to sources of data and key metrics that can provide insight.

AMS capability framework

This framework, developed by NHSE in conjunction with the BSAC, provides a standardised set of capabilities for all health professionals working in AMS specialist roles, at all levels of practice, across the healthcare system. Capabilities are aligned with 4 domains:

- professional practice
- leadership and management

- education
- research and quality improvement

In Figure 5.4 an ‘AMS specialist’ refers to a health professional working within an AMS team or role, delivering an AMS programme. AMS specialists should be able to demonstrate delivery of the required capabilities according to their role, regardless of profession or level of practice. Educational resources that provide the knowledge required to develop these capabilities are included. Exemplar job descriptions, person specifications and job plans are in development to support implementation.

Figure 5.4. Overview of Capability Framework for Antimicrobial Stewardship Specialists developed by NHS England and British Society for Antimicrobial Chemotherapy

Text version of Figure 5.4

Four boxes on the left of the screen contain the following text:

“Domain 1: Professional practice. Provides specialist AMS knowledge, skills and practices to shape and deliver AMS in their organisation and healthcare system, for the benefit of individual patients and services; collaborating with other patients, and the public.

“Domain 2: Leadership and management. Provides leadership across organisations and systems to optimise the management of infections and use of antimicrobials; leading on complex issues relating to AMR and behaviours driving antimicrobial use.

“Domain 3: Education. Develops and improves the knowledge, attitudes, and practices of others regarding the optimal use of antimicrobials; and uses their own professional development to improve AMS programmes and patient care.

“Domain 4: Research and Quality Improvement. Co-ordinates and surveillance and monitoring of antimicrobial use across services, organisations, and systems; and develops and applies evidence to improve AMS programmes and interventions and optimise the use of antimicrobials.”

Arrows extend from these boxes and intertwine pointing towards 3 bubbles containing the text:

1. “Core (enhanced): Supports the delivery of AMS activities.
2. “Advanced: Delivers and develops AMS programmes and activities.
3. “Expert: Leads and is responsible for AMS programmes.”

Additional text in the image is as follows:

“Capability statements and descriptors of practice for core, advanced and expert to guide users through benchmarking and professional development.

“Applicable to healthcare professionals specialising in AMS from all professional backgrounds working in all sectors of the NHS.

“Associated resources: Job descriptions, Person specifications, Job plans.“Signposting to educational resources for AMS knowledge and skills to support practitioners to move from core to advances and expert advice.”

End of accessible text.

Workforce strategic planning for AMS

A framework to support strategic planning for the AMS workforce was developed that articulates the capacity and skill mix requirements of AMS teams in different healthcare settings to deliver high and medium priority AMS activities based on the literature and stakeholder feedback. This work seeks to address the lack of national and international consensus on the number or skill mix of healthcare staff needed to provide effective AMS in primary and secondary care settings. It builds on findings from a baseline survey of AMS workforce in the NHS in England carried out by NHSE in 2022, which identified substantial variation in workforce capacity and skill mix between health care settings and across regions.

The framework was developed using the NHS Workforce Training and Education (NHS WTE) Six Steps Methodology to Integrated Workforce Planning® | Skills for Health involving co-production with stakeholders from a range of NHS settings. Implementation of this framework aligns directly with UK AMR NAP commitment 5.2 that states: “We will implement a system-wide approach to strong infection prevention and control and antimicrobial stewardship in health and

social care settings, aligning workforce planning with workforce needs and considering system-wide capacity and capability to mitigate and respond to incidents." The framework and its associated resources can be used by an ICB or provider organisation to strategically plan an effective AMS team to deliver AMS activities identified as high and medium priority across a system or organisation. Implementation resources such as materials for business cases and a workforce calculator are included as downloadable documents.

Community health services and mental health services

NHSE continues to engage and work with community health services and mental health services sectors via quarterly workshops. These ensure staff are made aware of national AMS activities and how they impact on the sector, enable networking, peer discussion and learning and collaborative development of sector-specific AMS tools. Outputs include the development of an AMS in Community, Mental Health and Offender Care settings educational resource page on FutureNHS, development of WAAW messages for these settings, working with Rx-info software developers to improve the standard reports available for these settings and development and pilot of a simple audit tool that can be used to benchmark practice in all inpatient areas within these settings.

AMS Health Inequalities – Health and Justice

NHSE commissions healthcare services in 147 Health and Justice Settings (HJS), aiming to provide equitable care for detained populations who experience significant health inequalities. Antibiotic prescribing patterns and healthcare professionals' views within HJS have been investigated for the first time to identify challenges, opportunities, and targets for AMS interventions, comparing HJS antibiotic prescribing to wider primary care data for England.

Prescribing data from HJS for 2023 to 2024 was analysed alongside primary care data from ePACT2 and PrescQIPP. A survey based on the COM-B (Capability, Opportunity, Motivation, and Behaviour) model of behaviour change, assessed 24 HJS healthcare professionals' knowledge and attitudes towards AMR. The data revealed significant variations in prescribing patterns across HJS. Data showed higher proportions of broad-spectrum antibiotic use in HJS (10.6%) compared to primary care (7.7%). HJS had significantly higher lymecycline and metronidazole prescribing. Prescribing durations often diverged from NICE guidelines, with significantly fewer 5-day courses in HJS. The survey identified barriers to AMS including professional-patient relationship dynamics, and challenges specific to acne and skin infection management. Pharmacy professionals constituted 54.2% of respondents, with overall strong AMR knowledge. Motivation to implement AMS strategies, however, was lower than capability or opportunity, particularly regarding acne management. This is the first comprehensive analysis of prescribing behaviours in HJS and highlights key AMS intervention targets: reducing broad-spectrum use, improving management of skin infections and acne, and aligning prescribing durations with guidelines. Actions so far include: formation of an AMS steering group, a radio broadcast interview, ongoing surveillance and reporting of antibiotic use in HJS.

Future actions

This section outlines the 2025 to 2026 plans for the confirmed national policies and commissioning associated with AMR. The new NHS 10 Year Health Plan is expected to be published in 2025 and a review of NHSE priorities for AMR will be undertaken with appropriate actions that continue to align with the commitments of the UK AMR NAP.

NHS Oversight Framework

The NOF for 2025 to 2026 includes ‘percentage of children prescribed antibiotics in primary care’ as a key patient safety metric for ICBs. This was developed by the AMR Programme in order to signal and support ICBs to prioritise AMS in this important cohort who are relatively high users of antimicrobials with consequent high risk of adverse outcomes.

NHS Standard Contract

The NHS Standard Contract 2025 to 2026 continues to emphasise the importance of AMR and Providers (NHS trust or an NHS foundation trust) are required to use all reasonable endeavours, consistent with good practice, to minimise its broad-spectrum antibiotic usage in accordance with the requirements of the NAP for AMR. Providers must also have regard to ‘NICE guideline NG15 Antimicrobial stewardship: systems and processes for effective antimicrobial medicine use’ and the AMS Toolkit for English Hospitals.

Optimising antimicrobial duration

New antibiotic prescription duration metrics will be published in the PrescQIPP Optimising antimicrobial duration dashboard to support delivery of the UK NAP for AMR. Optimising duration of lymecycline will be an NHSE priority area for improvement in FY 2025 to 2026.

Pharmacy Quality Scheme

A new Pharmacy Quality Scheme for 2025 to 2026 was launched to focus on antimicrobial stewardship for acute sore throat consultations in community pharmacies. It includes auditing of consultations with patients presenting with mild symptoms that currently do not pass the gateway point for the Pharmacy First clinical pathway for acute sore throat.

Chapter 6. Professional and public education, engagement, and training

Main messages

Healthcare professional education and training

The TARGET and RCGP collaborative webinar series continues to be a success, with high engagement and positive feedback for all 3 webinars held between November 2024 and March 2025.

TARGET training reached over 1,000 primary care professionals across England, significantly improving participants' knowledge, confidence and intentions to implement antimicrobial stewardship (AMS) actions. Process and impact evaluations confirmed positive behavioural changes, high satisfaction and a reduction in antibiotic prescribing rates.

Public education and engagement

e-Bug have successfully engaged educators and the public through social media and newsletters and have expanded their international network, partnering with 7 countries. Two free online training courses achieved strong enrolment, with most participants reporting increased knowledge and confidence in infection prevention and antimicrobial use.

A research study investigated public knowledge and attitudes towards antimicrobial usage (AMU) and antimicrobial resistance (AMR) in England, using survey data collected before, during and after the COVID-19 pandemic. Findings highlight the need for renewed public education campaigns and support for healthcare professionals to rebuild trust and promote appropriate antibiotic use.

Professional and public AMR campaigns

Following issues identified in the public knowledge survey findings, a campaign was targeted at younger audiences, aiming to engage them on the issue of AMR. The campaign introduced a mascot, Andi Biotic, to deliver important messaging around correct antibiotic behaviours and AMR awareness. An evaluation of the campaign is ongoing to review its effectiveness.

World AMR Awareness Week and European Antibiotic Awareness Day took place in November. The webpage hosting the toolkit of promotional resources was visited 4,061 times from publication in September 2024 to the end of 2024. A webinar was hosted to launch the campaign, attracting almost 1,000 registrations.

The Antibiotic Guardian campaign website's main page received 12,967 pledges in 2024, totalling 190,648 pledges made on the main page since inception of the campaign in 2014. A total of 104 organisations registered their AMS activities on the Antibiotic Guardian website in 2024. Analysis into the campaign's international reach revealed high engagement in Africa, highlighting its impact on supporting national, regional and local AMR strategies.

The Antibiotic Guardian Shared Learning and Awards took place for its seventh annual event on 9 June 2025. Seventy-five projects and case studies were submitted across all 13 categories and 48 were shortlisted. Shortlisted posters and video presentations are available on the Antibiotic Guardian webpage. Along with the presentation of awards, the event also featured lectures from experts in the field of AMR and AMS.

Introduction to Chapter 6

Public and professional engagement and education are key components of antimicrobial stewardship (AMS), as highlighted in the UK's 20-year vision (140) and UK 2024 to 2029 Antimicrobial Resistance (AMR) National Action Plan (NAP) (50). These strategic documents emphasise a collaborative approach that brings together healthcare professionals (HCPs), patients, service users, consumers and the wider public to co-develop, promote and implement strategies aimed at increasing awareness and driving behaviour change around AMR.

The UK NAP emphasises the importance of fostering a learning culture within healthcare settings by supporting educational strategies that are likely to result in meaningful behavioural change around AMR. Despite this, behaviour change is a gradual and complex process that requires sustained, coordinated efforts across multiple levels. Effective education and training, underpinned by behavioural science, are essential to ensure that professionals adhere to best practices and that the public is empowered to contribute meaningfully to the fight against AMR.

Commitments to improving infection prevention and control (IPC) practices among the public are also included in the UK NAP. These include promoting hand hygiene, surveillance of public awareness and attitudes towards AMR, and engaging educators and local authorities to ensure school leavers understand appropriate IPC practices and antimicrobial use.

This chapter outlines a range of initiatives undertaken during the 2024 to 2025 financial year (FY) aimed at educating, engaging and training both professionals and the public, forming a cohesive strategy to support AMS efforts.

Healthcare professional education and training

TARGET and RCGP webinar series

The Treat Antibiotics Responsibly, Guidance, Education and Tools (TARGET) and Royal College of General Practitioners (RCGP) collaborative webinar series continued between April 2024 and March 2025. The annual webinars aim to support HCPs working in or supporting the primary care setting to enhance their understanding and application of AMS practices. Most delegates were informed of the webinars through RCGP email (39%), RCGP website (28%), a colleague or referral (14%) or TARGET email or newsletter (8%). An overview of the attendances and feedback for each webinar is shown in Table 6.1.

Attendee satisfaction was calculated using the Net Promoter Score (NPS). NPS is a widely used metric that helps organisations gauge satisfaction by asking how likely someone is to recommend their service to others on a scale from 0 to 10. Respondents are grouped as Promoters (9 to 10), Passives (7 to 8), or Detractors (0 to 6). The score is calculated by subtracting the percentage of Detractors from the percentage of Promoters, resulting in a score between −100 and 100. A higher score indicates stronger satisfaction, with scores above 20 regarded as great and above 50 as excellent.

Webinar 1: Patient Perception of Infections and Antibiotics (November 2024)

The first webinar presented insights from the UKHSA public AMR survey data (2019 to 2024) covering public knowledge of antibiotics and antibiotic resistance, and public attitude and behaviours towards common infections and antibiotic use. The webinar aimed to discuss the role and impact that HCPs have in supporting public awareness of AMR topics. Participants reported a strong understanding of the link between prescribing and AMR and all respondents expressed an intention to use TARGET resources in their practice.

Webinar 2: Navigating AMS for New and Early Career Prescribers (January 2025)

This webinar was designed for early career professionals but was also suitable for experienced HCPs who wanted to refresh their knowledge. It introduced the issue of AMR in primary care and presented AMS activities that can help to alleviate its burden. Attendees reported a better or refreshed understanding of AMS practices, and all respondents intended to use TARGET resources when planning and implementing AMS activities.

Webinar 3: Managing Recurrent urinary tract infection (UTI) and Long-Term Antibiotic Therapy (March 2025)

The third webinar gave a comprehensive review of the management of recurrent UTI in primary care, including details of the latest updates to NICE guidance and introducing the newly published TARGET how-to guide for managing patients on long-term and repeat antibiotics. This session achieved the highest satisfaction rating across all webinars and is the highest performing webinar across all RCGP projects to date. Participants demonstrated a strong understanding of the impact of recurrent UTI on quality of life and the connection between UTI

prescribing and AMR. There was also a high level of intent to apply TARGET resources in future clinical practice.

Table 6.1. Webinar registrations, attendance rates and participant feedback

Webinar title	Registrations	Attendance	Participants likely to recommend the webinar to others	Satisfaction score (NPS)
Patient perception of infections and antibiotics	377	89 out of 377 (24%)	49 out of 51 (96%)	53
Navigating AMS for new and early career prescribers	395	133 out of 395 (34%)	63 out of 64 (98%)	41
Managing recurrent UTI and long-term antibiotic therapy	1,003	355 out of 1,003 (35%)	145 out of 151 (96%)	64

National implementation of the TARGET training

To support the implementation of AMS interventions included in the toolkit, TARGET provides national cascade training through a set of workshop materials. These workshops are designed using the capability, opportunity and motivation (COM-B) behavioural model to help drive meaningful change in clinical practice. A randomised controlled trial evaluation of the TARGET AMS workshop in general practices in England demonstrated a 6.1% lower antibiotic dispensing in intervention practices (141).

The training materials include:

- core slides – overarching information on AMR and why it is relevant to primary care physicians
- clinical scenarios – examples of common infections where research suggests there is overprescribing (the examples provide information on relevant resources and tools to facilitate appropriate prescribing conversations)
- action planning – tools for action planning for attendees provide an opportunity to plan how the learning from the training can be implemented within the attendee's own setting

Following the COVID-19 pandemic, rising antibiotic prescribing levels renewed interest in AMS training workshops among integrated care boards (ICBs). This presented an opportunity to

systematically cascade the training across England and evaluate its effectiveness in real-world settings.

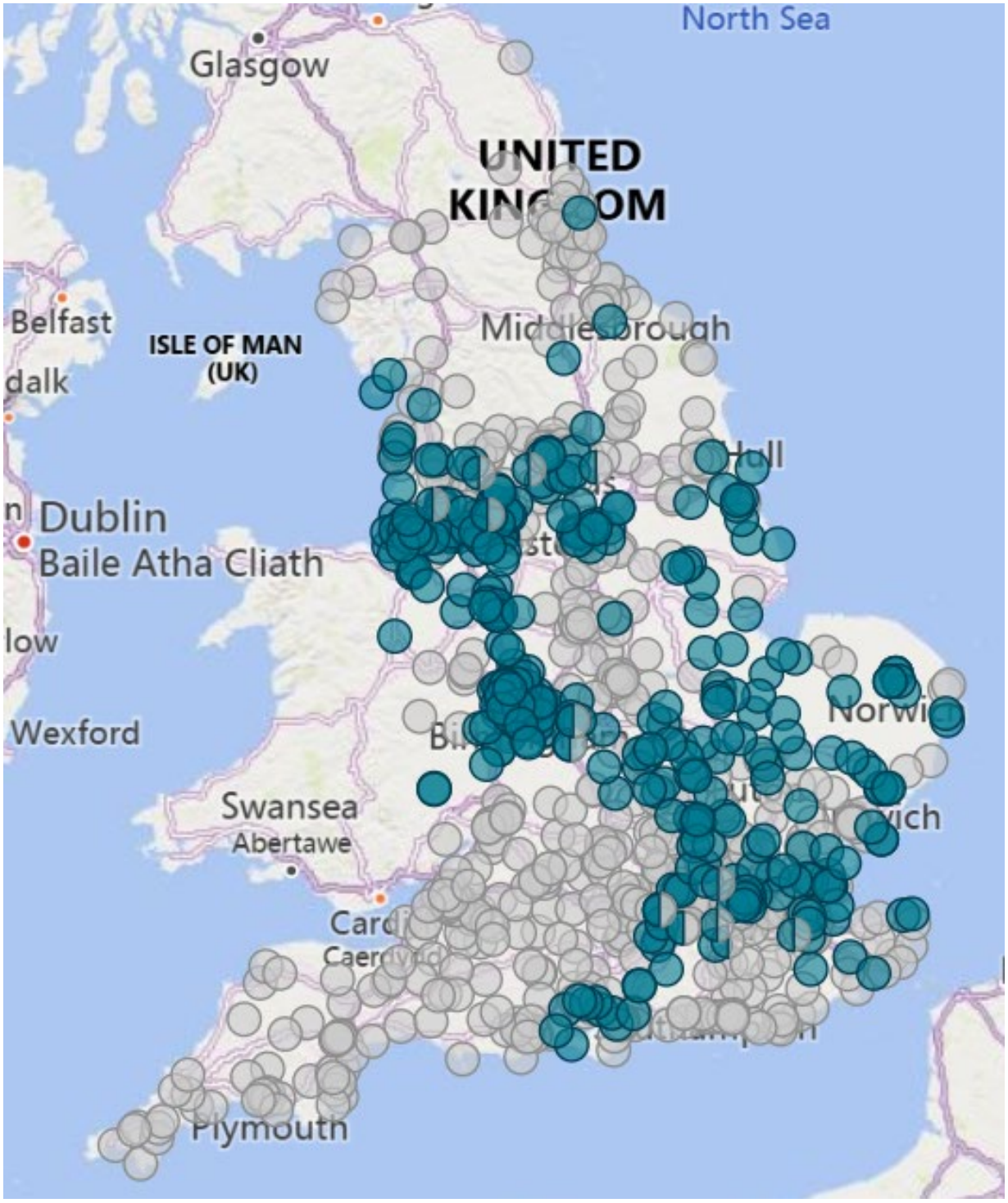
In October 2022, the UKHSA, in collaboration with NHS England (NHSE), launched a national rollout of TARGET training through ICBs. Five of the 7 NHSE regions agreed to participate. The London and South West regions, which had the lowest primary care antibiotic prescribing rates in the country, opted to prioritise their resources elsewhere. Training was rolled out across regions, with the cascade model suggested as a method for implementation, with trainers (Train the Trainers) training end users.

Process evaluation

Clinicians

The TARGET training toolkit was accompanied by pre- and post-session surveys to assess AMS attitudes and behaviours, knowledge and use of TARGET resources, intentions to implement AMS actions and their feedback on the training. To understand the user perspective, at least 2,539 evaluation surveys were completed from TARGET training workshops across England by March 2025. Geographical spread and type of training can be seen in Figure 6.1 and Figure 6.2. Participants were highly motivated following the workshops, with 81% (627 out of 775) planning to implement AMS activities in their practice, 34% of which planned to implement these within 3 months of attending.

Figure 6.1. Healthcare professionals trained using the TARGET cascade model, at each NHS region across England from introduction to June 2025, with the darker circles representing PCNs having at least one person trained



Text version of Figure 6.1

This figure shows a map of England with markers representing where TARGET training has been delivered from introduction to June 2025. There are clusters of markers around the East of England, Midlands and North West regions.

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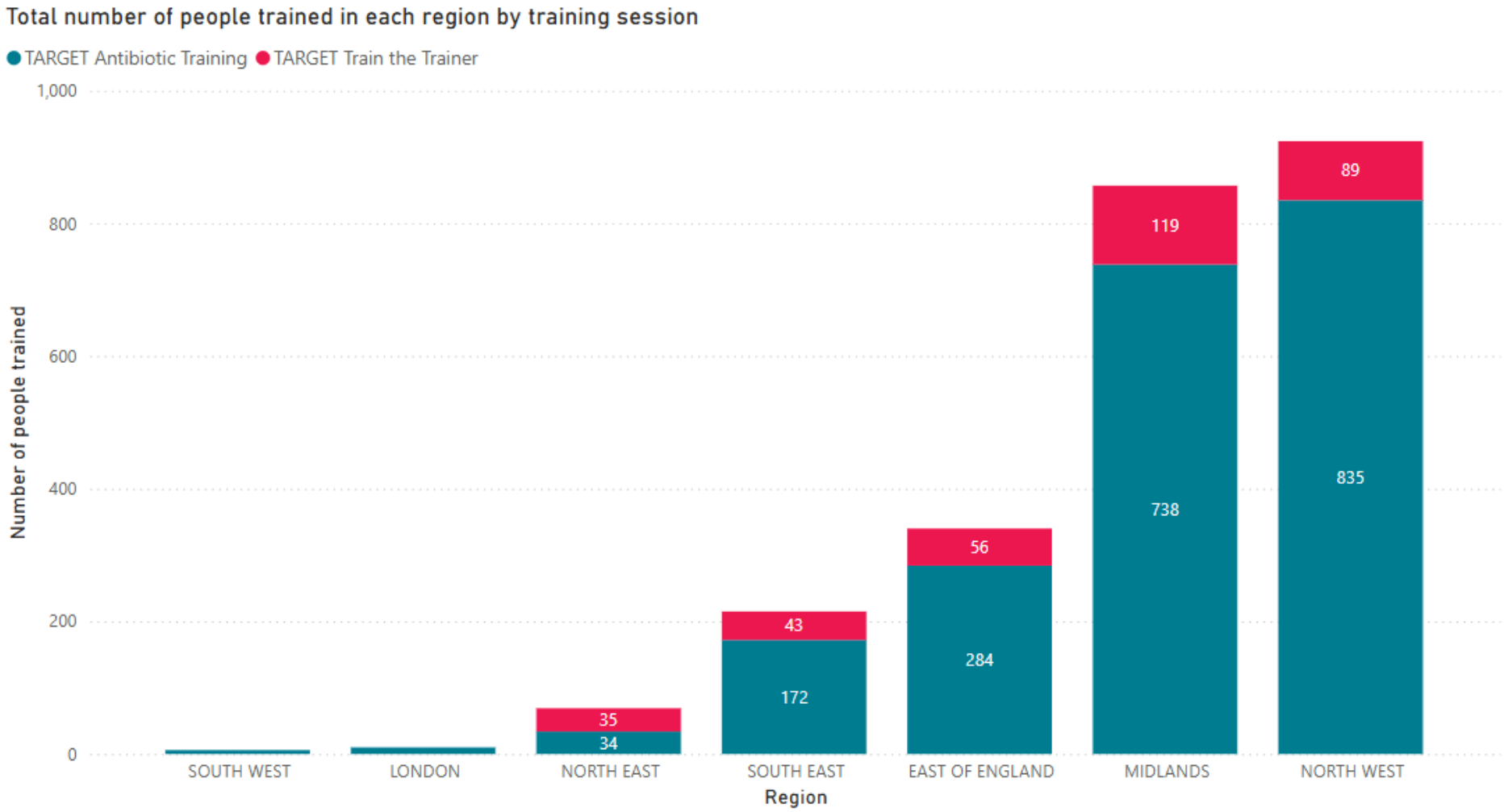
Figure 6.2. Total training sessions recorded and type of training delivered, at each NHS region across England as of March 2025



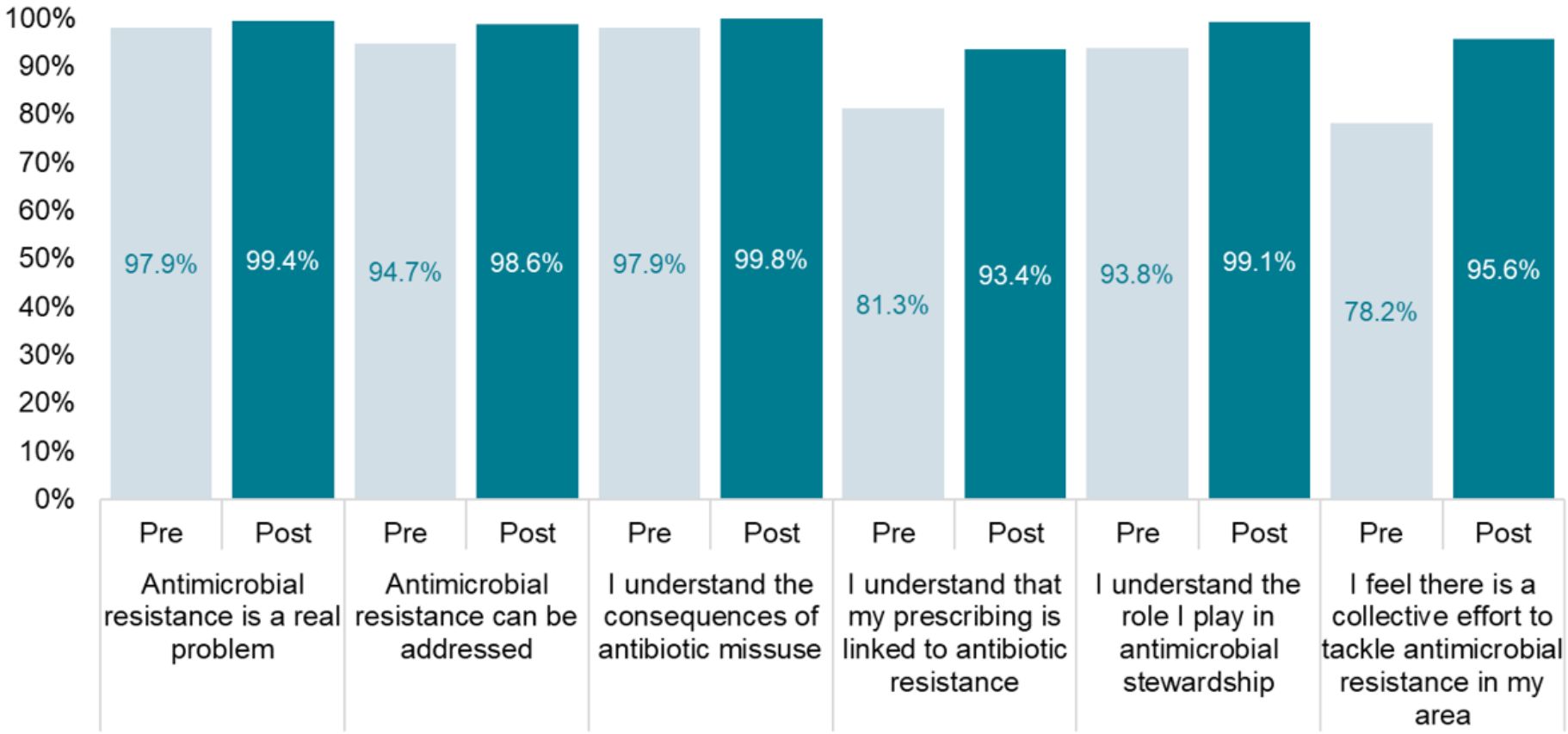
Text version of Figure 6.2

This graphic shows the number of training sessions recorded and type of training delivered at each NHS region across England up to March 2025. In the North West region, 835 people underwent TARGET Antibiotic Training and 89 people underwent TARGET Train the Trainer training. In the Midlands, 738 people underwent TARGET Antibiotic Training and 119 people underwent TARGET Train the Trainer training. In the East of England, these numbers were lower whereby 284 people underwent TARGET Antibiotic Training and 56 people underwent TARGET Train the Trainer training. In the South East region, 172 underwent TARGET Antibiotic Training and 43 people underwent TARGET Train the Trainer training. In the North East, 34 people underwent TARGET Antibiotic Training and 35 people underwent TARGET Train the Trainer training. Very low numbers of training were seen in the South West region and in the London region for this training.

End of accessible text.

Attendees found TARGET training to be a valuable use of their time, where they were able to understand (99%, 660 out of 666) and relate (98%, 651 out of 666) to the objectives and content of the training. Following the training, there was an increase in attendees' knowledge of the resources and tools available to support their stewardship actions. Although attendees demonstrated high baseline knowledge of AMS, there was a positive shift in their understanding that their prescribing is linked to antibiotic resistance (pre-training: 81%, 766 out of 942; post-training: 94%, 623 out of 666) and an understanding of the collective effort required to tackle AMR in their area (pre-training: 78%, 734 out of 942; post-training: 95%, 636 out of 666) (see Figure 6.3).

Figure 6.3. Healthcare professionals' agreement to statements on AMR before (*n* = 926) and after TARGET training (*n* = 656)



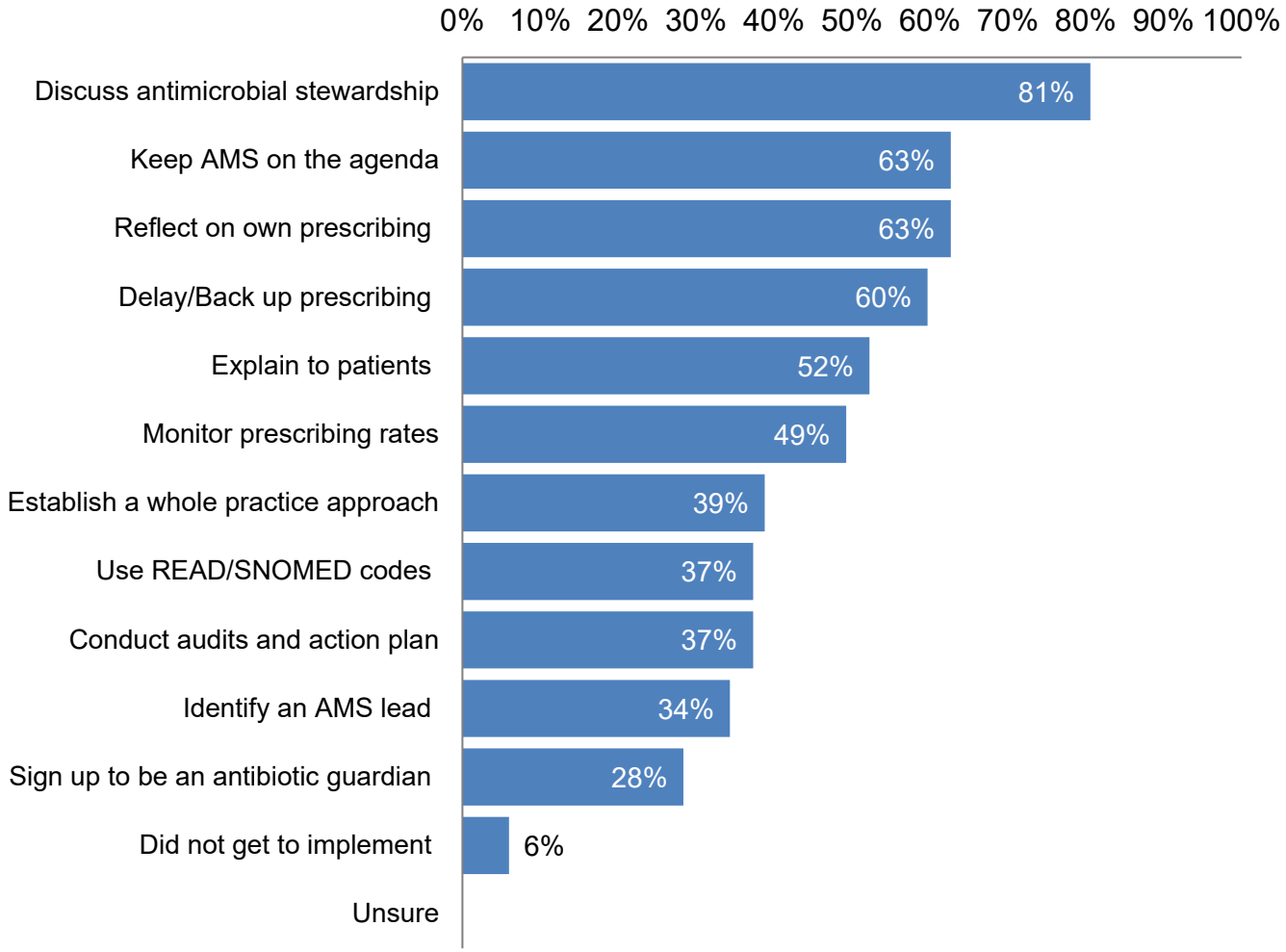
Attendees reported that they were most likely to implement AMS actions at both the practice and individual levels. Common planned actions included discussing AMS during practice or pharmacy meetings (94%, 600 out of 636), keeping AMS on the agenda (94%, 597 out of 636) and using appropriate clinical coding to support research into AMR (92%, 585 out of 636). Over half of attendees (55%, 310 out of 562) intended to implement AMS within 6 months of completing the training, and 74% (414 out of 562) anticipate no significant barriers to putting these actions into practice.

During TARGET training, attendees were asked for consent to be recontacted for follow-up. Feedback from regional leads and champions (*n* = 29) highlighted that strong stakeholder engagement (67%, 10 out of 15) and prioritisation of AMS (67%, 10 out of 15) facilitated successful rollout. However, competing priorities often hindered implementation. Many regional leads (59%, 17 out of 29) opted for ad-hoc training of primary care practices rather than a formal cascade approach (31%, 9 out of 29), highlighting the need for flexibility. Most training (79%, 23 out of 29) was delivered in person. Over half of the regional leads (62%, 18 out of 29) believed the training positively influenced prescribers, with many observing increased motivation for stewardship activities.

To understand the user perspective, at least 2,539 evaluation surveys were completed from TARGET training workshops across England by March 2025. Participants left the workshops highly motivated with 81% (627 out of 775) planning to implement AMS activities within their practice, 34% within 3 months of training.

A 6-month follow-up survey was sent to those who consented (*n* = 67). Most (94%, 63 out of 67) reported successfully implementing their planned strategies, with specific actions shown in Figure 6.4. For those that discussed antibiotic prescribing decisions with their patients as an AMS strategy, 91% (32 out of 35) agreed that the training had been helpful in having these discussions, with 97% (31 out of 32) feeling more confident in discussing AMR with patients. More importantly, 87% (27 out of 31) reported that the discussion affected the outcome of the consultation in relation to antibiotic prescribing.

Figure 6.4. Percentage of attendees who reported implementing AMS strategies following TARGET training



Interest in refresher training is high, with 82% (55 out of 67) of respondents indicating that they would be interested in attending. The optimal time for this training, according to the survey, is between 12 to 18 months after their initial training, with a condensed version of the training the preferred format.

Impact evaluation

To assess the impact of the TARGET AMS training on prescribing behaviour, quantitative analysis was conducted using prescribing data from ePACT2. Initial findings suggest a positive impact on antibiotic prescribing rates.

Using an interrupted time-series approach, post-COVID-19 data indicates that, on average, an ICB would dispense 0.56 fewer items per 1,000 patients per month following the training – equivalent to a 1.2% reduction in the dispensing rate. For context, an ICB with a population of 1.5 million people would see 841 fewer antibiotic prescriptions dispensed per month, on average. Additionally, each subsequent month post-training was associated with a further decrease of 0.08 items per 1,000 patients. These results were adjusted for background trends, seasonality, and the historical prescribing patterns within individual ICBs. Further analysis is ongoing.

TARGET FutureLearn course

The TARGET Antibiotics: Prescribing in Primary Care e-learning course, hosted on the FutureLearn platform, is a free educational resource developed in collaboration with the British Society for Antimicrobial Chemotherapy (BSAC). The course was refreshed in June 2024 to incorporate minor revisions and now consists of 5 modules to be completed weekly. It is specifically designed for primary care health professionals, covering AMS in the context of managing common infections. Between April 2024 and April 2025, the course recorded 555 enrolments. Of these, 63% (352 out of 555) engaged with the content by viewing at least one step in the module, and 55% (193 out of 352) actively marked their progress through the course. Feedback from participants was extremely positive: 95% (18 out of 19) reported that the course met or exceeded their expectations, and all participants (19 out of 19) reported gaining new knowledge or skills as a result of their participation.

Public and professional engagement activities

TARGET AMS campaign with RCGP

TARGET and the RCGP continued their annual collaborative AMS campaign targeting RCGP members and other primary care health professionals. The campaign used the 4 steps of the TARGET Cycle of AMS (see Chapter 4) as key messages, highlighting relevant resources within the TARGET toolkit at each stage (142 to 144):

1. Assess – use the TARGET self-assessment checklist and antibiotic audits to identify potential areas where action may be needed.
2. Learn – sign up to free TARGET webinars to learn about the latest guidance and best practices.
3. Act – use TARGET patient information leaflets to support shared decision-making during consultations.
4. Evaluate – reuse the TARGET self-assessment checklist and antibiotic audits to see if anything has changed following the previous steps.

Promotional campaign activities included:

- paid search advertising
- webinars covering specific topics within AMS (see TARGET webinars)
- social media posts (X, Facebook, LinkedIn, Instagram)
- regular content distributed to RCGP members and subscribers, including bimonthly newsletters and learning bulletins

A campaign landing page was developed featuring key messages, resources and TARGET webinars. The page received 47,224 clicks (Table 6.2), an increase of 42,147 compared to the 2023 campaign. This uplift was mostly driven by increased paid digital activity across social

media and Google, which achieved over 1.2 million impressions, considerably surpassing the 90,666 in 2023.

Table 6.2. Public and professional engagement with the TARGET toolkit across the communication activities delivered for the 2024 RCGP/TARGET campaign, measured by total clicks and compared with the 2023 campaign

Communication activity	2023	2024
Solus email (to all RCGP members)	1,518	989
Other email features (PCD, Learning, Weekly Digest)	1,152	725
Digital paid advertising (search and social)	2,383	45,474
Organic social (Facebook, Twitter and Instagram)	24	36
Campaign total	5,077	47,224

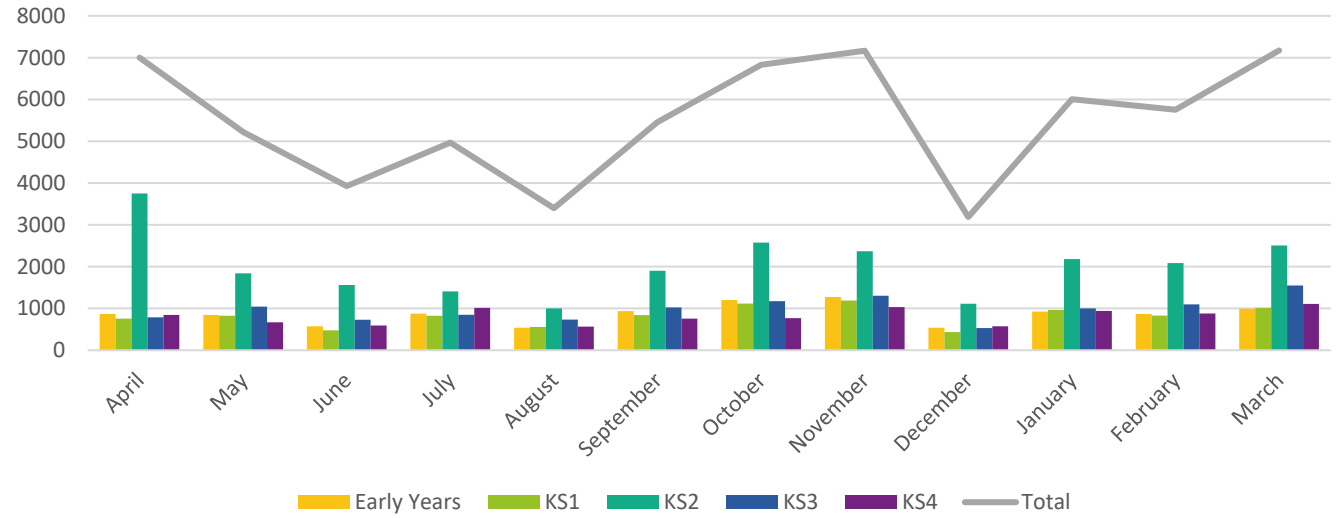
Public education and engagement

e-Bug programme

The e-Bug programme, operated by the UKHSA, is designed to engage children and young people across all communities with key messages on IPC and AMS. To achieve this, e-Bug provides free educational resources that aim to support and empower children and young people to contribute to the prevention of AMR by promoting appropriate IPC practices.

The programme's primary audiences include teachers, community leaders and educators. Between April 2024 and March 2025, the e-Bug website recorded a total of 128,356 page views (Figure 6.5). Website traffic reached its highest point in November, coinciding with e-Bug's social media campaign for WAAW, which was promoted on the social media sites X and Facebook, and via email. As expected, website activity declined during the Christmas holiday period, before increasing again in January.

Figure 6.5. Monthly views of the e-Bug website from April 2024 to March 2025



Communications

In December 2024, e-Bug established a Teacher Advisory Panel comprising primary and secondary school teachers in England to engage its key stakeholder group. The panel met 3 times during the academic year, providing a broad range of actionable insights.

e-Bug promotes their educational resources and public health campaigns through various social media platforms, including Facebook, X and YouTube, targeting teachers and educators. As of March 2025, the X account had over 3,000 followers, and the YouTube channel received more than 288,000 views between April 2024 and March 2025. Targeted campaigns were also delivered around World AMR Awareness Week (WAAW), British Science Week and World Immunisation Week.

In addition to social media outreach, e-Bug distributes a quarterly newsletter to nearly 10,000 subscribers. The newsletter includes updates on upcoming campaigns, public health guidance tailored to educational settings and information on relevant projects. e-Bug also continues to strengthen its international collaborations with partnerships established with Argentina, France, Hungary, Luxembourg, Northern Ireland, Norway and Wales. Efforts to expand this network of partnerships are ongoing and will continue into the 2025 to 2026 period.

e-Bug Training

The e-Bug Health Educator Training and Preventing and Managing Infections in Childcare and Pre-school are free courses available on the FutureLearn platform. They were developed by e-Bug, in collaboration with the BSAC, and closely align with e-Bug's classroom teaching resources, which are designed for children and young people aged between 3 to 16 years.

The e-Bug Health Educator Training course is primarily intended for educators and teachers working with children, but is also suitable for HCPs in paediatric settings. The course covers an introduction to microbes, application of behavioural changes to prevent infection spread and responsible antibiotic use. The course ran from 8 April 2024 to 8 April 2025 and recorded a total of 224 enrolments. According to post-course survey responses, all participants (11 out of 11)

reported that the course met or exceeded their expectations and that they had acquired new knowledge or skills.

The Preventing Managing Infections in Childcare and Pre-school course is tailored for individuals caring for children under the age of 4. It provides training to support individuals with an understanding of micro-organisms, infectious diseases and effective infection prevention and control practices within childcare settings. This course was available from 29 April 2024 to 29 April 2025 and recorded 692 enrolments. Survey feedback indicated that at least 55 participants found that the course met or exceeded their expectations, with 96% (53 out of 55) reporting that they had gained new knowledge or skills.

Vector-borne disease educational resource development

Vector-borne diseases (VBDs), transmitted by insects such as mosquitoes, ticks and fleas, cause over 700,000 deaths globally each year (145). Due to factors like climate change and increased global travel, these vectors are spreading into new regions, increasing the risk of transmission.

To raise awareness and improve understanding of VBDs, e-Bug is developing new curriculum-aligned educational resources for Key Stages 1 to 4. These resources aim to help students understand how tick- and mosquito-borne diseases spread and how to prevent them. The project is being developed in collaboration with international partners, the Travel Health and IHR team, the Medical Entomology and Zoonoses Ecology (MEZE) team, and UK educators.

A needs assessment was conducted with educators in England, France and Norway to identify educational gaps. Based on the findings, draft resources were created and reviewed through focus groups with educators. Once finalised, the materials will be piloted in a small number of schools to evaluate usability, suitability, and acceptability. Following the pilot, the resources will be rolled out more widely, including to international partners.

UK AMR public survey

Public knowledge and attitudes towards antibiotic use across England – pre- and post-pandemic

Antibiotic misuse is a major preventable contributor to AMR. Most antibiotics are prescribed in primary care where consultations for common self-limiting infections are highest, meaning that public knowledge may influence antibiotic prescribing. This study aimed to explore how public knowledge and attitudes towards antibiotics have changed over time.

Ipsos conducted interviews as part of routine surveys across England over 4 years. The surveys took place before the pandemic in 2020 (pre-pandemic), following the first year of the pandemic in 2021 (pandemic-Y1), following the second year of the pandemic in 2022 (pandemic-Y2) and after the pandemic in 2024 (post-pandemic). Random and quota sampling were used to ensure a representative sample. Questionnaire responses were weighted to ensure the results were broadly representative of the population. Pearson’s Chi-squared test was used to test for

differences in proportions across levels of categorical variables and between responses across the 4 years.

Responses were obtained from 2,022 (pre-pandemic); 1,676 (pandemic-Y1); 1,663 (pandemic-Y2) and 3,024 (post-pandemic) respondents.

The proportion of respondents who felt they had personal responsibility to tackle AMR increased from 57% pre-pandemic to 62% in pandemic-Y1 ($p < 0.05$), reducing to 46% post-pandemic. The proportion of respondents correctly answering the statement antibiotics will always speed up my recovery from an infection increased from 58% pre-pandemic to 65% in pandemic-Y1 and Y2 ($p < 0.05$), reducing to 56% post-pandemic. Knowledge regarding the appropriate use of antibiotics to treat ear infections, urine infections and COVID-19 was lowest post-pandemic.

Trust in HCPs regarding antibiotic prescribing peaked during the pandemic, ranging from 91% to 77%, and declined post-pandemic, falling to a range of 86% to 72%. Similarly, the proportion of respondents who reported they would be pleased if their GP did not prescribe antibiotics fell from 84% before the pandemic to 65% afterwards. The proportion of respondents likely to request antibiotics from their GP declined from pre-pandemic (21%) to pandemic-Y1 (19%) but increased post-pandemic (25%). Demographic variations were observed across nearly all survey questions.

This work highlights some concerning trends regarding antibiotic use and AMR following the pandemic. Knowledge regarding appropriate antibiotic use has quickly reverted to pre-pandemic levels, while levels of uncertainty have increased. Trust in HCPs has also declined, although this remains high. Future interventions should focus on rebuilding trust and improving communication between patients and HCPs, particularly targeting groups with lower awareness to support the goals of the UK NAP (146).

Professional and public AMR campaigns

World Antimicrobial Resistance Awareness Week (WAAW) and European Antibiotic Awareness Day (EAAD) 2024

WAAW took place between 18 and 24 November 2024 and EAAD on 18 November 2024. In 2023, the World Health Organization (WHO) rebranded the campaign from World Antimicrobial Awareness Week to World Antimicrobial Resistance Awareness Week after global consultations to better represent the challenges being faced. The 2024 campaign aligned its daily themes with the updated NAP for AMR, published in May 2024:

Day 1: Prevention – focused on IPC measures, including vaccination, supporting outcome 1 the NAP.
Day 2: Antimicrobials in clinical practice – highlighted good prescribing practices and public engagement, linking to outcomes 2 and 4 of the NAP.

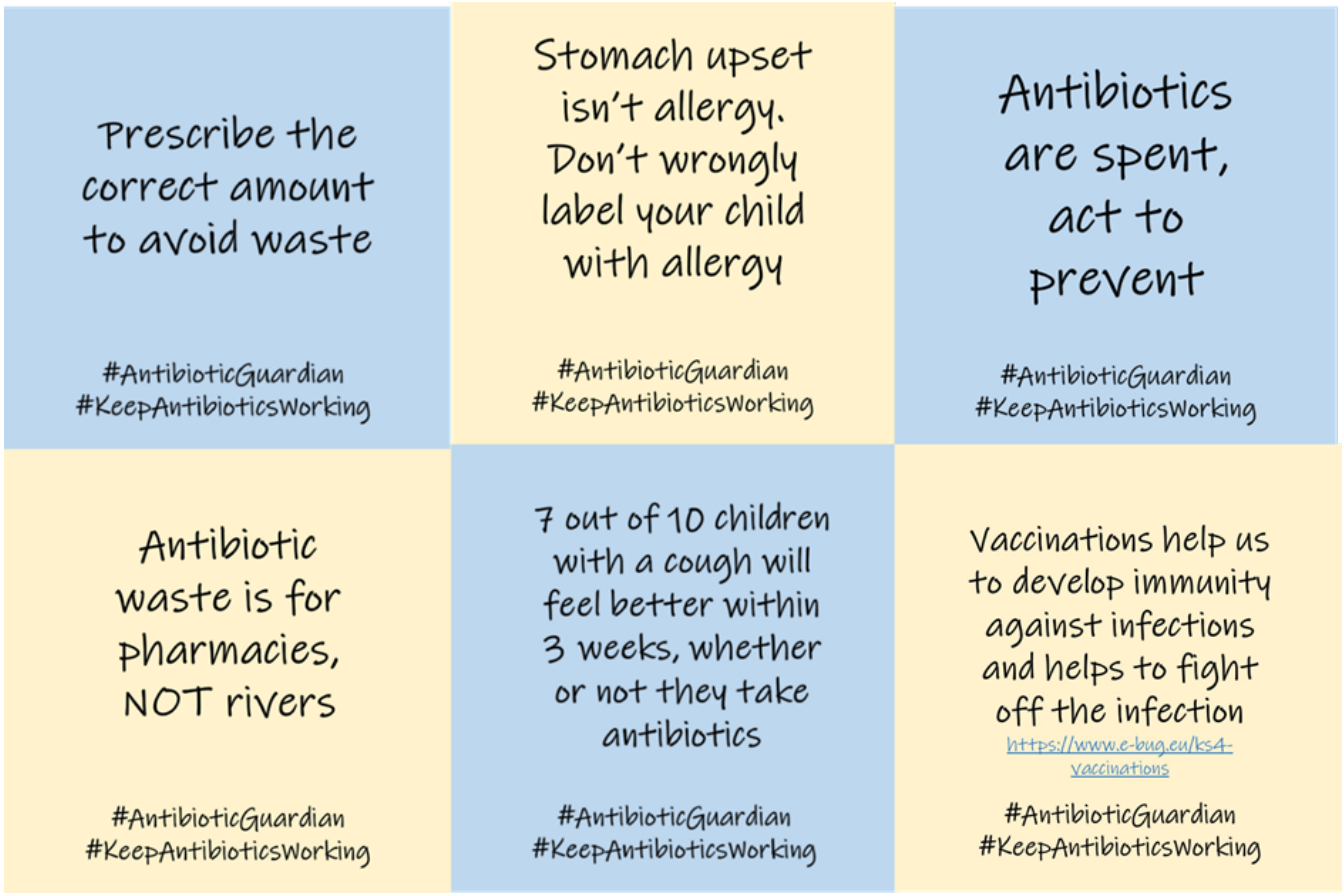
Day 3: Optimising diagnostics – promoted awareness of diagnostic tools, aligned with outcome 6 of the NAP.
Day 4: Antimicrobials and untrue or spurious allergy – addressed inaccurate penicillin allergy labels, linking to outcome 4 of the NAP.
Day 5: AMR and the environment and research – explored environmental impacts of AMR, such as disposal of antibiotics and environmental contamination and One Health research, linking to outcome 7 of the NAP.

Three cross-cutting themes underpinned all 5 days: children, sustainability, and inequalities. These were reflected in newly designed digital notes, examples of which are shown in Figure 6.6, which remained among the most shared resource during WAAW.

A refreshed toolkit was published in September 2024 to support HCPs, NHS organisations and local authorities to lead campaign activities. The toolkit was updated to reflect changes in COVID-19 practices, reinforce the One Health message and address health inequalities. In 2025, the key messages were reviewed and condensed to provide a more focused selection.

The webpage hosting the toolkit was visited 4,061 times between its publication in September 2024 and the end of 2024, an increase of 963 views from 2023. This may be due to the earlier publication of the toolkit and supports ensuring early publication of the toolkit in future years. Furthermore, the toolkit received 875 visits within WAAW week.

Figure 6.6. Selection of digital notes that were promoted for use during WAAW 2024



Text version of Figure 6.6

This graphic shows 6 digital notes in 6 boxes which read: prescribe the correct amount to avoid waste, stomach upset isn't allergy. Don't wrongly label your child with allergy. Antibiotics are spent, act to prevent. Antibiotic waste is for pharmacies, NOT rivers. 7 out of 10 children with a cough will feel better within 3 weeks, whether or not they take antibiotics. Vaccinations help us to develop immunity against infections and helps to fight off the infection: KS4 vaccinations. The bottom of each box also contains the text: #AntibioticGuardian, #KeepAntibioticsWorking.

End of accessible text.

To launch the 2024 campaign, a webinar was held to promote the early release of the toolkit, raise awareness of the UK NAP and celebrate the 10-year anniversary of the Antibiotic Guardian campaign. The event attracted 906 registrants and featured presentations from the Department of Health and Social Care (DHSC), 3 NHS organisations, the Microbiology Society and BSAC, NHSE, public health bodies for Wales, Scotland and Northern Ireland, the Veterinary Medicines Directorate (VMD) and previous Antibiotic Guardian Award winners.

WAAW and EAAD social media activity

During WAAW 2024 there were a total of 2,812 posts on X using the hashtags #WAAW, #AntibioticGuardian or #KeepAntibioticsWorking, with #WAAW being the most frequently used (54%, 1,513 out of 2,812). An additional hashtag, #ConfrontingAMR was introduced by the VMD to promote and link campaign activities to the NAP.

WAAW evaluation

In 2025, an evaluation was conducted to assess the implementation and impact of EAAD and WAAW activities in England from 2014 to 2024. The evaluation focused on social media activity, organisational actions, HCPs' awareness of the campaign, and knowledge of AMR and AMU.

The process evaluation utilised Google Advanced Search, social media analysis and a review of ESPAUR reports. It revealed diverse promotional strategies across NHS organisations (n = 4), government organisations (n = 3), academic institutions (n = 1), medical practices (n = 3) and advocacy groups (n = 1). These included infographics, videos and educational toolkits shared via web pages and social media. Visual content was especially effective in communicating complex AMR messages, such as how resistance develops and its public health implications. For example, Trinity College posted cartoon messages about AMR and the importance of responsible antibiotic use on X. Most web-based activities introduced and promoted WAAW and EAAD offering, downloadable toolkits including guidance documents, best-practice protocols, posters, leaflets and interactive content tailored to specific target groups. An example of these toolkits is the Supporting WAAW webpage from Gloucestershire Hospitals NHS Foundation Trust.

As part of the 2024 WAAW webinar registration, attendees were invited to complete a feedback survey on the toolkit. Over one-third reported using the toolkit in the previous 2 years (38%, 333 out of 906), and nearly all reported that they would recommend it to others (95%, 313 out of 330). The most valuable elements were the AMS key messages (95%, 308 out of 323), suggested actions (92%, 290 out of 315) and public awareness materials (89%, 284 out of 318). The most common activities reported were displaying and sharing Antibiotic Guardian or Keep Antibiotic Working materials (55%, 498 out of 906 and 54%, 486 out of 906).

Survey data from HCPs showed that perceived effectiveness of WAAW and EAAD varied with 51% (734 out of 1,427) and 13% (330 out of 2,639) rating them as effective or very effective, respectively. Notably, awareness of these campaigns was strongly correlated with higher knowledge scores (Z-score = −4.948, $p < 0.001$), suggesting a positive impact on professional understanding of AMR and AMU.

UKHSA Andi Biotic AMR campaign

Findings from the 2023 UKHSA public survey revealed high overall public awareness of AMR, with 65% of the public expressing concern and 87% acknowledging that antibiotics should only be taken when necessary. However, personal responsibility remains low, with over half of the public being unsure of their role in preventing resistance and 37% believing there is nothing they can personally do to help. This knowledge gap was pronounced among men, younger adults aged 18 to 34, and Black, Black British, Asian and Asian British groups. These demographics also demonstrate higher rates of antibiotic misconceptions, such as believing they are effective against cold and flu infections. Younger age groups report higher antibiotic use (61% to 66% using them at least once annually compared to 46% of the general population) and were significantly more likely to misuse them. Non-completion of prescribed courses when feeling better is particularly prevalent (13% to 22%, compared to 8% of the general population), as is using antibiotics prescribed for others (16%). These differences were also noted in men and Black, Black British, Asian and Asian British groups.

To address these issues, the UKHSA piloted a targeted campaign aimed at younger audiences, using earned and no-cost media channels, such as social media, with minimal paid promotion. The campaign built on the success of the 2017 'Keep Antibiotics Working' initiative and introduced a new mascot, Andi Biotic – an anthropomorphic pill designed to deliver serious messages in a fun and engaging way. The objectives of the campaign were to increase reach and visibility of correct antibiotic behaviours and to improve awareness and understanding of appropriate antibiotic use as a foundation for behaviour change.

Creative development

Pretesting with 18- to 24-year-olds in November 2023 showed that humour and meme-style content was effective in capturing attention, particularly on social media, whilst a non-patronising tone was essential. The ‘Keep Antibiotics Working’ brand remained well-recognised.

Research also supported the use of mascots, leading to a 30% increase in driving behavioural impact (147, 148).

Three scenarios featuring Andi Biotic were developed to address common misuses: taking antibiotics for viral infections, saving them for later or taking old antibiotics, and not following prescribing instructions. Supporting print and digital assets were available for dissemination to stakeholders via the campaign toolkit to increase reach through partnership. Feedback from focus groups with young Black and Asian British participants was taken into account to further develop the mascot character and appearance.

Implementation

The campaign was launched on 7 April 2025, primarily rolled out via UKHSA's social media channels (Facebook, Instagram, X, LinkedIn and BlueSky). In order to create excitement prior to the launch, Andi Biotic was teased across these channels for a brief period, and also appeared at the UKHSA conference. Engagement activities were shared across public health networks, government bodies and third-sector organisations. A stakeholder toolkit provided downloadable resources and guidance for local implementation.

Press coverage was secured in national outlets such as The Guardian and The Express, as well as regional and specialist publications, such as Knowle News, The Pharmacist and PR Week. In the latter stages of the campaign, social media posts were boosted to reach target audiences less likely to engage with content via UKHSA channels.

Evaluation

The campaign was a creative success that can be demonstrated to have captured the attention of the target audience, as evidenced by the high engagement rate. Organic social media engagement outperformed previous campaigns, including Childhood Immunisations and WAAW, across key metrics such as engagement rate and click-through rates. For example:

- Instagram posts achieved an average engagement rate of 2.8%, exceeding the channel average of 1.3%
- Facebook videos received over 40,000 organic views, ranking among the top 5 performers across UKHSA channels
- LinkedIn engagement for the first behaviour video reached 18.3%, compared to a channel average of 13.7%

Social listening indicated an increase in online conversations around the topic of antibiotic resistance during the campaign. Paid promotion also performed well, with click-throughs rate of 0.63, which is within a range generally considered good (0.5 to 1.5) when compared to industry average. Other campaign activities have also yielded positive results with the toolkit widely shared with a range of stakeholders who have been able to share it through their networks, such as NHSE, the Local Government Association, the Ministry of Housing, Communities and Local Government, and the Association of the British Pharmaceutical Association.

The toolkit was shared in UKHSA's weekly stakeholder cascade, where it was the most clicked link during the campaign launch period. Posters featuring Andi Biotic were displayed on all Amazon UK sites in staff areas. Despite a limited budget and no traditional news hook, the campaign achieved strong visibility and engagement, laying the groundwork for future targeted interventions.

Antibiotic Guardian Campaign

Public Health England (now UKHSA) launched the Antibiotic Guardian campaign in 2014, with the aim of transitioning from raising awareness to increasing engagement. The campaign encourages individuals across human and animal health, science, education and the general public to pledge their commitment to tackling AMR. In the 10 years since inception, the campaign surpassed 100,000 pledges in 2020 and ended 2024 with 190,648 pledges made via the main website page (Table 6.3), totalling over 200,000 when including all pledges from collaborative pages.

Table 6.3. Number and proportion of pledges annually from the main pledge page by pledge groups from the start of the campaign in 2014 to December 2024

Year	HCP number (%)	Public number (%)	Students number (%)	Unknown number (%)	Total number
2014	8,501 (69)	3,725 (30)	0 (0)	89 (1)	12,315
2015	7,979 (53)	4,542 (30)	2,322 (15)	159 (1)	15,002
2016	6,928 (46)	4,727 (31)	3,392 (22)	92 (1)	15,140
2017	8,494 (56)	3,518 (23)	3,028 (20)	130 (1)	15,170
2018	4,570 (55)	1,293 (15)	2,359 (28)	151 (2)	8,373
2019	5,899 (64)	1,234 (13)	2,022 (22)	134 (1)	9,289
2020	30,940 (84)	643 (2)	4,337 (12)	814 (2)	36,733
2021	29,608 (90)	627 (2)	1,571 (5)	617 (2)	32,423
2022	11,746 (84)	502 (4)	1,388 (10)	279 (2)	13,915
2023	16,486 (85)	438 (2)	1,950 (10)	447 (2)	19,321
2024	10,390 (80)	539 (4)	1,707 (13)	331 (3)	12,967
Total	**141,541 (74)**	**21,788 (11)**	**24,076 (13)**	**3,243 (2)**	**190,648**

The campaign webpage received 153,558 views and 12,967 pledges in 2024 (Figure 6.7). Notable spikes in activity occurred on 21 August, coinciding with the launch of the 2024 WAAW webinar, and again on 15 and 16 October, however it is unclear what may have caused this. Most pledges were made by health or social care professionals (80%, 10,390 out of 12,967), with 67% (8,628 out of 12,967) from pharmacy teams across primary, secondary and community care. Annexe Table 6.1 has a breakdown of pharmacy team pledges made during

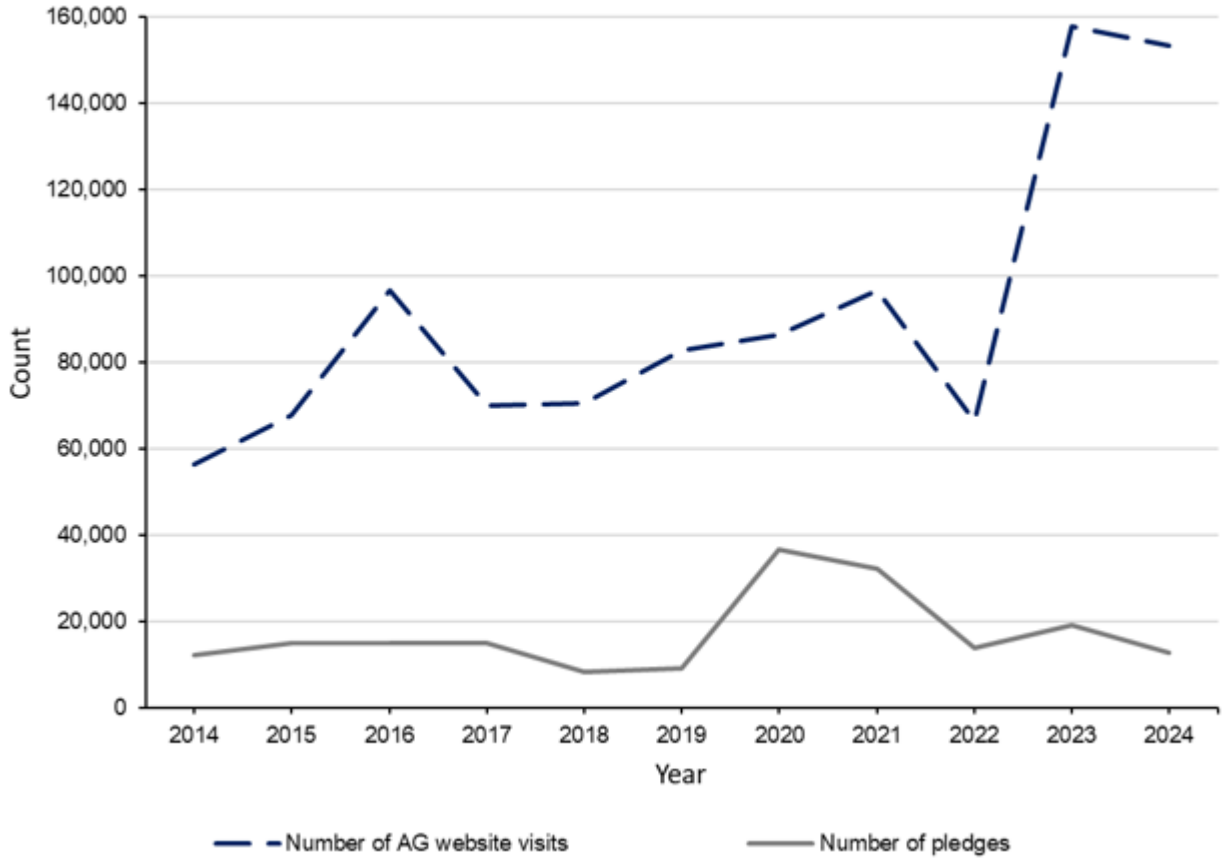
2024. Public pledges increased slightly from 2023 but remained proportionally low at 4% (539 out of 12,967) of all pledges. Pledges made from students, educators and scientists increased to 13% (1,707 out of 12,967), the highest since 2019. Community pharmacy remained the most common source of campaign awareness (44%, 5,646 out of 12,967), followed by colleagues (21%, 2,782 out of 12,967) and the NHS (9%, 1,163 out of 12,967).

Following the update of the Antibiotic Guardian website in 2023, additional demographic data was collected. Since April 2023, most pledges have been received by those aged 35 to 64 years (49%, 9,633 out of 19,809). Very few pledges were made by those under 18 or over 65 years (1.5% and 2.2% respectively). A large proportion of pledges came from Asian and British Asian individuals (25%, 4,968 out of 19,809), while engagement from Black, African, Caribbean or Black British groups remained low (6%, 1,219 out of 19,809).

In 2024, 104 organisations registered their AMS activities on the Antibiotic Guardian, primarily from GP practices (45%, 47 out of 104), hospitals (10%, 10 out of 104) and NHS primary care (9%, 9 out of 104).

A quarterly Antibiotic Guardian newsletter aimed at HCPs was launched in October 2024, in collaboration with the Microbiology Society. It featured AMS activities, patient and clinicians' personal experiences of AMR, event updates and promotional resources. The October and February editions of the newsletter were delivered to 29,899 and 22,001 recipients, with open rates of 20% (5,944 out of 29,899) and 19% (4,138 out of 22,001) and link click rates of 11% (3,165 out of 29,899) and 13% (3,173 out of 22,001), respectively.

Figure 6.7. Antibiotic Guardian pledges (including international pledges) made via the main pledge page each year, from 2014 to 2024 and annual number of visits to the Antibiotic Guardian main pledge page



Analysis of international antibiotic guardian pledges: a focus on Africa

Since its launch in 2014, the UKHSA has partnered with WHO Europe and the Belgian Antibiotic Policy Coordination Committee (BAPCOC) to translate the Antibiotic Guardian campaign into Russian, Dutch, French, Turkish and Welsh. In collaboration with the Africa Centre for Disease Control, pledges were also developed specifically for HCPs and the public in Africa.

By the end of 2024, the campaign had engaged 17,053 individuals from 194 countries across all 7 continents. The highest concentration of pledges came from Africa, Asia, and Europe (Table 6.4), with peak international engagement recorded in 2020 and 2018, with 4,613 and 2,632 pledges, respectively.

Between 2018 and 2024, 3,997 pledges were made on the African and South African sub-pages. Of these, 98% (3,925 out of 3,997) came from 40 African countries, while the remaining 2% (72 out of 3,997) came from 21 countries across Europe, Asia, North America and Oceania. The highest annual pledges were in 2018 and 2019, with 1,086 and

913 pledges, respectively. Notably, 41% (1,654 out of 3,992) of pledges were made in November, aligning with WAAW and EAAD.

Among those pledging via the Africa subpages, 68% (2630 out of 3,882) were HCPs, including prescribers (31%, 807 out of 2,630), educators (24%, 627 out of 2,630) and non-prescribing staff (21%, 229 out of 2,630), 21% (818 out of 3,882) were students, 11% (419 out of 3,882) were farmers and 0.4% (15 out of 3,882) were citizens.

Professional networks were the most common source of campaign awareness, including professional organisations (25%, 769 out of 3,028) and colleagues (22%, 676 out of 3,028). Other sources included social media (14%, 413 out of 3028), internet searches (10%, 294 out of 3,028), universities (8%, 248 out of 3,028), and conferences (7%, 213 out of 3,028). Knowledge of AMR was high among participants, with 61% (1,789 out of 2992) answering all 5 questions correctly.

Table 6.4. Analysis of international Antibiotic Guardian pledges based on continent (2015 to 2024)

Continent	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
Africa	66	105	133	1,405	1,344	1,026	718	353	882	444	6,476
Antarctica	0	0	0	0	0	0	0	0	0	1	1
Asia	67	243	191	209	273	3,054	246	130	558	722	5,693
Europe	151	591	448	885	642	399	272	159	155	122	3,824
North America	36	86	65	61	48	91	33	21	32	50	523
Oceania	17	36	43	17	115	18	18	8	7	11	290
South America	3	20	47	39	29	18	11	12	9	14	202
United Kingdom	0	0	0	12	4	3	1	4	5	1	30
Unknown	0	1	1	4	3	4	0	0	0	1	14
Total	**340**	**1,082**	**928**	**2,632**	**2,458**	**4,613**	**1,299**	**687**	**1,648**	**1,366**	**17,053**

Africa: South Africa (2,630), Nigeria (1654), Kenya (432), Uganda (398), Ghana (263).
Asia: India (4163), Pakistan (432), Malaysia (162), Bangladesh (105), Saudi Arabia (105).
Europe: Belgium (1972), Spain (460), Ireland (166), Italy (134), France (110).
North America: United States (261), Canada (92), Mexico (71), Trinidad and Tobago (19), Saint Lucia (19).
Oceania; Australia (210), New Zealand (56), Fiji (12), Papua New Guinea (4), Wake Island and the US Pacific (2).
South America: Brazil (115), Argentina (18), Colombia (15), Chile (12), Peru (12).

The Antibiotic Guardian campaign has successfully evolved into a worldwide initiative for AMR awareness and behavioural change. In Africa, the campaign has demonstrated strong engagement from HCPs and the public. These findings highlight the campaign's potential to support national and regional AMR strategies in Africa, especially when adapted to local contexts. However, further promotion and tailored strategies are needed to effectively reach the most impacted subpopulations and ensure that pledges lead to a decrease in antibiotic misuse and overuse in Africa.

Antibiotic Guardian Shared Learning and Awards

The call for entries for the 2024 to 2025 Antibiotic Guardian Shared Learning Awards (AGSLA) opened in October 2024. A total of 75 projects and case studies were submitted across 13 categories, with 48 shortlisted. Seventeen entries were received from international organisations. Full category breakdowns are available in Annexe Table 6.3.

Now in its seventh year, the AGSLA took place in-person, with hybrid virtual participation option available, on 9 June 2025. For the first time, the event featured an AMR lecture and panel discussion. Speakers included Dr Marisa Holubar (Clinical Professor, Division of Infectious Diseases, Stanford University School of Medicine), Professor Bola Owolabi (Director of Healthcare Inequalities, NHSE), Dr Fraser Broadfoot (Head of AMU Surveillance and Stewardship, VMD), and Becky McCall (PhD student, University of College London) A keynote address was delivered by Professor Isabel Oliver (Chief Medical Officer for Wales). The awards also featured a patient story on the challenges of recurrent UTIs.

The event was attended by 127 delegates from both UK and international organisations. Several projects which have been previously recognised at the awards have progressed to national projects or feature in the UK AMR NAP. A full list of shortlisted entries across all years can be viewed on the Antibiotic Guardian website. A new category, 'Tackling Health Inequalities', was introduced for the 2024 to 2025 awards cycle, recognising projects that address health disparities support the health inequalities outcome included in the updated NAP.

The AGSLA event represents a strong example of knowledge mobilisation in the AMR, promoting learning through poster presentations, panel discussions and publishing videos from shortlisted projects online.

Antibiotic Guardian Schools Ambassadors programme

The Antibiotic Guardian Schools Ambassadors programme, first piloted in 2019, aims to connect HCPs with local schools and community groups, to raise awareness about antibiotic use, AMR and IPC. The programme aligns with the UK AMR NAP and has seen over 400 individuals register to become an Antibiotic Guardian Schools Ambassador to engage young people in their communities.

Since 2021, the programme has aimed to target regions with the most deprived lower-layer super output areas through regional AMS pharmacy leads and the regional AMS pharmacy network. In 2023, the programme was expanded to include strengthened veterinary content, in collaboration with the VMD, to engage young people who may be pet or animal owners.

In 2024, 5 colleagues from Wales registered to become Antibiotic Guardian School's Ambassadors, compared to 26 in 2023, 189 in 2022, 110 in 2021 and 79 in 2019. The value of including veterinary content was highlighted again this year by 20% (2 out of 5) of registrants coming from the veterinary profession. However, the continued decline in the number of registrants since 2022 suggests that promotion in 2023 may have been ineffective, or that those who had previously registered did not re-register, though they may still be using the resources.

The programme demonstrates the commitment of HCPs to engage schools on AMR topics, even during the pandemic, and highlights the role of regional AMS lead networks in reaching deprived areas. The international reach of Antibiotic Guardian materials was demonstrated in 2022, suggesting that incorporating translated e-Bug materials in future versions of the Antibiotic Guardian School's Ambassadors lesson-planning toolkit could enhance accessibility. Future work will focus on improving promotion, strengthening the regional approach and designing robust impact indicators.

Challenges of assessing the cost effectiveness of AMR campaigns: considerations for policy makers

WHO has highlighted the necessity of economic evaluations to appraise interventions that address AMR and establish a financial case for investment in these approaches.

Following previous work on AMR campaigns, including:

- 'Assessment of global AMR campaigns conducted to improve public awareness and AMU behaviours: a rapid systematic review' (149)
- 'Assessing the impact of a national social marketing campaign for antimicrobial resistance on public awareness, attitudes, and behaviour, and as a supportive tool for HCPs, England, 2017 to 2019' (150)

A rapid review of cost-effectiveness analyses, which evaluated public AMR campaigns, was conducted in academic partnership with University of Warwick (151).

The review highlighted the main challenges in assessing the cost-effectiveness of AMR campaigns include identifying and measuring appropriate outcomes, including broader societal impacts, capturing relevant outcomes over a longer timescale, and accounting for the cost of AMR. These challenges have remained significant obstacles for over 20-years, making it difficult for policy makers to justify investment in public campaigns to combat AMR. The lack of

methodological progress in this area has limited the availability of economic evidence to inform decision-making.

Public awareness campaigns, which aim to increase knowledge and change behaviour surrounding antibiotic use, are particularly difficult to evaluate due to the complexity of measuring behaviour change and the lack of direct measures of outcomes. The authors recommend that an extended framework for cost-effectiveness analyses is required which includes wider outcomes over a longer timescale. This should also involve establishing willingness to pay thresholds through understanding societal preferences for antibiotic use, which is essential for informing policy decisions. They suggest that these will allow decision makers to consider broader economic indicators of the value of AMR campaigns designed to raise awareness and effect behavioural change among the general public, including long-term costs of AMR and their future impacts at a societal level.

The peer reviewed policy commentary now published in Public Health Journal is available at Challenges of assessing the cost effectiveness of AMR campaigns: considerations for policy makers.

Box 6.1. Progress against the UK AMR National Action Plan's (NAP) human health targets: public and professionals' knowledge of AMR and antibiotic use

The UK government's national action plan (NAP), Confronting antimicrobial resistance 2024 to 2029, includes 5 human health targets.

Target 2a states that by 2029, we aim to increase UK public and healthcare professionals' knowledge on AMR by 10%, using 2018 and 2019 baselines, respectively. A survey was conducted in March 2024 to determine levels of knowledge of AMR among the public and HCPs at the start of the 2024 to 2029 AMR NAP.

Four knowledge questions were asked of the public, including "Antibiotics are effective against viruses", "Antibiotics are effectives against cold and flu", "Unnecessary use of antibiotics makes them become ineffective" and "Taking antibiotics has associated side effects or risks such as diarrhoea, colitis, allergies".

In 2024 28% of the public answered all 4 knowledge questions correctly compared to 29% in 2018. Knowledge and knowledge changes over time varied by question.

Seven knowledge questions were asked of HCPs including "Antibiotics are effective against viruses", "Antibiotics are effective against cold and flu", "Unnecessary use of antibiotics makes them become ineffective", "Taking antibiotics has associated side effects or risks such as diarrhoea, colitis, allergies", "Every person treated with antibiotics is at an increased risk of antibiotic-resistant infection", "Antibiotic-resistant bacteria can spread from person to person" and "Healthy people can carry antibiotic resistant bacteria."

In 2024, 63% of HCPs answered all 7 knowledge questions correctly compared to 59% in 2019. This varied by healthcare profession with allied health professionals seeing the largest change in knowledge with 42% and 56% answering all knowledge questions correctly in 2019 and 2024 respectively.

Changes overtime should be interpreted with care due to differences in methodology and sample sizes used within the baseline and the 2024 surveys. For the healthcare professionals survey, recruitment methods differed between 2019 and 2024. Quota sampling and distribution of the questionnaire through professional networks (146, 150) while in 2024 a social marketing company used a sampling frame of 100 individuals per profession (primary and secondary care nurses, doctors and pharmacists) and the questionnaire was also promoted by Project Advisory Group members via a snowball sampling. Significant differences were also seen in professional groups between the 2019 and 2024 questionnaires with significantly higher numbers of doctors, pharmacists and dentists and significantly lower numbers of nurses and allied health professionals completing the questionnaire in 2024 compared to 2019. For the public survey, the 2018 data was obtained through the Eurobarometer survey whereas the 2024 survey was conducted only within the UK by a market research company (146).

Future actions

TARGET antibiotics programme

The TARGET programme will continue its collaborative webinar series with the RCGP, introducing 3 new topics to inform AMS best practices in primary care. While the full process and impact evaluation of the TARGET training rollout is expected in 2025, training rollout will continue. Interim findings highlight the need for refresher training and adaptation for other settings, such as emergency departments. Future efforts will prioritise areas with widening AMR-related inequalities, including those with higher deprivation.

e-Bug programme

e-Bug are developing new lesson plans on vector-borne diseases in partnership with France and Norway, with plans for implementation in each region. Following a 2023 teacher survey identifying a need for IPC training, e-Bug is working with UKHSA IPC and Regional Health Protection Teams to develop IPC training tailored for educators.

UKHSA Andi Biotic AMR campaign

Following the successful pilot of the Keep Antibiotics Working campaign featuring the Andi Biotic mascot, the UKHSA is preparing for the next phase. Plans include:

- launching the second phase during WAAW in November 2025
- creating culturally relevant and insight-led content throughout the year
- expanding influencer partnerships and exploring low-cost engagement opportunities

- strengthening stakeholder collaboration across government, local authorities, and the commercial sector
- sharing assets with the international public health community

Antibiotic Guardian

Future work will focus on recruiting more Antibiotic Guardians, particularly newly qualified HCPs. Efforts will look to enhance the campaign's contribution to improving public and professional knowledge, in line with the NAP for AMR.

Now in its seventh year, the Antibiotic Guardian Schools Ambassadors scheme continue to prioritise engagement in areas of deprivation in a commitment to tackling inequalities. Further promotional activities will aim to increase engagement beyond 2024 levels.

World AMR Awareness Week (WAAW)

The 2025 WAAW campaign will include 2 new daily themes: 'Tacking health inequalities' (day 4) and 'One Health and Research' (day 5). A new cross-cutting research theme. Furthermore, the key messages section will be consolidated, and additional resources will be included within the toolkit for 2025.

Chapter 7. Research insights and knowledge mobilisation

Main messages

A wide range of new and ongoing research projects were undertaken in the fields of HCAI and AMR in the last year, with the publication of over 100 peer-reviewed papers from across the UK Health Security Agency (UKHSA).

This chapter showcases key antimicrobial resistance (AMR) and healthcare-associated infections (HCAI) research projects within UKHSA and jointly with external stakeholders, undertaken from April 2024 to March 2025, highlighting the contributions to the goals of the UK 2024 to 2029 AMR National Action Plan (NAP). All of the projects showcased in the Research insights and knowledge mobilisation chapter are aligned with the NAP's outcomes and priorities.

The 2 National Institute for Health Research (NIHR)-funded Health Protection Research Units (HPRUs) working on HCAI and AMR (University of Oxford and Imperial College London) have produced a wealth of translational research aiming to impact public health practice and policy over the last 5 years from 2020 to 2025. An overview of research of the HPRUs is highlighted, with examples for where knowledge mobilisation has enhanced the impact of the work. The chapter also covers the aims of the latest HPRU.

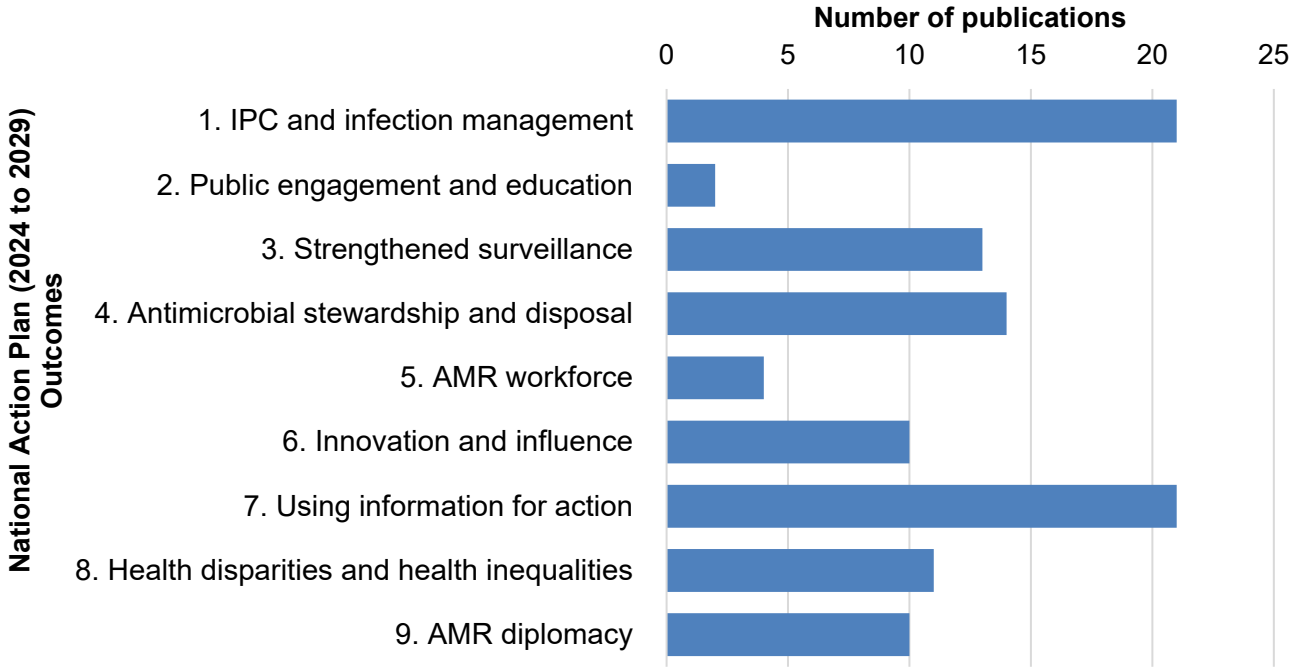
Introduction to Chapter 7

Within and in collaboration with the UKHSA, there are a wide range of new and ongoing research projects in the fields of healthcare-associated infections (HCAIs) and antimicrobial resistance (AMR), undertaken in the last financial year.

These projects cover many priorities in innovation, research, and development, including studies to improve our understanding of behaviours around antimicrobial usage, as well as contributing to evidence about new and existing control strategies, including infection prevention and control (IPC), antimicrobial stewardship (AMS), and the development of novel immunotherapeutics, technologies and vaccines. There is work to understand the risks of infection, resistance and mortality in patients.

The work is focused on supporting the achievement of the goals and commitments of the UK 2024 to 2029 AMR National Action Plan (NAP). This is demonstrated in Figure 7.1, which illustrates the breadth of peer-reviewed publications resulting from research undertaken by UKHSA against the 2024 to 2029 NAP outcomes. A complete list of these AMR-related publications from April 2024 to March 2025 is provided in the Annexe accompanying this report (Chapter 7).

Figure 7.1. AMR peer-reviewed publications from April 2024 to March 2025, by National Action Plan (2024 to 2029) outcome



Text version of Figure 7.1

A figure showing the number of peer-reviewed publications by NAP outcome: IPC and infection management = 21 publications, public engagement and education = 2 publications, strengthening surveillance = 13 publications, antimicrobial stewardship and disposal = 14 publications, AMR workforce = 4 publications, innovation and influence = 10 publications, using information for action = 21 publications, health disparities and health inequalities = 11 publications, AMR diplomacy = 10 publications.

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The UK AMR NAP for 2024 to 2029 has introduced key research priorities:

- what is the cost of AMR?
- what is the relationship between AMR and health disparities?
- how to influence public awareness and behaviour on AMR?
- how to address AMR in international settings?
- what are the basic drivers and effects of AMR, and how does it spread?
- how can we prevent AMR from spreading?
- how can we optimise the use of antimicrobials?
- what methods can be used to prevent, treat and manage infections without antimicrobial medicines?
- how can we drive innovation of new products for tackling AMR?
- how can we ensure what is known to work is implemented?

Research is ongoing across all these questions and detailed within the outcomes and commitments of the UK 2024 to 2029 AMR NAP. This chapter outlines examples of AMR and HCAI research projects, peer-reviewed publications and conference abstracts, all undertaken by the UKHSA from April 2024 to March 2025. These projects showcase research across many fields within AMR and are organised according to the following topic areas:

- strengthening surveillance and epidemiology
- AMS and prescribing
- impact of COVID-19 on AMR
- infection prevention and control (IPC)
- novel therapeutics, technologies and vaccination

We also provide an overview of the research from the 2 National Institute for Health Research (NIHR) Health Protection Research Units (HPRUs) in the topic area of HCAI and AMR, led by Imperial College London and the University of Oxford, both in partnership with the UKHSA.

Research projects

Strengthening surveillance and epidemiology

Health inequalities in incidence of bacteraemias: a national surveillance and data linkage study, England, 2018 to 2022

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Peer-reviewed publication

Background Health inequalities exist globally, but limited data exists on this topic for bacteraemia. Aim: In this study we investigated health inequalities surrounding bacteraemia in England, to identify high-risk population groups and areas of intervention.
Methods We retrospectively analysed English surveillance data between 2018 and 2022 for *Escherichia coli, Klebsiella species, Pseudomonas aeruginosa*, and both meticillin-sensitive and resistant *Staphylococcus aureus* (MSSA, MRSA) bacteraemia. Crude incidence rates stratified by index of multiple deprivation and ethnic groups were calculated; age-adjusted rate ratios were estimated using negative binomial regression models.
Results We identified 342,787 bacteraemia cases. Across all pathogens, as the level of deprivation rose, so did the age-adjusted bacteraemia incidence rate ratio. Compared with residents of the 20% least deprived areas of England, residents of the 20% most deprived areas had a 2.68-fold increased bacteraemia rate for MRSA (95%CI:2.29 to 3.13) and 1.95-fold for *E. coli* (95%CI: 1.84 to 2.05), and 15% higher odds of dying within 30days of any bacteraemia (95%CI: 1.13 to 1.19). After age adjustment, the incidence of all bacteraemia was higher in the Asian and Black groups compared with the White group: for MRSA, 79% higher in the Asian

(95%CI: 1.51 to 2.10) and 59% higher in the Black (95%CI: 1.29 to 1.95) groups. The exception was MSSA, whose incidence was highest in the White group.
Conclusion Disproportionately higher age-adjusted incidence of bacteraemia occurred in deprived areas and ethnic minorities. These disparities are likely multifactorial, possibly including socioeconomic, cultural, and systemic risk factors and different burden of comorbidities. Better understanding these factors can enable targeted interventions.

Bloodstream Infections in Critical Care Units in England, April 2017 to March 2023: Results from the First 6 Years of a National Surveillance Programme

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Background Patients in critical care units (CCUs) are at an increased risk of bloodstream infections (BSIs), which can be associated with central vascular catheters (CVCs). This study describes BSIs, CVC-BSIs, organism distribution, percentage of antimicrobial resistant (AMR) organisms, and case fatality rates (CFRs) over the first 6 years of a voluntary national CCU surveillance programme in England.
Methods Surveillance data on BSIs, CVCs, and bed days between April 2017 and March 2023 for adult CCUs were linked to mortality and AMR data, and crude rates were calculated.
Results The rates of CCU-BSIs and CCU-CVC-BSIs were stable for the first 3 years (3.6 and 1.7 per 1,000 bed days in 2019 to 2020), before increasing by 75% and 94% in 2020 to 2021, respectively, and returning to near pre-pandemic levels by 2022 to 2023. Gram-negative bacteria accounted for 50.3% of all CCU-BSIs, followed by Gram-positive bacteria (39.6%) and *Candida* spp. (8.6%). *Klebsiella* spp. saw increases in percentage AMR, whereas other organisms saw declines or similar levels. The overall CFR was 30.2%.
Conclusions BSI incidence in CCUs remained stable across the study period, except for an increase in 2020 to 2021 which reverted by 2022 to 2023. This data provides a benchmark for CCUs and give insight into long-term AMR patterns where comparable national data is limited.

Climbing incidence of *Clostridioides difficile* post-COVID-19 pandemic: a descriptive surveillance study, England, 2017 to 2024

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Background *Clostridioides difficile* Infections (CDI) in England have been rising in recent years after a period of sustained reduction and stability, coinciding with the COVID-19 pandemic. We analyse CDI incidence before and after the COVID-19 pandemic.
Methods Case-level data on laboratory-confirmed CDI in England, from 1 April 2007 to 31 March 2024, was extracted from the UKHSA's national mandatory surveillance system. Data was linked to Hospital Episode Statistics (HES) and Office for National Statistics (ONS) data for demographic, clinical and mortality information.
Results CDI incidence rates increased 32.9% from 2020 to 2021 to 2023 to 2024 reaching 29.5 cases per 100,000 population, the highest rates since 2012 to 2013. Increases were more prominent in hospital-onset, healthcare-associated (HOHA) cases, 48.3% (13.2 vs 8.9 per 100,000 bed days) compared to 2018 to 2019, respectively. During the same period, incidence increased in all demographic groups, notably, those aged 85+, 36.7% and 32.7%, males and females, respectively. But also concerningly, community-onset type (COIA incidence rose by 24.1%, from 2.9 to 3.6 per 100,000 population, followed by COCA incidence, by 14.3%, from 4.9 to 5.6 per 100,000 population). The Black ethnic and Asian ethnic groups experience the greatest rises of 53.3% rise (from 15.0 to 23.0 per 100,000 population) and 43.0% (16.5 to 23.6 per 100,000), respectively. Thirty-day all-cause mortality rate rose 15.2% since 2020 to 2021, to 3.8 deaths per 100,000 population. Recurrent infections observed an upward trend, with proportion of relapse cases increasing from 10.2% in 2020 to 2021 to 10.8% in 2023 to 2024. Key antimicrobial prescribing trends remained stable with moderate increases, by defined daily dose (DDDs) rate in secondary care clindamycin observed an 18.1% increase, co-amoxiclav 17.1%, and 3rd generation cephalosporin (16.6%), but remain below pre-pandemic levels.
Conclusions The rising incidence of CDI in England following the COVID-19 pandemic is concerning and warrants in-depth investigation to understand drivers and control swiftly.

A metric to measure mortality due to antibiotic-resistant bacteraemia in the UK using public health data

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ESCMID conference

Background A simple metric to communicate the number of deaths due to antibiotic-resistant bloodstream infections (BSIs) is needed across key pathogens (initially *Escherichia coli*, but to be extended to *Klebsiella pneumoniae, Klebsiella oxytoca*, Acinetobacter spp. and Pseudomonas spp.) where resistance is defined as non-susceptibility to an antibiotic. Quantifying mortality due to drug-resistant bacterial infections is challenging due to baseline and time-varying confounding and the need for different analytical strategies for community and

hospital onset infections. The work has utilised a novel ‘Sequential trials’ approach that allows us to make causal inferences about mortality attributable to antibiotic-resistant BSIs under the assumption of no unmeasured confounding.
We considered 2 counterfactuals, giving 2 versions of the metric, corresponding to deaths which could have been averted if: (1) infections that occurred had been susceptible to key antibiotics; (2) infections that were resistant to key antibiotics had not occurred.
Methods For 2023 we linked reported infections from the UKHSA’s Second Generation Surveillance System (SGSS), English hospital admissions from the NHS’s Hospital Episode Statistics (HES), and the Office for National Statistics’ (ONS) mortality data, via patient NHS number. All-cause mortality within 30 days of infection was calculated, and cases classed as hospital onset if recorded 2 or more days into a hospital stay. Different models were run for community and hospital onset and for both counterfactuals.
Results Unadjusted estimates of excess mortality due to antibiotic resistant *E. coli* BSIs were 523 (8.8% of 5954 deaths) under counterfactual 1 and 3151 (52.9%) under counterfactual 2. After adjusting for comorbidities, age and sex, it was estimated that 436 (7.3%) deaths would have been avoided if the infection had been susceptible and 2866 (48.1%) deaths would have been avoided if resistant infections had been prevented altogether.
Conclusions This metric communicates the extent of deaths due to antibiotic-resistant *E. coli* BSIs in England. Further work will focus on expanding this method to a UK-wide dataset and to more pathogens.

Sepsis and Infection Burden Surveillance in Secondary Care in England

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Sepsis is the body’s over reaction to an infection where the immune response damages its own organs and tissues. It is a complex syndrome with a high mortality rate; but no biomarker or gold-standard test exists to diagnose it. Instead, clinicians rely on a combination of tests and clinical signs and symptoms to screen for, and diagnose, sepsis, making surveillance of sepsis particularly challenging. A pragmatic approach to sepsis surveillance, which does not incur any front-line NHS staff time, is to utilise International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) diagnosis codes available in administrative datasets such as the National Health Service (NHS) Hospital Episode Statistics (HES). However, sepsis-specific codes are subject to changes in definitions, updated diagnosis and

coding guidance as well as revisions in the diagnosis codebooks which can significantly bias identification of cases and the burden.
Under the premise that all sepsis cases develop from an underlying infection, UKHSA are developing an alternative approach to sepsis surveillance by characterising and estimating the burden of all infections in English NHS secondary care providers using ICD-10 codes for infection in the HES administrative dataset. UKHSA has developed a code set for infection and infection-related conditions that expands previous work to also include codes relating to viral, helminthic, fungal and protozoal pathogens and related conditions. The expanded code set was developed through an iterative process of literature and expert clinical review by NHS infectious disease consultants and the UKHSA infection and pharmacy leads. Each code was reviewed by an infectious disease clinician against agreed inclusion and exclusion criteria. Ambiguous or contentious codes (for instance codes relating to conditions with non-infectious and infectious causes) were discussed as a group and a decision to include or exclude was made by consensus opinion.
The code list has been used to extract continuous inpatient spells from the HES database, using standard procedures. The surveillance will estimate the burden of infection historically and will use the Secondary Uses Service (SUS) to provide routine prospective infection burden estimates (to be co-designed and co-produced with key stakeholders). Rates per 100,000 patients will be derived using mid-year population estimates from the Office of National Statistics (ONS). Burden and rates will be stratified by patient and healthcare characteristics nationally and at different geographies, where possible, to explore health inequalities and identify vulnerable patient groups.
The hospital admission and stay data will be linked with data from other datasets including the NHS Emergency Care Dataset (ECDS) for A&E admissions, death certification data from the ONS, Electronic Prescribing and Medicines Administration data (providing antimicrobial usage data) and UKHSA's Second Generation Surveillance System (SGSS) (providing confirmed microbiological source of infection and antimicrobial susceptibility testing and resistance data). Validation of the code set will include comparison against existing independent sources of data such as the Mandatory surveillance of GNBSI, the national Point Prevalence Surveys of Healthcare-associated infection and Antimicrobial Use, sepsis CQUIN data, as well as prospectively with data from selected trusts and other NHS infection audits.

Evaluation of UKHSA surveillance outputs related to the antimicrobial resistance national action plan 2024 to 2029

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Background A vast list of regular and semi-regular surveillance reports, metrics and data tables are produced and made available, publicly or to specific stakeholders, by UKHSA to deliver on their responsibility of providing surveillance for action, some of which provide data used to

monitor progress of targets laid out in the UK's antimicrobial resistance (AMR) national action plan. These include various reports, dashboards and data sheets on bacterial and fungal infection incidence, surgical site infections, bloodstream infections, ICU reports and antibiotic use, prescribing and stewardship. Anecdotal feedback indicates that, while these outputs provided are seen to be highly informative, accessing information across multiple platforms can be challenging for users. This evaluation aims to assess the impact and reach of these outputs, alongside how their presentation and content can be made more useful.

Methods This study will use a cross-sectional, mixed-methods approach. An online survey targeting diverse stakeholders will examine how AMR and HCAI surveillance outputs are accessed, used, and perceived. Follow-up interviews or focus groups will explore their practical application, accessibility, acceptability, usefulness and impact in more depth. Website analytics and citation searches will offer further insights into surveillance data use and reach.

Dissemination of OXA-23 carbapenemase-producing *Proteus mirabilis* and *Escherichia coli* is driven by transposon-carrying lineages in the UK

Authors

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Carbapenem-resistant Enterobacterales are a significant threat to global public health. We characterized *bla*$_{\text{OXA-23}}$-positive *Proteus mirabilis* (n=8) and *Escherichia coli* (n=3) isolates from human clinical samples collected between 2021 to 2024 in the UK. Whole genome sequencing (WGS) was used to generate data, and a core gene SNP-based phylogenetic tree was constructed to assess the genomic relatedness among the isolates. To provide an international context, we included publicly available genomes. Short-read mapping to a reference genome enabled reconstruction of the genomic neighbourhood around *bla*$_{\text{OXA-23}}$. Minimum inhibitory concentration (MIC) determination was performed using broth microdilution and results interpreted using EUCAST guidelines. UK *P. mirabilis* isolates belonged to ST142 and were closely related (2 to 13 SNPs) to French isolates from 2017 to 2019. *E. coli* ST38 isolates harboured *bla*$_{\text{OXA-23}}$ and showed high genetic relatedness (5 to 9 SNPs) among themselves. In *P. mirabilis*, *bla*$_{\text{OXA-23}}$ was associated with transposon Tn*6703*, while *E. coli* harboured a novel composite transposon, designated Tn*7816*, bordered by 2 copies of IS*15DIV* and with 3 copies of *bla*$_{\text{OXA-23}}$. *bla*$_{\text{OXA-23}}$ was integrated into the chromosome in all isolates. All isolates were resistant to amoxicillin/clavulanic acid (>32 mg/L) and with meropenem MICs above the

EUCAST screening cut-off (0.5 to 1 mg/L). In conclusion, UK *bla*$_{OXA-23}$-positive *P. mirabilis* isolates belong to the same clonal lineage (ST142) previously reported in Belgium, Germany, Switzerland and France, suggesting introduction of this lineage into the UK. This is the first report of an *E. coli* ST38 lineage with chromosomally-encoded *bla*$_{OXA-23}$ located within a novel transposon Tn*7816*. WGS plays an important role in identifying the mechanism(s) of transmission of emerging carbapenemase genes.

What are we missing? Data from the Gonorrhoea Undetected Resistance Laboratory Study (GURLS)

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Peer-reviewed publication

Objectives Increasing ceftriaxone-resistant *Neisseria gonorrhoeae* is of public health concern. A cluster of ceftriaxone-resistant *N. gonorrhoeae* was identified in 2022, which was linked to heterosexuals from the Asia-Pacific region who were studying at UK universities. The possibility of further transmission within and beyond this network was of concern, particularly as not all gonococcal cases have a positive culture for antimicrobial susceptibility testing to be performed. We, therefore, undertook a case finding exercise using an *N. gonorrhoeae penA* real-time PCR to identify undetected transmission of ceftriaxone-resistant strains. The PCR detects *penA*-60.001, which is the most common gonococcal ceftriaxone-resistance mechanism. The aim of this Gonorrhoea Undetected Resistance Laboratory Study was to estimate the prevalence of undetected ceftriaxone-resistant *N. gonorrhoeae* in England.
Methods Sexually transmitted infection surveillance data (2017 to 2021) was combined with university data on student country of origin to identify sexual health services in English

university towns with the highest number of gonorrhoea cases among those of Asian ethnicity born in selected countries of the Asia-Pacific region. Residual *N. gonorrhoeae*-positive molecular specimens from women (as a proxy for heterosexual behaviour) aged 18 to 30 years were sent to the UKHSA for testing.

Results Between February 2023 and March 2024, 921 specimens meeting the inclusion criteria were received, of which 661 were reconfirmed as *N. gonorrhoeae*. Of these, one was positive on the *pen*A PCR, indicating ceftriaxone resistance; this specimen came from a previously identified case, therefore no 'undetected' cases were identified.

Conclusions This case-finding exercise provided reassurance that ceftriaxone-resistant *N. gonorrhoeae* in England is currently adequately detected through the existing UKHSA-enhanced surveillance activities. The current *pen*A PCR is a useful tool in the fight to keep gonorrhoea a treatable infection; however, it requires expansion as it does not currently detect all *pen*A alleles responsible for ceftriaxone resistance.

Antimicrobial stewardship (AMS) and prescribing

A national audit of antimicrobial prescribing in Critical Care Units in the United Kingdom

Authors

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Antimicrobial stewardship (AMS) is critical to effectively treat infection whilst reducing the risk of driving AMR, particularly in critically ill patients. In 2023, the UKHSA published an updated antimicrobial stewardship toolkit 'AMS guidance – Start Smart Then Focus' (SSTF). Key components of the toolkit are prescription of antimicrobials according to local or national guidance, then review at 48 to 72 hours guided by clinical and microbiological data. This approach is also supported by National Institute for Health and Care Excellence (NICE) guidance. It is over twenty years since the last national survey of antibiotic use in Critical Care units in the UK. The extent to which guidance is followed, and the impact of AMR on prescription practices in this setting is unknown.

We conducted a prospective national audit with aims to i) describe unit-level stewardship and infection prevention and control (IPC) practices across the UK; ii) assess how often

antimicrobials are prescribed and reviewed in critically ill patients, audited against UKHSA and NICE guidance and iii) determine how often prescriptions need to be amended due to confirmed resistance. Sites were approached through the Trainee Research in Intensive Care (TRIC) Network and the Intensive Care Society. All sites received approval from local audit departments prior to data collection. Sites conducted a snapshot audit of all patients on their critical care unit over a 24-hour period (from 31 March to 14 April 2025) and patients on antimicrobials were followed-up for up to fourteen days. Data was collected by the direct clinical care team and anonymous data was submitted electronically in compliance with GDPR requirements.

In total, 155 sites submitted data across all 4 nations of the UK. In total, 2,637 patients were screened of whom 1604 (60.4%) were on antimicrobial therapy. Data for 3,146 individual prescriptions and 449 cultured isolates was collected. The data is currently being analysed in preparation for publication.

This snapshot audit will provide an overview of antimicrobial use and stewardship in UK critical care units. Our analysis will determine the extent to which UK AMS guidance is being followed but also the extent to which AMR is driving antimicrobial prescriptions. Our work to determine unit level guideline adherence will allow us to identify and disseminate good practice and inform the next iterations of UK AMS programmes. Furthermore, this work will support identification of areas for further targeted quality improvement initiatives and research.

Reducing antibiotic prescribing rates in young children in an outpatient primary care setting—a systemwide quality improvement initiative

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Peer-reviewed publication

Objectives To improve antimicrobial stewardship (AMS) and reduce unnecessary antibiotic prescriptions in young children in a British primary care setting.
Methods Forty-nine general practices in the South of England each hosted a 1 h in-house workshop, facilitated by trained local pharmacy professionals. This type of educational outreach approach using TARGET (Target Antibiotics Responsibly, Guidance, Education and Tools) antibiotic materials has previously been shown to reduce antibiotic dispensing in a UK primary care setting. The workshop included a review of antibiotic prescribing data, a presentation on paediatric AMS showcasing locally agreed paediatric prescribing guidelines and safety netting resources from the Healthier Together website, and formulation of a local action plan. The primary outcome measure was total oral antibiotic prescriptions ('items') dispensed per 1000

patients aged under 5 years for the year after the workshop, compared with the previous year's dispensing.
Results The median prescribing rate for children under 5 years of age changed from a baseline of 48.9 per 1000 patients prior to the intervention to a new median monthly prescribing rate of 39.0 per 1000 patients following the intervention. There was no increase in paediatric presentations to primary care following the intervention.
Conclusions This low-cost intervention has the potential to reduce primary care antibiotic prescribing in children and we did not detect an increase in GP attendance rates after this intervention in our study. It could easily be rolled out nationwide

Assessing the impact of using a patient counselling prompt—the TARGET antibiotic checklist in England's community pharmacies

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Introduction: An estimated 1.27 million deaths globally were caused by antibiotic-resistant infections in 2019. Outcome 2 of the UK national action plan to combat antimicrobial resistance is improved public engagement and education with a specific and measurable target.
Methods: The use of the TARGET antibiotic checklist was incentivised in the PQS for 2021 to 2022 and 2023 to 2024 for patients presenting with antibiotic prescription in community pharmacy during a 4 week period each year.
Results: A total of 406,333 patients were counselled using the TARGET antibiotic checklist, with 10 081 community pharmacies participating in either year and 6,209 community pharmacies participating in both years. The most common indications for both years were chest and urinary tract infections with amoxicillin and nitrofurantoin, respectively, being the most frequently prescribed antibiotics for both PQS years examined. A total of 27,898 influenza vaccinations were delivered by community pharmacies prompted by discussions whilst using the antibiotic checklist. In addition, 140,473 patient information leaflets were provided to patients to improve knowledge about their condition and treatment and to support future self-care.
Conclusions: The investment in training and resources for community pharmacies through the PQS has provided opportunities for strengthening antimicrobial stewardship by equipping them with the tools to improve patient knowledge of antibiotic use, symptom resolution and antimicrobial resistance using the TARGET antibiotic checklist, as well as other resources from the TARGET Antibiotics Toolkit.

Implementation of a National Antimicrobial Stewardship Training Programme for General Practice: A Case Study

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Introduction Approximately 71% of antibiotics in England are prescribed in general practice settings. Whilst there are various impactful training resources available to support clinicians in antimicrobial stewardship (AMS) activities, implementation, reach, and uptake affect how successful they are nationally. This case study explores the feasibility, acceptability, and usefulness of embedding the TARGET (Treat Antibiotics Responsibly, Guidance, Education and Tools) AMS training into a local incentive scheme.
Methods Black Country Integrated Care Board (ICB) invited a representative from all associated general practises to a TARGET AMS training event; attendance was linked to a local incentive scheme. Data was collected via a pre- and post-workshop survey capturing TARGET toolkit knowledge, AMS attitudes and behaviours, training feedback, and intention to implement AMS behaviours. Descriptive analyses were conducted.
Results 157 and 101 attendees completed the pre- and post-session surveys, respectively. In total, 89% agreed that attending the session was a good use of their time. The proportions of attendees stating an intention to use the TARGET toolkit and implement a range of AMS strategies following the session were high (TARGET Toolkit: >82%, AMS strategies: >90%). Most attendees planned to implement these actions within 3 months (47%) or within 3 to 6 months (30%).
Conclusions Results suggest that embedding the training into a local incentive scheme is a viable implementation approach in extending training reach. Although the impact on prescribing rates is not yet available, the high engagement and intention to implement AMS strategies observed should inspire confidence in this approach to training implementation.

Adaptation of the WHO AWaRe (Access, Watch, Reserve) antibiotic classification to support national antimicrobial stewardship priorities in the UK: findings from a modified Delphi approach to achieve expert consensus

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Peer-reviewed publication

Following recent updates to the WHO AWaRe (Access, Watch, Reserve) classification and in preparation for the UK's next 5-year Antimicrobial Resistance National Action Plan (AMR NAP) for 2024 to 2029, a review of the AWaRe categories was completed to better reflect UK-specific antibiotic resistance patterns, usage data, and stewardship practices.

A 4-stage modified Delphi survey involving multidisciplinary experts from across the UK was conducted to review the categorization of systemic antibiotics for use in both primary and secondary care settings across the UK, proposing a nationally adapted classification.

Seventeen antibiotics were reclassified compared to the 2023 WHO AWaRe list, including a proposed reclassification of first-generation cephalosporins from the Watch to Access category, marking a key change from the 2019 England AWaRe classification where all cephalosporins were grouped under Watch.

The study also demonstrated, using England's national antibiotic consumption data as a case study, that from 2018 to 2022 Access antibiotics accounted for over 60% of human antibiotic use: 69.7% by the WHO 2023 classification and 63.7% by the proposed UK-adapted 2024 classification.

The consensus-driven UK-AWaRe adaptation aimed to enhance national antimicrobial stewardship efforts and support monitoring of antibiotic usage targets outlined in the UK's AMR NAP 2024 to 2029.

Exploring community pharmacy professionals and general practitioners' views on primary care communication and pathways to access antibiotics in England

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Introduction: With most antimicrobials in England being prescribed in primary care, collaboration on antimicrobial stewardship (AMS) between general practitioners (GPs) and community pharmacists (CPs) is important. Previous research identified barriers to communication between GPs and CPs across England.
Methods: Five qualitative focus groups and 9 semi-structured interviews were conducted with GP and community pharmacy professionals (CPPs) independently. Two reconvened focus groups with GPs and CPPs present together provided a holistic discussion on initial findings and practical solutions. Data was analysed thematically.
Results: Nine CPs, 3 pharmacy technicians and 12 GPs participated. Four themes emerged: nature of GP-CP interactions, role recognition, barriers to AMS and overcoming barriers. Many CPs, particularly those not co-located with a GP surgery, reported challenges in contacting GPs. Proximity of location between CPs and GPs influences ease of communication and relationship management. GPs highlighted having limited or no awareness of the availability of medicines at the point of prescription. Suggested solutions to optimize collaborative working on AMS included providing functionality to share topline patient notes with prescriptions, a system that tracks and summarizes stock levels and having central points of contact between CPs and GPs.
Conclusions: The challenges reported have implications on the collaborative relationship between GPs and CPs and solutions are needed to optimize AMS between primary care health professionals. The appetite for digital transformation suggests that strategic conversations with senior stakeholders are needed.

Mixed-method impact and implementation evaluation of the ‘Pharmacy First’ services for management of common conditions – March 2025 update

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In January 2024, Pharmacy First (PF) was launched across England. This new NHS service enables community pharmacists to supply prescription-only medicines, including antibiotics, to treat 7 common health conditions. The programme aims to ensure faster access to medical care and reduce pressure on general practitioners (GPs). The aim of the National Institute for Health and Care Research (NIHR) funded Pharmacy First Evaluation is to perform a mixed-method evaluation to answer the following questions: how are the 7 PF minor illness Patient Group Directives (PGDs) being implemented across England, what explains this pattern, and what are their impacts on volume of prescribing, patient case-mix of GP consultations, Accident and Emergency (A&E) and hospital use, equity of access and cost for different groups of patients in different contexts?
The public, patients, healthcare, and public health professionals and policymakers need to know whether and how current policy initiatives aimed at widening the range of access to antimicrobials impact AMR and patient outcomes.
The research is led by a team at London School of Hygiene and Tropical Medicine (LSHTM), working in collaboration with the Universities of Nottingham, Manchester and the Bennett Institute at the University of Oxford, as well as the UKHSA. The mixed methods evaluation will include quantitative, economic and process evaluations, as well as an analysis of policy impact. The team at the UKHSA will evaluate how antimicrobial use and antimicrobial resistance (AMR) change following the introduction of PF. Detailed methodology was published in March 2025 in the mixed methods protocol.
The 3-year NIHR project started in February 2024. A description of prescribing trends in the first year post introduction is available in Chapter 3 and of consultation outcomes and demographics in Chapter 6.

Impact of COVID-19 on AMR

The changing trends of Gram-negative bloodstream infections associated with a urinary tract infection following the COVID-19 pandemic

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UKHSA conference

Background Gram-negative bloodstream infections (GNBSIs) are on the rise. Efforts to reduce the incidence of GNBSIs are particularly challenging as they can originate from a range of primary source infections. Surveillance reports have consistently identified urinary tract infections (UTIs) as the most common source of GNBSIs. The UTI pathway could therefore serve as a critical point for disrupting GNBSI transmission. The COVID-19 pandemic has shown the potential to disrupt the transmission, incidence and risk factors for GNBSIs, particularly those originating from UTI.
Methods GNBSI cases were identified using mandatory surveillance data and linked to routine hospital admission data. Cases associated with a UTI were identified via the primary focus field

of the infection record or the presence of a urine sample submitted for culture. Descriptive statistics were produced, and multivariable logistic regression models were developed to evaluate significant changes in predictor variables following the pandemic period. We analysed data from financial years 2019 to 2020 and 2022 to 2023 to compare pre- and post-COVID-19 pandemic trends.
Results 18,832 UTI-associated GNBSI hospital admissions were identified in 2019 to 2020. Following the pandemic, this decreased to 14,164 in 2022 to 2023. This reduction was largely driven by a reduction in *Escherichia coli* infections, which comprised the majority of cases (83.5% in 2019 to 2020 and 79.2% in 2022 to 2023). *Pseudomonas aeruginosa* infections also experienced a decline, while the number of *Klebsiella* spp. infections remained relatively consistent. Similar patterns in risk factors were observed across the 2 study periods, with infections found to disproportionally affect the elderly population with a median age ranging between 75 to 77 years. A high number of cases occurred in patients that experienced a urinary catheter prior to infection or were diabetic. The reduction in cases following the pandemic period was found to be more pronounced in community-onset cases compared to hospital-onset. Significant changes in risk factors were also observed in community-onset cases following this period, with a reduction in the odds of infection in females for *E. coli* infections but an increase in Asian ethnic groups and care home admissions for both *E. coli* and *Klebsiella* spp. infections.
Conclusion UTIs represent a major source of GNBSIs. Targeting key populations at risk of UTIs, such as those aged 65 years and over, care home residents, or patients with a urinary catheter may be effective in reducing GNBSI rates. The COVID-19 pandemic led to a substantial decrease in community-onset UTI-associated GNBSIs, highlighting a need for further investigation.

Impact of the COVID-19 pandemic on healthcare-associated bloodstream infections in England, between April 2017 and March 2023: A retrospective cohort study

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Background The COVID-19 pandemic caused disruption to healthcare services and altered typical trends of bloodstream infections (BSI).
Methods We analysed the incidence of *E. coli*, Klebsiella spp., *P. aeruginosa*, meticillin-resistant and meticillin-susceptible *S. aureus* (MRSA and MSSA) bacteraemia, reported to the mandatory bacteraemia surveillance programme in England between financial years 2017 to 2018 and 2022 to 2023.
Results Incidence rates of *E. coli* and MSSA rapidly declined at the start of the COVID-19 pandemic; 33.3% and 12.8%, respectively. Whereas *Klebsiella* spp. and *P. aeruginosa*, hospital-onset (HO) rates spiked in April 2020 and January 2021, 130% and 74% respectively. Counts and rates of all BSIs returned to pre-pandemic levels by financial year 2021 to 2022,

with the exception of *E. coli* BSIs, which remained on average 23.3% and 11.4% below counterfactual and pre-pandemic levels in March 2023. We note MRSA rates shifting to an upward trajectory, reaching levels not seen since 2011 to 2012. Increased antimicrobial resistance (AMR) to *E. coli* BSIs were observed in piperacillin/tazobactam by 17%, from 9.1% in FY2019 to 2020 to 10.6% in 2022 to 2023. Between 2019 to 2020 and 2022 to 2023 *Klebsiella* spp. saw a respective 37.8% and 9.9% increase in resistance to third-generation cephalosporins and piperacillin/tazobactam. Increased resistance across most antibiotics was seen in MSSA, including 20.0% resistance to clarithromycin, clindamycin, erythromycin and macrolides. MRSA saw tetracycline resistance increase 56.8% from 14.9 in 2019 to 2020 to 23.4 in 2022 to 2023.

Conclusions COVID-19 has had a significant and varying impact on incidence of BSIs and associated antimicrobial resistance in England. Better understanding of these changes and potential implications are needed.

Epidemiology of *Escherichia coli* bloodstream infection antimicrobial resistance trends across South West England during the first 2 years of the coronavirus disease 2019 pandemic response

Authors

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Peer-reviewed publication

Objectives: Between 2016 and 2019, the proportion of *Escherichia coli* bloodstream infection (BSI) with resistance to at least one antibiotic increased nationally. Public health interventions implemented in response to the COVID-19 pandemic changed population contact patterns and healthcare systems, with consequent effects on epidemiological trends of numerous pathogens. We investigated the impact of COVID-19 restrictions on epidemiological trends of *E. coli* BSI AMR across South West England.

Methods: We undertook a retrospective ecological analysis utilising routine surveillance data of *E. coli* BSI cases reported to the UKHSA between 2016 and 2021. We analysed AMR trends for antimicrobial agents including amoxicillin-clavulanate, ciprofloxacin, piperacillin-tazobactam, gentamicin, third-generation cephalosporins and carbapenems before and after the implementation of COVID-19 restrictions (23 March 2020) using Bayesian segmented regression.

Results: We identified 19,055 cases. A total of 50.2% were male. Median age was 76 (interquartile range, 65 to 85 years). Piperacillin-tazobactam (−2.90% [95% highest density interval −4.51%, −0.48%]) and ciprofloxacin (−2.40% [95% HDI −4.35%, 0.48%]) resistance demonstrated immediate step changes at the implementation of COVID-19 restrictions(152). Gentamicin (odds ratio [OR] 0.92 [95% HDI 0.76, 1.12]) and third-generation cephalosporins

(OR 0.95 [95% HDI 0.80, 1.14]) exhibited decreasing annual resistance trends after the implementation of COVID-19 restrictions, with moderate evidence for a lower OR after restrictions as compared to the period before (gentamicin Bayes Factor = 5.10, third-generation cephalosporins Bayes Factor = 6.67).
Discussion: COVID-19 restrictions led to abrupt and longer term changes to *E. coli* BSI AMR. The immediate effects suggest altered transmission, whereas changes to resistant *E. coli* reservoirs may explain trend effects.

Evaluation of the impact of COVID-19 on antimicrobial resistance (AMR) in Gram-negative bacteria in England

Authors
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Introduction Antimicrobial resistance (AMR) in Enterobacterales represents a critical threat to global health. Detecting important changes in the epidemiology of resistance associated with priority pathogens and phenotypes in large public health surveillance datasets is challenging but potentially beneficial if the causal factors underlying these can be identified. In this study we sought to investigate longitudinal trends in AMR associated with *Klebsiella pneumoniae* and *Escherichia coli* bloodstream infections in England as well as the timing of "changepoints" associated with significant increases or decreases in the proportion of resistant isolates.
Methods Reporting of *E. coli* and *K. pnuemoniae* bloodstream infections to the UKHSA is mandatory in England. Using this data, we used generalised additive models (R package 'mgcv', accounting for seasonality with the incorporation of a day of year smooth where relevant) to analyse trends in the proportion of isolates resistant to 6 antibiotics (ciprofloxacin, gentamicin, co-amoxiclav, piperacillin-tazobactam, meropenem and co-trimoxazole) from 1st Jan 2012 to 31st Dec 2023. 'Changepoints', where the trend significantly changes direction more than would be expected by chance, were determined to occur where the upper and lower bound of 95% posterior credibility intervals both crossed 0.
Results For most antibiotics, we observed changepoints where the proportion of resistant isolates began to drop shortly before introduction of restrictions relating to the COVID-19 pandemic in late 2019 and early 2020. More recently, the proportion of resistant isolates has increased for most classes of antibiotics though the timing of changepoints was variable (for example June 2020 for piperacillin-tazobactam versus May 2022 for co-amoxiclav in *E. coli*). Particularly striking increases were observed for third generation cephalosporins, ciprofloxacin and piperacillin-tazobactam. In general, the magnitude of increases was greater for *K. pneumoniae* compared to *E. coli*. We observed that changes in resistance trends are generally

more exaggerated for nosocomial patient groups and in particular that recent increases in co-amoxiclav resistance in *E. coli* have been driven by healthcare exposed patients.

Conclusions

Our analysis highlights that whilst lockdowns associated with the COVID-19 pandemic may have potentiated changes in the proportion of AMR associated bloodstream infection isolates, these changes appear to have been beginning prior to this. The sharp recent increases in resistance are concerning and warrant ongoing surveillance. Recent increases in piperacillin-tazobactam, third generation cephalosporin and nosocomial onset co-amoxiclav resistance highlight the importance of healthcare exposure in the epidemiology of AMR.

COVID-19 Therapeutics Use by Social Deprivation Index in England, July 2020 to April 2023

Authors

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Peer-reviewed publication

Coronavirus disease-19 (COVID-19) has disproportionately affected certain demographics in England, exacerbating existing health disparities. Effective therapeutics are a critical line of defence against COVID-19, particularly for patients at elevated risk for severe disease. Surveillance systems were established to monitor the usage of COVID-19 therapeutics in hospital and community settings and to inform stewardship. Three antiviral therapies—nirmatrelvir plus ritonavir (Paxlovid®), remdesivir (Veklury®), and molnupiravir (Lagevrio®)—and 2 neutralising monoclonal antibody therapies (nMAbs)—sotrovimab (Xevudy®) and casirivimab with imdevimab (Ronapreve®)—were in use in England between July 2020 and April 2023. This paper aims to illuminate trends in the utilisation of COVID-19 therapeutics treatment in both hospital and community settings, stratified by the Index of Multiple Deprivation (IMD) in England. Chapter 3 of the English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Report 2022 to 2023 also discusses the epidemiological surveillance of these 5 directly acting antiviral COVID-19 therapeutics' use in England between 2022 and 2023.

Infection prevention and control

Machine learning prediction of antimicrobial resistance in *Escherichia coli*

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Phenotypic antimicrobial susceptibility testing (AST) evaluates bacterial response to antibiotics to predict the likelihood of therapeutic success but is time-consuming. Recent studies have demonstrated the utility of whole-genome sequencing (WGS) with machine learning to predict resistance phenotypes alongside bacterial characterization. This study aims to integrate machine learning with genomic data to predict the minimum inhibitory concentration (MIC) for *E. coli* of 8 antibiotics used to treat Gram-negative infections (ciprofloxacin, amikacin, tobramycin, gentamicin, cefepime, ceftazidime, aztreonam and meropenem).
E. coli genomes (*n* = 3,439) and their phenotypic MIC data was collected between 2013 and 2023 and derived from human (*n* = 3,157), animal (*n* = 83), meat (*n* = 111) and environment (*n* = 88) origins from the UK. The MIC prediction model was built using Random Forest (RF) regression. RF models were trained by using presence or absence of genes and single-nucleotide polymorphisms (SNPs) as predictors and the phenotypic MIC (log2 transformed) as a continuous response variable. The models with the greatest R^2 values were identified through tuning hyperparameters and 5-fold cross-validation. The dataset was randomly split into 80% training and 20% testing subsets. To mitigate potential bias due to the specific data split, we performed 100 different random splits, thus training 100 independent models for each antibiotic. To evaluate the predictive accuracy, the predicted MIC for each isolate was compared to the phenotypic MIC for each antibiotic, following the ISO 20776-2:2021 and 20776-2:2007 guidelines.
The genomic analysis showed that the *E. coli* isolates were highly diverse and belonged to 8 phylogroups, with ST131 representing only 20%, ST73 11%, and the remaining 69% comprising less common and rare STs. RF models demonstrated essential agreement (predicted vs. phenotypic MIC within ±1 dilution) >90% for ciprofloxacin (91%), amikacin (94%), aztreonam (93%) and meropenem (94%). No prediction bias was detected across all 8 antibiotics. After converting predicted MICs to binary phenotypes (susceptible (S) or resistant (R)), although the sensitivity did not reach the 95% threshold for all antibiotics, specificity and major error rate (S result predicted as R) were ≥95% and ≤3%, respectively, for amikacin, gentamicin, aztreonam and meropenem.

This method demonstrates that machine learning can be used to predict MIC values for ciprofloxacin, amikacin, aztreonam and meropenem from WGS data. This study highlights the potential of using AMR genes, accessory genes, and SNPs to predict MIC values for certain antibiotics, but improvements are needed. Exploring alternative methods, such as XGBoost and LASSO, and utilising kmer-unitig data could enhance predictive accuracy.

Cost and clinical impact of IPC measures for CPE in hospitals: a cost-effectiveness model

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ESCMID conference

Background Carbapenemase-producing Enterobacterales (CPE) colonisations and infections are increasing globally and pose a serious threat to public health. Despite this, evidence on the transmission and control of CPE and particularly the cost-effectiveness of infection prevention and control (IPC) interventions is sparse. This study estimates the cost and clinical impact of screening strategies on the spread of CPE in hospitals.
Methods A stochastic, compartmental, dynamic mathematical model was developed to simulate the transmission of CPE in a typical hospital over 5 years. The model simulated the movement of patients within and between hospital and the community, including nosocomial transmission from colonised and infected patients, and transmission from the environment. Parameters were identified from the literature and primary data where possible. Costs were considered from a hospital perspective. Multiple screening and control strategies were modelled, with outputs in terms of changes in numbers of colonisations, infections and costs (by cost component). Patients that tested positive were placed under enhanced IPC measures.
Results Preliminary results found that compared to no testing for CPE, culture testing all admissions decreased the total number of infection days by 25% and was associated with a 2% increase in total hospital costs. Culture testing admissions that had previously been discharged positive in the past year resulted in a 5% decrease in infection days compared to no testing, and a 0.2% reduction in costs. Culture testing all admissions with a previous inpatient attendance in the last year (including previous discharged positives) reduced infection days by 7% and increased costs by 0.2%. Testing was the largest driver of additional costs, while decreased length of stay through infection reduction was the largest driver of savings. Future research will estimate incremental cost-effectiveness ratios of different testing and IPC intervention strategies to determine which interventions are most cost-effective, as well as assess the associated uncertainty and data needs.
Conclusions Preliminary model predictions suggest that undertaking admission screening can considerably decrease CPE infection days for relatively modest increases in costs, and that targeting this screening can lead to more efficient and even cost-saving strategies.

The role and needs of teachers and schools in infection prevention and control post COVID-19

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Introduction: COVID-19 highlighted the importance of infection prevention and control (IPC) across all settings. This study aimed to understand current teacher IPC knowledge and measures in schools, the teacher's role in infectious disease outbreaks in schools, school and teachers' needs around IPC, and how all these may have changed since the COVID-19 pandemic.
Methods: Quantitative data was collected via an online survey and qualitative data via focus group interviews. Survey questions were reviewed using descriptive analysis, and thematic analysis was used for the open-ended survey questions and focus group interviews.
Results: A total of 1000 teachers completed the survey across a range of teaching roles; 8 headteachers participated in the workshops. Respondents reported that IPC measures are now less frequently implemented during an infectious disease outbreak than during the pandemic. About 71% of respondents who have been teaching for at least 2 years (at the time of the survey) said their role has changed since the pandemic; now having more responsibility for pupil health and hygiene, and 72% of them reported feeling better prepared to deal with a public health outbreak compared to pre-pandemic. Furthermore, around 84% reported they had no IPC training, and 1-in-3 (35%) had unmet IPC needs.
Conclusions: Schools and teachers play a pivotal role in preventing the spread of communicable disease as highlighted during the COVID-19 pandemic. Training and updated policies would support the educational workforce who feel their needs are not being met.

Development of patient-level risk profiles for *Escherichia coli* bloodstream infections (BSI) in England

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Background *Escherichia coli* is the most common cause of clinically-significant BSI in England. Incidence is increasing year-on-year, largely driven by community-acquired infections. This rise disproportionately affects more deprived areas and individuals of Black or Asian ethnicity.

We aimed to identify risk factors associated with community-onset *E. coli* BSI to develop patient-level risk profiles.
Methods Case-level data reported between 2018 and 2024 on the UKHSA mandatory healthcare-associated infections surveillance programme was extracted and enriched with Hospital Episode Statistics (HES) and Office for National Statistics (ONS) datasets adding ethnicity and deprivation attributes, respectively. A multilevel Bayesian negative binomial model produced predicted rates of *E. coli* BSIs from observed data across regions of England, while accounting for individual- and area-level risk factors.
Results The model had a median relative error between observed and predicted rates of 7.7% (absolute error: 55 cases per 100,000 population, correlation: 0.861). 'High-risk' regions (with a higher predicted rate than the ethnic group-specific national average) were spatially dispersed for the White ethnic group, whereas Black, Asian, and Mixed ethnic groups had more clustered regions of elevated risk. Predicted rates showed greater contribution to community-onset community-associated cases versus hospital-onset in the 2 most-deprived quintiles, and those of Black or Asian ethnic groups.
A region in North-East England had the greatest predicted standardised risk score in the Asian ethnic group's community-onset cases (3.11 standard deviations above that the national community-onset average). Patient's care setting (A&E or outpatient) contributed 12.1 cases per 100,000 population to this region's predicted *E. coli* rate, followed by sex and deprivation at 6.8 and 3.0, respectively, compared to the national average.
Conclusions Health inequalities resulted in significant variation of predicted BSI risk. Our model produced reasonable predictions and was an improvement over more simplistic methods. These patient-level risk profiles could predict communities with large burdens of infection and channel interventions.

Preventing and managing urinary tract infections: Exploring interventions and strategies implemented by NHS commissioning organisations in English primary care, 2017 to 2022

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Introduction The majority of antibiotics are prescribed in primary care. Urinary tract infections (UTIs) are the second most common reason for antibiotic prescribing in this sector. This study explores activities used by English Clinical Commissioning Groups (CCGs) to improve UTI prevention and management 2017 to 2022.
Methods An online questionnaire was sent to CCG primary care chief nurses and medicines optimisation leads August to September 2022. Qualitative data was mapped to the Theoretical Domains Framework.
Results Participant response rate was 14.1% (56 of 397), with representation from 29.2% (31 of 106) CCGs and across a range of roles. Education and training were the most reported intervention types, while changing the environment to facilitate behaviours was the least. Most interventions targeted general practice staff and patients, followed by care home staff, and residents and their families. The most reported success measures included reduction in

antibiotic prescribing (54.5%, 97 of 178 interventions); positive stakeholder feedback (42.1%, 75 of 178); and increased adherence to diagnostic guidelines (32.6%, 58 of 178). 48.8% (20 of 41) stated their UTI activities had not been formally evaluated. Barriers and facilitators to intervention implementation included: availability of resources and time; staff collaboration; availability and accuracy of information; public and staff beliefs; systems and processes; and staff roles and responsibilities.
Conclusions UTI interventions rolled out through English health authorities could be further improved through structures that increase capacity to effectively evaluate activities and share learning. Staff engagement and collaboration are key facilitators to implementation and should be leveraged in further initiatives, while support and guidance are provided to adapt initiatives to fit in the changing healthcare landscape.

Does Antibiotic Resistance exist in *Chlamydia trachomatis* strains sourced from patients using Doxycycline for STI Prevention?

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Chlamydia is a common sexually transmitted infection (STI) and can lead to health problems if left untreated (for example pain when urinating, rectal pain and Pelvic Inflammatory Disease). Chlamydia infections are treated with antibiotics. Interestingly, the bacteria that causes Chlamydia (*Chlamydia trachomatis*) is one of the very few disease-causing micro-organisms for which natural and true AMR has not been reported. AMR is where the organism becomes resistant to the antibiotics that are used to treat it, and therefore people remain infected. Recently, a new, innovative and proactive opportunity for STI control has been reported. This preventative approach to STI management is called doxycycline post-exposure prophylaxis (or doxyPEP), where people at higher risk of getting STIs take a dose of the antibiotic doxycycline, after sex to help prevent infection. This has been shown to be extremely effective in reducing the acquisition of new STIs (particularly Chlamydia and Syphilis). However, there is concern that this could lead to *C. trachomatis* becoming resistant to doxycycline. There are currently no laboratories in the UK, that are able to detect AMR in *C. trachomatis,* or surveillance programmes to monitor the effectiveness of treatment.
This project aims to investigate whether *C. trachomatis* is developing AMR in people who are taking doxyPEP. This is a proof-of-concept study, which will grow strains of *C. trachomatis* in the laboratory from samples taken from individuals who have Chlamydia infections who are also taking doxyPEP. The *C. trachomatis* strains that successfully grow will have their DNA examined for the presence of known AMR genes, with particular focus on the presence and absence of those related to doxycycline resistance. The data generated will be used to determine how useful future *C. trachomatis* AMR references and surveillance services would be for clinicians and public health bodies.

Research to better understand how the built environment contributes to the spread of infection

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HCAIs are complex and multi-factorial but there is growing appreciation that the healthcare environment can be a reservoir for organisms with the potential for infecting patients. The UK AMR National Action Plan (2019 to 2024) recognises that building design can facilitate and enhance IPC and recommends the “designing in” of IPC measures. However, it also acknowledges that IPC interventions should be informed by research and that there is a need to enhance the evidence-base.
Over the past year, and in collaboration with UKHSA colleagues, the NHS, academic and industry partners, the Infection and Built Environment Team has utilised the full-scale, model hospital ward built at UKHSA Porton to investigate microbial contamination and control. Recreating a healthcare environment for experimental purposes has its challenges but use of this bespoke facility has allowed the team to assess the effectiveness of new and existing infection prevention strategies – importantly without impacting patients or disrupting clinical practice and bridging the gap between the laboratory and the real-life clinical setting.

Studying antibiotic resistance in *Trichomonas vaginalis* using whole genome sequencing

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Trichomonas vaginalis (often shorted to TV) is one of the most common STIs in the world. Each year, there are over 276 million new cases globally. In 2023 alone, over 9,000 cases were diagnosed in England, with nearly 90% of them found in women.
TV can cause symptoms such as unusual vaginal discharge, itching around the genitals, and pain when urinating. However, many people with TV don’t have any symptoms at all. TV is usually treated with antibiotics, but in some cases, the infection doesn’t go away. This is because the TV organism has become resistant to the antibiotics – a problem known as antimicrobial resistance (often shortened to AMR).
When TV becomes resistant, it often happens because of small changes (or “mutations”) in its genetic material. These changes can help the infection survive treatment. Scientists can look for these mutations by examining the DNA of the infection in the lab – a process called whole genome sequencing.
By studying the genetic differences between infections that responded to treatment and those that didn’t, we can learn more about how resistance develops. This information could help create better tests to show which antibiotics are likely to work for a specific infection.
In this study, we will aim to eventually compare the genetic makeup of TV infections in people who were cured after treatment with those in people whose infections didn’t respond. We’ll also look for different strains of TV across England to help us understand more about how similar

strains are and how TV changes over time. The first step will be to identify and review all the existing literature relating to TV whole genome sequencing to inform the rest of the study.

Novel therapeutics, technologies and vaccination

Predicting the impact of RSV immunisation on antibiotic use and resistance: a modelling and economic analysis for England

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ESCMID conference

Background Respiratory Syncytial Virus (RSV) immunisations including vaccines and monoclonal antibodies could reduce the burden of RSV infections. However, to fully quantify the benefits of these programmes, an understanding of the potential additional impact of reduced RSV infection on the use of antibiotics and the subsequent implication for antibiotic resistant infections is essential. Population-level evidence links specific antibiotic use, typically prescribed for respiratory tract infections (RTIs), to resistant urinary tract infections (UTIs) in the community. Therefore, viral immunisations could reduce the burden of antimicrobial resistance (AMR), as UTIs in the community are considered an important source of resistant bloodstream infections with considerable health and economic consequences.
With RSV prophylactics recently licensed for use in the UK, this study forecasts their impact on antibiotic prescriptions and resistant UTIs to inform health economic evaluations. Insights are intended to guide immunisation and AMR policies for improved population health.
Methods Eight RSV immunisation programmes were evaluated at an England national level including:

- base-case – Palivizumab (short acting monoclonal antibody) for very high-risk infants
- long-acting monoclonal antibodies – for infants administered seasonally, seasonally with annual catch up and annually
- vaccines – for mothers administered seasonally or annually and for older adults administered seasonally

Recently published ecological regression analyses were integrated with an existing dynamic transmission model of RSV to predict the impact of prophylactic programmes on primary care antibiotic prescriptions by antibiotic class in England. These class-specific prescribing reductions were combined with population-level associations of extended spectrum penicillin use and resistant UTIs in the community to forecast subsequent impact on resistance.

Outcomes informed a probabilistic health economic model evaluating the cost-effectiveness of programmes, including reductions in antibiotic use and resistance.

Preliminary findings Out of all evaluated programmes, seasonal vaccination of adults 65 years and over against RSV was projected to reduce the most antibiotic prescriptions at 0.38% of all primary care antibiotic prescriptions in England, equating approximately 130,000 prescriptions annually. Antibiotic reductions were primarily of classes typically used to treat RTIs: penicillins, tetracyclines, and macrolides. This programme was subsequently projected to reduce the greatest volume of reported resistant *E. coli* UTIs in the community. However, cost savings and health benefits from reductions in both antibiotic prescriptions and subsequent resistant UTIs were minimal, with a limited impact on the overall cost-effectiveness of all evaluated programmes.

Conclusions RSV prophylactics, particularly for older adults, may alleviate RSV infections and complement existing UK strategies to limit antibiotic usage. However, their impact on resistant UTIs in the community is likely minimal. More evidence is required to discern the full health and economic implications of reduced antibiotic exposures, including an analysis of how specific antibiotic use affects resistance stratified by age and more detailed costs and consequences of resistant infections.

This work provides a framework for estimating the impact of interventions aimed at reducing antibiotic exposure on the burden of AMR, applicable to strategies beyond viral prophylactics.

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Investigating the interaction of human complement with a diverse panel of *Neisseria gonorrhoeae* strains

Authors

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Whilst it has been demonstrated that 4CMenB vaccine can provide some protection against gonorrhoea, the immune mechanisms responsible and the breadth of this protection remains to be characterised. *N. gonorrhoeae* expresses antigens that can interact with human complement proteins system, such as binding of Factor H (FH) via the outer membrane proteins PorB and NspA, sialylation of LOS, and generation of antibodies that block bactericidal targets. The Pathogen Immunology Group at UKHSA Porton Down have developed flow cytometric assays that determine the amount of IgG and individual complement proteins binding to the surface of gonococci. We will use these assays to dissect the role of complement interactions with a diverse panel of gonococcal strains to determine the factors important for antibody and complement-mediated killing, which will allow for further insights into the effects of bacterial strain variation on the impact of 4CMenB and vaccines currently in development.

Thus far, we have shown that IgG binding to a panel of gonococcal strains does not predict bactericidal killing, with some strains binding large amounts of IgG remaining resistant to antibody and complement-mediated killing. In contrast much lower levels of IgG binding are bactericidal to other strains. We are evaluating this observation with a panel of 21 diverse gonococci. We are also evaluating antibody dependent and antibody independent binding of FH, C3c and C5b-9 to the various strains to allow comparison with bactericidal activity of test sera.

Selection and evaluation of *Neisseria gonorrhoeae* strains and development of standardised assays

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UKHSA-Porton has been invited to sit on an international working group (partners including NIAID, MHRA, University of Oxford, Gates Foundation) with the objectives of identifying suitable strains of *N. gonorrhoeae,* and standard reagents, for the development of standardised immunoassays for the evaluation of current and future gonococcal vaccines.

Discovery and evaluation of antibiotic combinations to target multi-drug-resistant Gram-negatives

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Antibiotic resistance in Gram-negative bacterial pathogens is a major global concern and threatens to limit the effectiveness of all current therapies. Indeed, it is estimated that resistance to current antimicrobials was directly attributable to approximately 1.27 million deaths worldwide in 2019 alone. This dire situation is expected to dramatically worsen in the coming years if no

action is taken, leading to enormous impact on our global health and economy. Thus, new antibiotics, or new solutions using existing antibiotics, are urgently needed. Currently the only 'routine' combination being tested in the UK is ceftazidime/avibactam + aztreonam. Our project is trying to address the problem of antibiotic resistance by discovering new synergistic combinations of existing antibiotics that have activity against some of the most globally dominant Gram-negative bacterial pathogens.
There is a treasure trove of licensed antibiotics that can be revisited and evaluated. We have developed a high throughput screen of all major antibiotic classes by the adaptation of an existing method for *Mycobacterium tuberculosis*, known as DiaMOND to identify combinations of existing antibiotics that are synergistic against MDR gram negatives using an unbiased and standardised approach. We have performed preliminary screens to the assess pairwise combinations of 20 antibiotics (297 combinations in total across all major classes) against 3 strains of *Escherichia coli*; a drug sensitive lab strain (ATCC 25922) and 2 multidrug-resistant isolates (EC958 and ST410) in 384-well plates, using detection of ATP or fluorescence. Synergistic combinations are being evaluated further in chequerboards, to confirm synergy between specific pairings by the 'highest single agent method'. Preliminary results showed that a few different antibiotic combinations demonstrated additive effects against MDR strains including (as expected) ceftazidime/avibactam.

Development of High-Value Biomarker Diagnostic Tests for Hard-to-Diagnose Infections

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The UK Government's 2019 20-year plan for AMR, Contained and Controlled: The UK's 20-year Vision for AMR, outlines 3 key objectives: (1) reducing infection burden, improving treatment of resistant infections, and minimising transmission across communities and healthcare settings; (2) promoting optimal antimicrobial use and stewardship across all sectors; and (3) developing and deploying new diagnostics, therapies, vaccines, and interventions, ensuring access to both new and existing technologies. This strategy builds on the UK AMR National Action Plan (2019 to 2024), which highlighted Priority 4.4.1: incentivising R&D for new diagnostics. It notes significant diagnostic gaps, particularly the need for new biomarkers to differentiate bacterial from viral infections, and pathogenic from commensal bacteria, as well as faster diagnostic tools. Current tests for most bacterial infections can take up to 48 hours, often leading to empirical, and sometimes inappropriate, treatment.
To address this, we are developing biomarker-based diagnostic tests for 2 difficult-to-diagnose conditions: Sepsis and Tuberculosis. These are currently in early development as laboratory-based qPCR assays and point-of-care lateral flow devices (LFDs). Our LFD test development for TB, funded by the Knowledge and Asset Development Fund, is scheduled for clinical evaluation in 2026 to 2027 in collaboration with coworkers in India. These projects aim to directly support the UK's AMR strategy by enabling earlier, more accurate diagnoses in both high- and low-acuity, including community settings. These personalised medicine approaches are also designed to monitor treatment response, predict disease severity, and enhance

antimicrobial stewardship – ultimately improving patient outcomes and reducing unnecessary antimicrobial use.

Novel vaccines and therapeutics for Tuberculosis and other respiratory diseases

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It is widely accepted that strategies to vaccinate individuals from specific diseases in many circumstances will combat the threat of multi-drug resistance. The Aerosol Infection Microbiology Group are a partner in an international consortium with an aim of diversifying the vaccine development pipeline, recognised as a priority area in the Global TB Vaccine research and development roadmap, to treat tuberculosis more effectively. NEWTBVAC-HORIZON has 19 partners, worldwide, and is funded by the Horizon Europe programme, which also aims to improve understanding of lung immunity in tuberculosis in order to establish a diverse and innovative global TB vaccine pipeline targeting mucosal immunity. The group at the UKHSA is one partner proving pre-clinical models with which to evaluate new vaccine candidates in this consortium.

New therapeutic strategies to combat AMR are urgently needed. The UKHSA is a partner in a second Horizon Europe funded programme. Novel Immunotherapies for Tuberculosis and other Mycobacterial Diseases (ITHEMYC) has 11 partners, worldwide, which aims to establish a critical path for selection of promising innovative adjunct TB immunotherapies and the group at the UKHSA is one partner using pre-clinical models to progress these immunotherapy candidates towards trials in humans.

Open Innovation in AMR Research

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The Open Innovation in AMR platform was established with support from DHSC to support the evaluation of novel therapeutic agents against a range of WHO priority pathogens (bacterial and fungal) and high consequence viruses, including SARS CoV-2. The platform supports a range of studies with external researchers, underpinning early-stage discovery and evaluation of new antimicrobials developed in the academic research community and by SMEs, with a focus on non-traditional therapeutics such as bacteriophage and microbiome modulators.

More than 38 visiting researchers, including PhD students and post-doctoral scientists have spent time in the labs at the UKHSA Porton Down, learning how to carry out microbiological evaluation of new therapeutics. Aside from the research aspects, this supports much-needed

interdisciplinary skills development in an area recognised as internationally scarce and suffering from a ‘brain drain’.
The Open Innovation in AMR platform, in collaboration with colleagues from the AMR Reference Lab are providing microbiological support to the Pathways to Antimicrobial Clinical Efficacy consortium the UKHSA PACE Collaboration. To date, 8 of the 11 awardees have made use of the UKHSA services. The UKHSA is also joining the PACE Delivery Partners Network, where skills and expertise from across UKHSA will be showcased for potential partnerships with industry and academia.

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Health protection research units (HPRUs)

The NIHR-funded HPRUs in HCAI and AMR, led by Imperial College London and the University of Oxford, both in partnership with the UKHSA, ran for 5 years from April 2020 to March 2025 and have produced translational research outputs intended to impact public health policy and practice.

HPRU at Imperial College London

Research within the HCAI and AMR HPRU at Imperial College London, recognising the different skills required to address the threat of AMR and HCAIs, brought together researchers from a range of disciplines and professions, including doctors, engineers, epidemiologists, microbiologists, pharmacists, behavioural scientists, economists, and nurses, with the aim to deliver applied research across 4 interlinked themes of:

- priority pathogens – identified factors affecting emergence, evolution, transmission, acquisition, carriage, and pathogenesis of organisms, to shape interventions, improve clinical management, and develop diagnostic workflows
- precision prescribing – investigated and developed the role of novel, technological solutions to drive a shift from one-size-fits-all approaches towards individualised antibiotic prescribing
- practice, design and engineering – pursued evolving research on the development of bespoke stewardship and IPC solutions informed by social science and implementation research
- population health and policy – maximised the utility of data collected within the NHS and the UKHSA, building upon existing work

Over each year of the HPRUs, case studies have summarised the achievements and impact of the work conducted. These impact case studies illustrate the value that the research brought to the health and wealth of the nation, including improving patient outcomes, reducing health inequalities, serving the health needs of under-served communities and building national capacity and capability to conduct high quality health and social care research. The impact case

studies of these highly successful and valuable projects show the breadth and scale of what has been achieved, with some examples here:

2020 to 2021:

Hospital onset COVID-19 infection (HOCI) surveillance

This project developed pragmatic case definitions for HOCI prior to national definition development and used data routinely collected through electronic healthcare systems to develop a novel surveillance system, which linked with national surveillance systems, to identify, monitor and reporting HOCI providing daily reports on incidence and trends over time to support HOCI investigation and geo-temporal reports using network analysis to interrogate admission pathways for common epidemiological links to infer transmission chains.

Outbreak of GES-5-positive *Klebsiella oxytoca*

The nationwide circulation of a GES-5 carbapenemase encoding plasmid vector was revealed. This work demonstrated the translational potential of whole genome sequencing (WGS) to facilitate the development of rapid detection assays to produce clinically actionable information for routine use.

Bacterial and fungal co-infection of patients with COVID-19 research, helped to inform and was cited by the World Health Organization (WHO) in their Interim Guidance on Clinical management of COVID-19. It showed that only 8% of patients were reported as experiencing bacterial/fungal coinfection during hospital admission. Secondary analysis demonstrated wide use of broad-spectrum antibacterials, despite a paucity of evidence for bacterial coinfection. On secondary analysis, 1,450 out of 2,010 (72%) of patients reported received antimicrobial therapy. The research showed that there was a lack of evidence to support frequent prescription of broad-spectrum empirical antimicrobials in patients with coronavirus-associated respiratory infections.

2021 to 2022:

The impact of COVID-19 on antimicrobial use, infection and AMR

This was an investigation into the pandemic's impact on primary and secondary care antimicrobial prescribing and the resulting patient outcomes associated with observed changes in prescribing patterns and changes in methods of healthcare delivery. In primary care, were the first research team to report the significant reduction in GP antibiotic during wave 1 and 2 of the pandemic (up to March 2021). This has led to further investigation of whether there have been any unintended consequences associated with reduced antibiotic use and delayed or missed treatment. In acute care, assessed the incidence of healthcare associated bloodstream infections in both COVID-19 and non-COVID-19 patients, the results suggested that despite the rapid expansion of intensive care capacity during the COVID-19 surges, more patients acquired bloodstream infections, including those ones without COVID-19.

New multidrug-resistant *Corynebacterium striatum*

New multidrug-resistant *Corynebacterium striatum* infection during the 2 COVID-19 waves was investigated within our NHS hospital network. Genomic analysis characterised the 2 genetically distinct clones of *C. striatum* circulating at the same time during the first COVID-19 wave which

emerged in intensive care patients during the first COVID-19 wave in the UK as a result of sudden changes in the healthcare system due to the pandemic. National surveillance has subsequently commenced to further characterise *C. striatum* isolates across different hospital networks nationally.

2022 to 2023:

Optimised prescribing tools

Optimised prescribing tools were developed, including a triple quadrupole Liquid Chromatography-Mass Spectrometry (LC/MS) method for the simultaneous quantitative measurement of cefiderocol and meropenem in serum, the development of machine learning and synthetic outcome estimation tool for individualised antimicrobial cessation and closed-loop control of continuous piperacillin delivery.

2023 to 2024:

Applying intelligent data linkage and machine learning to blood culture data to identify healthcare associated bloodstream infections caused by common skin commensals

Skin commensals are bacteria that reside on our skin and normally cause no harm. However, once they enter the body, especially when entering the bloodstream, they can cause severe infections. The current national surveillance systems monitor infection causes by using microbiology samples collected from different locations of the body. However, it is impossible to monitor infections caused by skin commensals because we cannot differentiate whether the bacteria identified in the blood culture were from the patient's bloodstream or from skin entering the blood sample.

Researchers used intelligent data linkage and machine learning algorithms to analyse data from blood cultures along with patients' antibiotic prescribing history, biomarkers (for example, c-reactive protein), and vital signs (for example, blood pressure) to differentiate true infections from contaminants to help develop surveillance for this type of infection.

Genomic investigation of the emergence of healthcare-associated drug-resistant pathogens occurring during the COVID-19 pandemic

Epidemiological patterns of HCAIs changed during COVID-19. Pathogens which were previously a major cause of HCAIs declined while others suddenly caused increasing numbers of infections.

In response to increased incidence of neonatal *Staphylococcus capitis* bacteraemia in England, the team investigated *S. capitis* isolates collected from across the UK, revealing the widespread presence of the emerging multidrug-resistant NRCS-A clone in neonatal intensive care units (NICU), and evaluating clinical outcomes. Based on this work, the UK government created an online collection of guidance, data and analysis.

These findings informed 'operational excellence' improving local clinical practice and delivering new laboratory methods and guidelines, by preventing spread there was also a positive economic impact.

How knowledge mobilisation enhanced the impact of this work

Dissemination included peer-reviewed publications (doi.org/10.1016/j.jinf.2023.06.020, doi.org/10.1016/j.jhin.2023.06.030, doi.org/10.1016/j.cmi.2022.09.016, doi.org/10.1016/j.jinf.2024.106191) and based on the discoveries, the UKHSA released a peer-reviewed national guidance on reinforcing cleaning in neonatal units and the need for further evidence to create a safe hospital environment for vulnerable neonates. This recent data informed national incident response and will inform Staphylococcus capitis: guidance, data and analysis updates.

2024 to 2025:

Portable molecular diagnostic platform for rapid point-of-care detection of infectious diseases

The unit, in collaboration with diagnostics spin-out company ProtonDX and Northwest London Pathology, has helped to evolve and field-test a molecular diagnostic platform for rapid point-of-care detection 'Dragonfly' (Nature Communications, 2025) for use during mpox outbreaks. The platform which incorporates an innovative, laboratory-free sample preparation technology (Analytical Chemistry, 2024), was developed to address the urgent need for rapid, decentralised molecular testing to support outbreak investigations and targeted disease surveillance in low-resource settings.

Dragonfly has also been proven to work for community-level screening of asymptomatic malaria carriage in The Gambia and Burkina Faso. If implemented regionally, this approach could transform responses to emerging infectious threats and improve patient outcomes.

How knowledge mobilisation enhanced the impact of this work:

The platform has influenced discussions with ministries of health and WHO stakeholders regarding decentralised testing strategies and integrated disease surveillance. The findings of this work have been disseminated through peer-reviewed publication (doi.org/10.1021/acs.analchem.4c00319, doi.org/10.1038/s41467-025-57647-3).

Using artificial intelligence to improve intravenous to oral antibiotic switching in hospitalised patients

Promoting early intravenous to oral switching of antibiotics (IVOS) is an NHS and UKHSA priority. To help support doctors and pharmacists identify patients that are safe to undergo IVOS, an artificial intelligence algorithm, using NHS patient data that provides recommendations to doctors on whether IVOS is safe on any given day was developed. The tool was successfully evaluated in a simulation experiment supported by 45 physicians and pharmacists from 23 hospitals across England and Wales. Subsequently, the tool was evaluated against expert decision making within 2 hospital-wide point-prevalence surveys.

This tool has received technology accelerator funding and is now being testing at Imperial College Healthcare NHS Trust to determine its impact on IVOS.

How knowledge mobilisation enhanced the impact of this work:

Dissemination included peer-reviewed publication (doi.org/10.1038/s41467-024-44740-2) and presentation at ECCMID 2025 ('Prospective evaluation of a machine learning-based decision support system for intravenous-to-oral antibiotic switching. William BOLTON, United Kingdom').

HPRU at the University of Oxford

The HCAI and AMR HPRU at the University of Oxford aimed to find better ways to manage and prevent threats from AMR and HCAI, by detecting them faster, working out who needs protecting most and how this can be done. It also consists of 4 research themes which are:

- populations
- interventions
- contexts
- sequencing

The impact case studies from the HPRU at the University of Oxford are:

2020 to 2021:
Lateral Flow Devices detect the majority of infectious individuals with COVID-19, including asymptomatic cases:
The study enabled the use of COVID-19 Lateral Flow Devices to detect asymptomatic infection in hospitals and workplaces, use of daily testing of COVID-19 contacts to avoid quarantine, and large-scale pre-event testing to enhance safer attendance. The research directly measured the relationship between the viral load of COVID-19 infected individuals and their ability to transmit the virus to their named contacts and hence determine the ability of Lateral Flow Devices to detect infectious individuals.
This study was the first in the world to directly measure the infectiousness of infected individuals by following their immediate contacts both in and outside the household.

2021 to 2022:
Providing SARS-CoV-2 bioinformatics to the world: Global Pathogen Analysis Service (GPAS):
GPAS is an online platform that automates the process of turning jumbled, raw genome sequencer data into information that can directly drive public health decisions. It was created to reduce the need for in-house bioinformatics expertise: labs around the world usually have to wait days (or weeks) for results to come back, and they need an in-house expert to do it. With GPAS, they can have the answer in less than an hour, without expert staff. The service is offered free of charge for SARS-CoV-2 and has already processed thousands of samples for 7 organisations on 4 continents.

The SARS-CoV-2 Immunity and Reinfection Evaluation (SIREN) study: investigating immunity and vaccine effectiveness throughout the evolving COVID-19 pandemic:
The SARS-CoV2 Immunity and Reinfection Evaluation (SIREN) study is a unique, large-scale partnership with NHS healthcare workers providing an agile response to the evolving pandemic. It is one of the national core studies established in response to COVID-19 and an NIHR urgent priority study, providing vital research into immunity and vaccine effectiveness. The SIREN study was established early in the pandemic with participants undergoing regular testing for up to 2 years. Analysis of these testing samples helps the UK to evaluate the immune response to COVID-19, build understanding of the protection offered by vaccines and provide insight into COVID-19 reinfections.

2022 to 2023:
A model-based evaluation of hospital admission screening strategies which has informed revised national guidelines for the detection and control of carbapenemase-producing Enterobacteriales (CPE)
Detections of CPE are rising globally, which poses a significant threat to public health as CPE are antibiotic-resistant, can spread rapidly within healthcare settings and infections are associated with poor clinical outcomes. Effective screening, identifying CPE-carriers at hospital admission, could help control hospital spread. Findings from our evaluation of existing England guidelines for control of CPE identified changes that could double the carriers selected for screening (in most England hospitals) and could also reduce the burden on hospital laboratories. These findings informed new national guidance and are now in use by many hospitals.

2023 to 2024:
Combined network analysis and mathematical modelling informing the introduction of sentinel-based whole genome sequencing surveillance to deliver efficient, rapid identification of novel *Clostridioides difficile* strains in English hospitals
It is important to detect novel *C. difficile* strains quickly so treatments and control can be adapted – strains can be identified using gene sequencing, but laboratory capacity is limited. This research informed a new *C. difficile* surveillance programme for English trusts, selecting a small number of trusts to supply specimens (from *C. difficile* infection patients) to the sequencing laboratories. Using simulations of inter-hospital spread of a theoretical new strain, the research identified which combination of trusts would deliver the quickest detection of a novel strain – no matter where it first appears and make best use of limited laboratory facilities. Additionally, the analysis was used to support response to a *C. difficile* outbreak: the research identified hospitals at higher risk, enabling public health officials to alert them so they could take proactive protective measures.

How knowledge mobilisation (KM) and the KM toolkit enhanced the impact of this work:

Dissemination and engagement facilitated policy change: with accessible communication of complex modelling methodologies, tailored presentations and workshops to different audiences: data scientists, epidemiologists, clinical colleagues, and policymakers, and encouraging

feedback throughout. Engagement improved clinical practice: through strong relationships and trust built with the UKHSA teams. Enabling rapidly shared, actionable HPRU outputs to support national incident response

Innovative dashboard helps to identify a previously-unknown data quality artefact that was creating misleading trends in antimicrobial resistance

Regular surveillance of trends AMR is part of UKHSA's remit for protecting the public health and is conducted using laboratory data from the Second Generation Surveillance System (SGSS). In 2023, an unusually large increase in *Haemophilus influenzae* macrolide resistance was noticed by the AMR epidemiology team at the UKHSA. Utilising a novel dashboard that had been developed as part of the HPRU, it was possible to quickly ascertain that the increase was not genuine, but instead caused by an anomaly in the SGSS data. This was subsequently confirmed by the SGSS team who launched a large response and investigation into it. Without the dashboard, the true cause of the apparent increase may not have been discovered until a much later date (it had already been unnoticed for a year) and could have led to further wasted time and resources in unnecessary response activities.

How knowledge mobilisation and the KM toolkit enhanced the impact of this work:

Dissemination and widespread sharing of the dashboard across multiple teams within the UKHSA, at an R conference and university groups working with electronic health records. Engagement with the SGSS team and the relevant teams at the UKHSA around data quality and the centrally implemented surveillance

2024 to 2025:

Using genetics to diagnose and treat tuberculosis

We developed a computational pipeline that consumes the raw data files produced by genetic sequencers and tells you what species of Mycobacteria are present. If *M. tuberculosis* is detected it produces the genetic letters that it is made from and uses this to predict which antibiotics the infection will be susceptible to (and to which it will be resistant). It also tells you if there are any other samples that are similar genetically and so could be part of the same outbreak. The first-generation pipeline is still used today in the UKHSA having been deployed around 2017 to 2018. This new second-generation pipeline fixes many of the problems encountered over the years and, since it has been incorporated into EIT Pathogena, is available for users worldwide.

Using sequencing of bacteria routinely undergoing public health surveillance to understand why Enterobacterales cause bloodstream infection

Many of the bacterial species that cause bloodstream infections are resistant to antibiotics, resulting in increasing rates of morbidity and mortality in the United Kingdom. Data shows that there are regional disparities in AMR and the burden of infections falls disproportionality on individuals from ethnic minorities and socio-economically deprived communities. All cases put a high burden on the NHS.

The team partnered with colleagues in the UKHSA and across 10 NHS sites to collect bacteria causing infections, enable the relevant linkage to patient data.
This study worked with hospitals across 8 of the 9 geographic regions of England, collecting better data, developing a bioinformatics pipeline, linking to the UKHSA datasets, that can be standardised for the hospital sites, linking datasets (UKHSA, Hospital Episode Statistics (HES) and SGSS) and analysing the data to understand the distribution of harmful bacteria according to healthcare exposure, social deprivation, population-level antibiotic prescribing, geography and following the COVID-19 pandemic. The project is aiming to develop a national genomic surveillance system and is supporting other work between the UKHSA and the University of Oxford to develop a risk score for AMR bacteria that cause bloodstream infections.

Implementation of point-of-care tests to reduce antibiotic prescribing in primary care
Trial evidence indicates that using point-of-care tests (POCTs) reduces antibiotic prescribing for acute infections in primary care. However these tests are not used routinely and more evidence is required before they can be widely used.
A European programme of work, including a randomised controlled trial, to assess the impact of POCTs on antibiotic prescribing, was conducted. No differences in antibiotic prescribing between the POCT arm and usual care were found, but there was some evidence that prescribing changed for some groups of patients. A systematic review of patient and clinician views of tests indicated that POCTs need to be one part of a wider multifaceted intervention to influence antibiotic prescribing.
These findings have important implications for primary care guidelines and commissioning decisions regarding POCTs and can help to identify how POCTs can be used to the greatest value.

Knowledge Mobilisation Toolkit

Knowledge mobilisation (KM) is getting the right information to the right people in the right format at the right time, so as to influence decision making and enhance impact. KM includes dissemination, knowledge transfer and knowledge translation.

The Oxford HPRU has developed a Knowledge Mobilisation Toolkit containing an array of tools, plus supporting information to help users navigate KM and apply it to their own research, facilitating translation to impact. It has been shared and promoted widely and is used by multiple researchers within academia and the UKHSA, across HPRUs and other partnerships. It has achieved strong buy-in from senior leaders and active researcher engagement.

The goal of the KM Toolkit has been to maximise the impact of the research projects carried out within the HPRUs and to capture and communicate those impacts as widely as possible. It supports a wider KM strategy aiming to:

- embed knowledge mobilisation within organisational cultures
- develop collaborations and facilitate engagement

- support active and varied dissemination and communication
- measure impact, evaluate success and improve the evidence base for knowledge mobilisation

This has ultimately facilitated the implementation of more effective, evidence based and collaborative policies and practices.

The KM Toolkit is organised into 4 main areas:

1. Understanding KM: key documents that help to explain what KM is and why it is needed
2. Performing KM: how you can begin to actively perform KM within your team. The main component is the 'Knowledge to action' (K2A) framework.
   Supplementary resources are also included in support of the K2A framework, including a stakeholder mapping tool, a general communications plan framework, and a framework for engaging colleagues with KM and working KM into the 'organisational DNA'.
3. Evaluating KM: enables self-evaluation of KM practice, using the KM maturity model. This tool enables teams to map current KM practice, identify strengths and target areas for improvement to support their business objectives.
4. Reporting KM: guided by the NIHR KM reporting requirements for HPRUs.

There are 2 key tools within the toolkit which support the primary aims:

1. Public Health England (PHE) (the predecessor to UKHSA) developed K2A (Knowledge to Action) Framework which supports the development of KM within projects. K2A aims to bridge the gap between knowing and doing – between knowledge and intelligence and policy and practice – ensuring that data and evidence are effectively used to improve people's health. This evidence-based approach uses conversational prompts to enable users to engage in structured and reflective conversations about their project aims, the key messages that they would like to relay, the relevant stakeholders and collaborators that can act on this information, and the best routes of relaying this information for each stakeholder (Figure 7.2).
2. The KM maturity model is a self-assessment tool, developed by the UKHSA Knowledge and Libraries team. It helps teams identify and map their achievements around knowledge mobilisation and their goals, and plan ways to realise them, identifying strengths and weaknesses, and target areas for improvement. It provides a benchmark, allowing teams to record and review progress and gives measures and indicators to show the types of activities that can be introduced to demonstrate progress against an outcome.

Figure 7.2. Schematic of Knowledge to Action Framework components (from KM Toolkit)

Text version of Figure 7.2

This graphic contains 4 boxes labelled 'What?', 'How?', 'Who?' and 'Why?'. 'When?' is written in a circle in the centre overlapping with all 4 boxes.

Text inside the What? box reads: "It's important to have a clear vision of the main message you want to communicate and the lessons you want to share. What do they need to know about – what level of detail/type of knowledge? General content, functionality, methods/caveats, interpretation."

Text inside the How? box reads: "How will you get your message(s) across to this audience? Consider: methods available, forums, evidence of effectiveness."

Text inside the Who? box reads: "Who is the audience? Consider the role they bring: champions, partners, users (general, technical). What organisations are they from? What 'day job' do they have? Who would it be helpful to collaborate with? Consider: what they bring to the table, how they can assist in planning, doing, evaluating."

Text inside the Why? box reads: "Why have you undertaken this work? Why is it important? Why should they see or use this product? What public health issues does this product address? What knowledge do you want to mobilise? What are the main messages and why are they meaningful to this audience? What do you want to achieve with these messages for this

audience (change attitudes, change behaviour/practice, raise awareness, share knowledge of tools)?”

At the bottom of each box, there is a When? graphic and beside this it reads: “What is your time scale for these activities? Are there any other activities taking place that might influence the uptake of this knowledge?”

End of accessible text.

The KM Toolkit was designed with a focus on ease of use, ensuring accessibility and encouraging engagement. A suggested approach guides users through each element step-by-step, and all resources are labelled ‘essential’ or ‘encouraged’ to allow for different levels of engagement or time available.

Future HPRU
The NIHR launched 13 new HPRUs in 2025. As previously, the HPRUs are intended to act as multi-disciplinary centres of excellence with the purpose of supporting the UKHSA in delivering its functions and objectives for public health protection, including an immediate response to emerging priorities and by building an evidence base for public health protection policy and practice.

The third iteration of the HPRU in HCAIs and AMR, which runs until 2030, is a partnership between the University of Oxford and the UKHSA, with the objective to conduct research to inform the prevention and control of HCAIs and of AMR and support the delivery and accelerate progress towards the UK 2024 to 2029 AMR National Action Plan.
To achieve this, the vision of the University of Oxford and UKHSA HCAI and AMR HPRU is to integrate powerful, increasingly rich types of community and hospital data becoming available at increasing large scales with increasingly sophisticated models. The research aims to innovate and identify the most efficient and cost-effective approaches for the detection, surveillance, investigation and reduction of HCAI and AMR to support delivery of value-for-money, evidence-based, high-quality public health interventions. Furthermore, the HPRU aims to train the next generation of public health-focussed researchers to work together across multiple disciplines and ensure that a diverse range of patients and the public are integrally involved in the research, throughout its design, conduct, reporting and impact.

Chapter 8. ESPAUR oversight group members' activities and actions to tackle AMR – mapping to the National Action Plan

Main messages

The ESPAUR Oversight Group comprises over 30 stakeholder organisations including the UK nations and national organisations, professional and educational bodies, healthcare providers and regulators.

A total of 15 stakeholders have contributed to this year's ESPAUR report (British Dental Association (BDA), British Infection Association (BIA), British Society for Antimicrobial Chemotherapy (BSAC), Care Quality Commission (CQC), College of General Dentistry (CGD), IQVIA, Microbiology Society, Royal College of General Practitioners (RCGP), Royal College of Nursing (RCN), RX-Info Ltd, Veterinary Medicines Directorate (VMD – DEFRA), NHS England (NHSE), Public Health Wales, Public Health Agency (Northern Ireland), Antimicrobial Resistance and Healthcare Associated Infection (ARHAI) Scotland (Figure 8.1).

A total of 45 updates from 7 organisations in support of 16 commitments and 6 outcomes within the 2024 to 2029 National Action Plan (NAP) for Antimicrobial Resistance (AMR) have been reported to ESPAUR between May 2024 and June 2025. These include, but are not limited to, undertaking global antimicrobial stewardship (AMS) programme initiatives to promote appropriate use of antimicrobials; attending international conferences and meetings on AMR for advocacy and to ensure partnership in handling AMR; delivering workshops and professional educational programmes on infection prevention aligned to AMS; producing guidelines and educational resources; publishing evidence-based guidance on public and political engagement; promoting pharmacy resources such as the TARGET antibiotics toolkit.

The ESPAUR Oversight Group comprises over 30 stakeholder organisations including the UK nations and national organisations, professional and educational bodies, healthcare providers, regulators and has the following members:

- Department of Health and Social Care (DHSC), including AMR Policy Team, Dental Public Health, Office for Health Improvement and Disparities (OHID)
- DHSC Expert Advisory Committee on Antimicrobial Prescribing, Resistance and Healthcare Associated Infection (APRHAI)
- British Dental Association (BDA)
- British Infection Association (BIA)
- Bennet Institute for Applied Data Scient (OpenPrescribing/OpenSAFELY)
- British National Formulary (BNF)
- British Society for Antimicrobial Chemotherapy (BSAC)

- Care Quality Commission (CQC)
- College of General Dentistry (CGDent)
- Independent Healthcare Providers Network (IHPN)
- IQVIA
- Microbiology Society
- National Pharmaceutical Advisers Group/ICB Chief Pharmacist representation
- National Institute of Health and Care Excellence (NICE)
- NHS England (NHSE)
- Primary Care Pharmacy Association (PCPA)
- Royal College of Nursing (RCN)
- Royal College of Pathologists
- Royal College of Physicians (RCP)
- Royal College of General Practitioners (RCGP)
- Royal College of Surgeons (RCS)
- Royal College of Paediatrics and Child Health (RCPCH)
- Royal Pharmaceutical Society (RPS)
- Rx-Info Ltd
- Specialist Pharmacy Service (SPS)
- UK Clinical Pharmacy Association: Pharmacy Infection Network (UKCPA PIN)
- Veterinary Medicines Directorate (VMD – DEFRA)
- Antimicrobial Resistance and Healthcare Associated Infection (ARHAI) Scotland
- NHS National Services Scotland
- Public Health Scotland
- Public Health Wales
- Public Health Agency Northern Ireland (Health and Social Care Northern Ireland – HSCNI)
- public partner and patient representation
- UKHSA (previously PHE) (represented by individuals with appropriate expertise from AMR and HCAI Division, Behavioural Insights, regions, Field Service, microbiology services and communications teams)

British Dental Association

The British Dental Association (BDA) works nationally and internationally, addressing the role of dentistry in AMR.

Dr Mick Armstrong and Dr Susie Sanderson OBE, Chair and member respectively, of BDA's Health and Science Committee, represent the BDA on the Council of European Dentists' AMR working group.

The Word Dental Federation (FDI) Task Team on Preventing AMR and Infections continues to advocate for the role of dentistry within the AMR agenda, part of FDI's Science Committee programme of work, and is chaired by BDA Health and Science Committee member, Dr Wendy

Thompson, with Dr Sanderson OBE, a member. In 2024, Dr Thompson attended the UN High-Level Meeting on AMR and chaired a side meeting on AMR at the first-ever WHO Global Oral Health meeting.

The BDA supported a joint statement for World AMR Awareness Week (WAAW) 2024, aligning with Evidence-based Dentistry's December 2024 issue on antimicrobials.

BDA members and University of Manchester dental students, Qasim Arain and Amaan Amjad, worked with the Antibiotic Guardian team, sharing the message "antibiotics don't cure toothache" with the local community and exploring views about antibiotics, toothache and resistance, presenting their findings in a poster at ESCMID Global 2025.

Alongside campaigning for patient access and properly funded urgent care, the BDA raises awareness of AMS through its teams. In 2024, BDA Indemnity invited Dr Yvonne Dailey, Lead Consultant Dental Public Health, NHS England North West, to present at the well-received Dentolegal Study Day on safe and responsible use of antibiotics and risk management for reducing unnecessary prescribing.

British Infection Association

The British Infection Association (BIA) is professional organisation and registered charity. Its aim is to maintain and improve the quality of care provided by clinical infection services. The Association fulfils this aim by supporting healthcare workers from a variety of disciplines who provide care for patients with infection. Support is provided through conferences, education resources, members email discussion forum, research grants and publication of research through Journal of Infection and Clinical Infection in Practice. Throughout 2024 and 2025 activities have included:

- the ID:IOTS podcast, an educational resource aimed at infection trainees that provides the basics of antimicrobial therapy and resistance alongside other key infection topics
- Infection Quick Reference Guides (IQRGs) designed to complement UKHSA Standard Microbiological Investigation documents. Thes guides provide at a glance guides to testing based on clinical syndromes. In 2024 IQRGs for meningitis and encephalitis were published. Guides for acute gastroenteritis, pneumonia, sepsis and skin and soft tissue will be updated in 2025
- BIA guidance published in 2024 –
    - UK guidelines for the investigation and management of eosinophilia in returning travellers and migrants
    - Tools for optimising clinical consultation activity in infection services in the United Kingdom
- BIA awarded approximately 45 scientific and travel grants to early career researchers over the past 2 years and have established an early career researchers network

- a new sustainability council role was created in 2025 to drive forward sustainability in infection services
- in 2024 the BIA established a new collaboration with the Intensive Care Society to support antibiotic and diagnostic stewardship within critical care settings

British Society for Antimicrobial Chemotherapy

The mission of the British Society for Antimicrobial Chemotherapy (BSAC) is to build the world's most dynamic community of infection experts. Its vision is a world where the workforce is equipped to prevent and manage infection, including those due to drug-resistant pathogens. The BSAC fulfils the mission and works toward the vision by providing high-quality open access support to a wide range of professionals across the world. This support takes many forms: free membership, workshops, conferences, educational resources, advocacy, and the publication of research via its Journal of Antimicrobial Chemotherapy, and the online open access education and research journal JAC-Antimicrobial Resistance.

The Society offers a rich portfolio of activities that support the UK National Action Plan (NAP) alongside many other local, national, regional and global efforts to neutralise the threat of AMR. Throughout 2024 to 2025 these activities included:

- establishing and extending the Global Antimicrobial Stewardship Accreditation Scheme (GAMSAS), a continuous quality improvement programme seeking to identify barriers to successful stewardship practice and build a global community of accredited AMS Centres of Excellence – the GAMSAS scheme features as a case study in the current UK AMR NAP
- providing the secretariat for the All-Party Parliamentary Group on Antimicrobial Resistance, orchestrating meetings with UK Government ministers and civil servants, and conducting global campaign partnerships through Stop Superbugs and Wounds That Won't Heal
- operating a PhD Parliamentary Internship programme through the office of Baroness Natalie Bennett and Dr Danny Chambers MP
- running an Infection Learning Hub which includes more than 70 open access e-learning courses with translations into 6 languages for some courses
- embedding the UK Outpatient Parenteral Antimicrobial Therapy (OPAT) programme – which aims to bring care closer to home. BSAC has worked with NHSE to develop a business case and cost calculator to support the establishment of new services and to aid the expansion of existing ones
- managing the UK Antimicrobial Registry, developed in partnership with the University of Aberdeen, to capture the real-world use of antimicrobial agents and to identify where unmet clinical need lies
- maintaining a national susceptibility testing programme, supporting laboratories using EUCAST methodologies and serving as the national susceptibility testing committee for the UK

- supporting the Drug Stability Testing Programme to provide an expanding repository of open access data on the stability of drugs and medical devices, compliant with UK NHS standards as provided by the relevant Yellow Cover Documents

The Society is also a registered National Institute for Health and Care Research (NIHR) partner and serves, and is available to serve, as an implementation partner on large consortia research projects and randomised controlled trials (RCTs).

Care Quality Commission

The Care Quality Commission (CQC) makes sure health and social care services provide people with safe, effective, compassionate, high-quality care and encourages care services to improve. We regulate against the Health and Social Care Act 2008.

The Medicines Optimisation Team at CQC has been raising awareness and understanding of the NAP and good AMS internally to support colleagues who register and inspect services. Teams have received training specific to their sector of work in health and social care, in addition to an updated, more general e-learning package. CQC celebrated WAAW with an internal bulletin explaining the threat of antimicrobial resistance and a call to action. CQC continues to support ESPAUR and its members through attendance at meetings and work with the NHSE Antimicrobial Prescribing and Medicines Optimisation (APMO) team.

College of General Dentistry

For World AMR Awareness Week 2024, the College of General Dentistry (CGDent) led production of the annual joint statement from twenty oral and dental organisations across the UK: AMR to kill more than cancer: dental organisations heed the call to ‘Educate. Advocate. Act Now!’ – College of General Dentistry.

Over the year, the CGDent contributed to international efforts to tackle AMR through the International College of Dentists and International Association for Oral, Dental and Craniofacial Research. Dr Wendy Thompson FCGDent, the College of General Dentistry’s AMR Lead, chaired a side meeting on AMR at the WHO’s first ever Global Oral Health Meeting in Bangkok. Standards and guidance for the UK dental profession are published by CGDent. Over 20,000 dental professionals and practices have registered for website access to view them, including on antibiotic prescribing.

CGDent continues to press for dental AMS efforts to place the onus on healthcare systems to provide access to oral health care which prevents infections and avoids the need for antimicrobials wherever possible.

IQVIA

IQVIA is actively contributing to the UK's response to AMR through data-driven initiatives and partnerships.

A key focus is the use of real-world evidence to inform decision-making across healthcare stakeholders. One of IQVIA's major contributions is through the IQVIA Medical Research Data (IMRD), a robust real-world dataset that enables population-based research. A recent study using IMRD, published in BMJ Open, examined trends in urine sampling and antibiotic prescribing for lower UTIs in English general practice between 2015 and 2022.

IQVIA is also enhancing AMS through the development of Antimicrobial Dashboards. Created in collaboration with NHS clinicians and external partners and using IQVIA's Hospital Pharmacy Audit (HPA) data, these dashboards provide actionable insights and monitor key AMR metrics, supporting targeted interventions and improving stewardship outcomes.

In September, IQVIA hosted a side event at the UN General Assembly highlighting the role of public-private partnerships in addressing AMR. The event featured the launch of a white paper, developed between IQVIA, St. George's University of London and the University of Oxford, which examined the role of national antibiotic assessment reports in informing policy and optimising antibiotic use. The findings revealed increased global use of AWaRe antibiotics and gaps in national AMR action plans in enabling policy-based approaches.

A panel discussion followed which concluded by encouraging stakeholders to identify their roles and form partnerships to effectively combat AMR. IQVIA will be focusing on the data-driven aspects of the response hoping to lead the design and implementation of a collaborative approach to support the realisation of the 2024 AMR political declaration's commitments.

Microbiology Society

The Microbiology Society is a membership charity for scientists interested in microbes, their effects and their practical uses. It has a worldwide membership based in universities, industry, hospitals, research institutes, schools, and other organisations.

Our members have a unique depth and breadth of knowledge about the discipline. The Society's role is to help unlock and harness the potential of that knowledge. We do this by bringing together and empowering communities that shape the future of microbiology. We generate public benefit by fostering communication both among communities of microbiologists and between microbiologists and other communities who can translate that knowledge in useful ways.

Because of the diverse range of challenges and opportunities our members encounter, the Society works in a variety of modes. By engaging through the membership, and amplifying the

voices of the members, sometimes the Microbiology Society is a leader, sometimes it works in partnership with like-minded scientific organisations, and sometimes it convenes different communities.

In the 5 years between 2023 and 2027, the society's principal goal is to strengthen our culture of being a community-driven Society by amplifying our members' voices, wherever they are in the world, and empowering them to embed the benefits of microbiology within wider society. In October 2023, following consultation with the membership, the society launched Knocking Out AMR. Through a series of workshops in January 2024, we gathered insights from our membership and the wider AMR community to understand the challenges they're facing and the role of the Society in helping to confront these issues. From this, the Knocking Out AMR vision statement was launched, which outlines the specific activities the society is committed to delivering. Through delivery of the Knocking Out AMR project, the society will support cross-disciplinary working and promote policy discourse to address the challenges facing the AMR community, who are working to drive forward solutions to AMR.

Since the project's launch the society has:

- hosted 22 cross disciplinary events with over 1,200 attendees
- developed professional development sessions and resources to share knowledge across groups including funders and regulators
- funded 17 public engagement events hosted by Microbiology Society Champions, reaching over 1000 people across 13 countries
- engaged with over 350 members on AMR policy through surveys, panel discussions, workshops and panel discussions

Royal College of General Practitioners

The Royal College of General Practitioners (RCGP) continue to collaborate with the UKHSA to implement the TARGET antibiotics toolkit to support primary care providers utilise AMS interventions in their practices (see Chapter 6). In addition, the RCGP incorporates AMS topics within the clinical learning programme and RCGP Prescribing and Medicines Optimisation Special Interest Group.

Royal College of Nursing

The Royal College of Nursing (RCN) continues to incorporate AMS in the Infection Prevention and Control (IPC) educational programme. A review of this programme is set for June 2025 with the intention to keep AMS in the agenda.

The Nationwide IPC training and webinars include AMS updates aligned with the National Antibiotic Plan.

Rx-info

Provision of regular data feed of detailed antimicrobial usage data to UKHSA.

Continued provision of antimicrobial data covering secondary care across England, Scotland and Northern Ireland via the Define platform.

Engagement with the Antimicrobial Lead Pharmacists at national, regional and hospital Trust level to support data analysis.

Support and attendance at meetings with Mental Health Specialist Trusts that have been reviewing activity.

Review and development of key secondary care and ICB-level antimicrobial reporting metrics.

Liaison with dm+d authors to ensure that the standard data dictionary keeps up to date with active clinical practice.

Veterinary Medicines Directorate and Department for Environment, Food and Rural Affairs

The Veterinary Medicines Directorate (VMD) continues to coordinate the Animals, Plants, Food, and Environment components of the UK's AMR National Action Plan (NAP) 2024 to 2029. This includes managing Defra's commitments and overseeing the UK-wide Animals, Plants, Food and Environment Delivery Board. The work summarised below directly contributes to commitments 2.1, 3.1, 3.2, 4.3, 5.4, 5.5, 6.4, 7.1, 9.1, 9.3 and 9.5 of the AMR NAP. The wider Defra Implementation Plan represents roughly 130 deliverables contributing to 16 of the 30 commitments within the AMR NAP.

The VMD continues to work closely with the livestock and companion animal sectors to promote good antimicrobial stewardship and antibiotic use data collection in each sector. In 2024, we revised the UK legislation on veterinary medicines, the Veterinary Medicines Regulations, which included changes to strengthen laws on antibiotic prescribing in animals to support antibiotic stewardship. In addition, the livestock sectors, coordinated by the Responsible Use of Medicines in Agriculture Alliance (RUMA) Targets Task Force, are in the process of developing a new set of sector specific antibiotic targets, due to be published later in November 2025.

Here we present results from the 2023 VARSS report which includes surveillance data from the last year of the previous AMR NAP and marks a decade of collecting data under the harmonised monitoring programme, allowing us to look at long-term trends as well as year-to-year changes. Over the past 5 years, collaborative efforts with veterinarians and the farming industry have sustained a 59% reduction in antibiotic use since 2014, and sales of highest

priority critically important antibiotics have fallen by 84%. Alongside the reductions in use, our key indicators for resistance in pigs and poultry continue to show declining trends. Looking more closely at antibiotic use data by sector in the last year shows a mixed picture, with some sectors (in particular, pigs and gamebirds) seeing an increase in use in 2023. If upticks in use become trends, we expect to see this reflected by rising AMR levels.

The report also includes new baseline AMR data from sheep, beef, and dairy cattle, species which are not included in our established harmonised surveillance programmes, which was collected under one of the pilots of the PATH-SAFE programme. This PATH-SAFE programme has now concluded and publications for the portfolio of AMR based PATH-SAFE pilots are planned throughout 2025.

AMR surveillance in animals is well established in the UK, however most clinical testing is done by private veterinary laboratories and is not shared with government. In 2024 to 2025, the VMD led a project within the National Biosurveillance Network to address barriers to sharing AMR data. The VMD-led project was delivered successfully, and further funding to continue this important work has now been secured from the Integrated Security Fund.

AMR surveillance data in the UK animal population from 2024 will be published in the upcoming VARSS report on 18 November, 2025 and will be available at Veterinary Antimicrobial Resistance and Sales Surveillance.

Internationally, the VMD supported the UK's advocacy for a UN political declaration on AMR, championing data-driven action and a global commitment to ensure prudent and responsible use in agri-food systems. In addition, the VMD is leading the UK's work to support the establishment an Independent Panel for Evidence on AMR, ensuring science and evidence guide future interventions.

NHS England

The NHS England (NHSE) AMR Programme comprise 5 national workstreams: Antimicrobial Prescribing and Medicines Optimisation (APMO), Data, Diagnostics, Infection Prevention and Control, and New Payment Models. The national teams in these workstreams work closely with each of the seven regional teams to provide leadership to the NHS in England to improve equitable access to and optimisation of antimicrobial use and enhance infection prevention and control. In addition to the National Guidance and Implementation Resources highlighted earlier in this chapter, a range of Regionally led initiatives have also been developed and implemented to facilitate achievement towards the UK National Action Plan – Confronting antimicrobial resistance 2024 to 2029. Examples include:

Promoting antimicrobial awareness to school-age children: a toolkit for local authorities

NHS East of England, the UKHSA and Southend Council worked collaboratively to run a campaign to improve AMR awareness in children and their carers. This involved producing 'Tools for Schools' a communications toolkit that for the first time collated a wide range of

evidence-based public health resources, including those from e-Bug, Antibiotic Guardian, UK-PAS, TARGET, SPS, vaccination and sustainability resources for use in healthcare settings, local authorities and Children and Young Persons (CYP) settings such as schools.

The multi-media campaign involved using diverse methods to reach and engage the target population via a range of digital media and community-based initiatives. It reached a wide audience (including vulnerable and hard to reach groups) and was well received. In doing so, AMR awareness increased, individual behaviour change pledges were made, and several community actions were influenced. Overall:

- 30,256 primary and secondary school aged children in 60 state and private schools in Southend (including 6 SEND institutes) received the school newsletter about AMR
- 47 elective home educated children and adults attended the face-to-face workshop of hideous histories cringey cures
- 20 social media posts and 8 online articles accessed by over 9,500 members of the Southend community
- 39 members attending the Youth Council meeting, with representation from looked after children LGBYQ+, electively home educated, learning and physical disabilities, BAME communities
- 75% of local authority public health colleagues said that they would pledge to become an Antibiotic Guardian after the local authority session
- 77% of Southend Youth Council said they were thinking of pledging to become an Antibiotic Guardian after the session

Paediatric AMS resources for primary care prescribers

The South East and Midlands regions established a joint project to focus on primary care antibiotic prescribing for children aged 0 to 4 years. Following a survey of primary care clinicians a suite of resources to support optimal prescribing was developed. The paediatric AMS resources include: key messages for primary care prescribers around increased rates of prescribing in the 0 to 4 age group and actions that could be taken, template text and guidance for local point-of-prescribing alerts in clinical IT systems, resources to support back-up prescription strategies, information on the gut microbiome, and a dedicated paediatric respiratory tract infections training pack with accompanying presenter notes to allow local delivery of training to optimise prescribing. The project aligns to and complements the national focus on antibiotic prescribing for children, as evidenced by the NHS Performance and Assessment Framework metric for prescribing of antibiotics to children aged 0 to 9 years.

COPD_PET pilot evaluation

This pilot evaluated a prevention-focused toolkit to reduce exacerbations and antibiotic use in patients with COPD within Luton's eQuality primary care network (serving a patient population of approximately 40,000). Conducted by a pharmacist and pharmacy technician across GP practices in Bedfordshire, Luton, and Milton Keynes ICS, it originally targeted patients with ≥2 antibiotic courses and high short acting beta agonists use within the previous 12 months. Of the

125 patients identified, 75 were reviewed, with 63 followed up at 6 and 12 months; 40% (*n* = 50) did not attend, cancelled, or declined, and 12 were lost to follow-up.

The reviewed cohort was diverse, with 39.7% White British, 27.0% Mixed British, and 9.5% South Asian (Pakistani, Bangladeshi, Asian other). The reviewed patients were older (mean age 70 vs. 65), with 45.3% aged 70+ compared to 34.0% in the not-reviewed group, which had more patients aged 50 to 59 (30.0% vs. 13.3%). This suggests that younger patients, despite having COPD exacerbations, may have a lower perceived need for intervention, potentially due to milder symptoms or competing priorities such as work, contributing to their higher non-attendance rate.

Antibiotic prescriptions fell from a baseline mean of 3.77 per patient per year to 1.84 per patient per year at 12 months (mean reduction 1.94 per patient per year, 51.5% relative reduction), with 82.5% of patients experiencing a reduction. A comparison with the not-reviewed patients (*n* = 50) at 12 months showed that reviewed patients had fewer prescriptions, with a mean difference of −0.74 per patient per year (95% CI: −1.09 to −0.39, $p < 0.001$) representing a 28.7% relative reduction. Hospital admissions due to COPD also showed a trend towards reduction but this was not statistically significant (mean number of admissions reduced from 0.35 to 0.17 at 12 months, 50% relative reduction, $p = 0.078$).

Patient surveys (*n* = 24, 32% response from 75) rated the review highly – 83% scored their experience a 4 out of 5 or 5 out of 5 (2 out of 24 and 22 out of 24 respondents respectively), 92% (22 out of 24) trusted clinicians, and 75% noted significant disease management impact – with quotes such as “First time I have been informed fully of COPD.” The top benefits were “how and when to use your rescue pack” and “the role of antibiotics” (19 out of 24 responses each), aligning with self-management gains (“Patient showed a good understanding of antibiotic education”) and physical benefits (“Now joined a gym”).

The toolkit shows promise for COPD management and AMR goals. Recommendations include targeting high-risk and newly diagnosed patients, enhancing training, and adapting delivery via telehealth, home visits, flexible scheduling, digital solutions, and multilingual resources to reach non-attenders, housebound individuals, ethnic minorities, and younger patients, alongside workflow integration with other priorities to increase primary care engagement and maximise impact with patients.

Public Health Wales

The HCAI, AMR and Prescribing (HARP) Programme provides professional support to the NHS to reduce the burden of HCAIs and AMR across Wales. This is delivered through the publication of reports including antimicrobial usage and resistance, and feedback against Welsh Health Circular targets and UK AMR NAP ambitions. The HARP team also provides surveillance data for antimicrobial usage, resistance and HCAI via NHS facing data portals and dashboards.

Finally, HARP supports the Health Boards and Welsh Government by providing technical expertise in microbiology, AMS and Infection Prevention and Control (IPC).

National AMS activities in 2024 to 2025 included the provision of a range of AMS related guidelines including a ‘how-to’ guide for backup prescribing, and penicillin allergy de-labelling guidelines; collaboration with Health Education and Improvement Wales to develop and deliver a range of AMS e-learning modules and webinars; teaching on a range of under and post-graduate courses including pharmacy, public health, specialist IPC training and the specialist infection management course run in collaboration with Swansea University; the annual national Point Prevalence Survey of secondary care antimicrobial prescribing; and bi-annual AMS and IPC national conferences, which this year focused on organisational and individual projects delivering aspects of AMS in support of the UK AMR NAP, and a day focused on the role of behaviour science in delivering good AMS and IPC.

European Antibiotic Awareness Day (EAAD) and WAAW this year built on previous campaigns using a wide range of social media assets and focused on AMS and sustainability. This was delivered through IV to Oral Switch messaging in acute hospitals, and a one-health message in primary care. Nigel Owens, international rugby referee, BBC commentator and Welsh farmer, provided videos, interviews and sound-bites in Welsh and English for our social media channels as well as being interviewed by ITV Wales. Our ‘Light up blue for AMR’ campaign included participation by Welsh government buildings and the National Library for Wales, Welsh veterinary schools and Welsh castles.

For more information on activities, including published reports and guidelines, visit the HARP programme webpage.

Public Health Agency, Northern Ireland

The Northern Ireland AMR implementation plan has provided a renewed focus for the Public Health Agency (PHA) and the Strategic Planning and Performance Group (SPPG) to deliver against the commitments and targets of the UK NAP 2024 to 2029. To support benchmarking and performance improvement a new method was introduced to set targets for MRSA bloodstream infections and *Clostridioides difficile* (CDI). SPPG invested in the development of a primary care dashboard to provide prescribing data to general practice federations and engage local stewardship reporting and activity. This has been enhanced through education sessions on infection management, AMS and TARGET toolkit to Family Practitioner Services (FPS) that is general practice, community pharmacy, dental and optometry. PHA supported continued improvement of trust-specific dashboards to promote AMS activities. In secondary care, work is ongoing to support the roll-out of a single digital healthcare record (Epic/Encompass) including validation of AMC to patient level in all Trusts. WAAW was supported across all health and social care stakeholders and offered an opportunity for widespread engagement with the public and healthcare professionals around AMR. A comprehensive communication plan promoting key messages on AMR, AMS, self-care for a range of common infections and encouraging safe

disposal of antibiotics was delivered through the distribution of AMR promotional materials to FPS and through social media. The re-launch of e-Bug as an educational resource for primary and post-primary schools was welcomed by stakeholders as an opportunity to engage children and young people in preventing AMR.

Scottish One Health Antimicrobial Use and Antimicrobial Resistance

In recognition of the importance of the 'One Health' ethos to the sustainable control of AMR, the SONAAR programme within ARHAI Scotland monitors trends in antimicrobial use and resistance.

The SONAAR annual report contains information on use of antibiotics in humans across primary care and in acute hospitals along with small animal veterinary practices, and the levels of antibiotic resistance found in a range of important human and animal infections. This data is used by organisations such as the Scottish Antimicrobial Prescribing Group (SAPG) to inform antimicrobial prescribing policy and develop initiatives for AMS; Scottish Microbiology and Virology Forum (SMVF) to support the development of testing strategies for NHS diagnostic laboratories in Scotland; and a range of animal stakeholder groups to support development and delivery of a co-ordinated quality-driven approach to veterinary prescribing practice, education and surveillance data.

The SONAAR 2024 report will be published in November 2025 on the NHS National Services Scotland website to coincide with WAAW. For this publication ARHAI Scotland and Public Health Scotland (PHS) will take a co-ordinated approach with ARHAI Scotland providing human antimicrobial use and AMR data and PHS providing animal health data ensuring a continued One Health approach to antimicrobial surveillance and antimicrobial stewardship.

Actions being taken by ESPAUR Oversight Group members to support progress towards commitments and targets within the UK National Action Plan

ESPAUR encourages Oversight Group members to submit their AMR and AMR activities to ESPAUR quarterly. A total of 45 updates from 7 organisations in support of the 2024 to 2029 UK AMR NAP commitments and outcomes have been reported to ESPAUR. Table 8.1 outlines examples of the AMR and AMS activities submitted by ESPAUR OG members that have been collated and individually linked to the 2024 to 2029 UK AMR NAP outcomes and commitments.

Stakeholders have undertaken a range of activities to contribute to the outcomes and commitments of the 2024 to 2029 UK AMR NAP. These include, but are not limited to, undertaking global AMS programme initiatives to promote appropriate use of antimicrobials;

attending international conferences and meetings on AMR for advocacy and to ensure partnership in handling AMR; delivering workshops and professional educational programmes on infection prevention aligned to AMS; producing guidelines and educational resources; publishing evidence-based guidance public and political engagement; promoting pharmacy resources such as the TARGET antibiotics toolkit.

Figure 8.1. Examples of activities undertaken by ESPAUR Oversight Group members to support the UK National Action Plan for AMR 2024 to 2029

Theme: Global partner
Outcome: AMR diplomacy
Commitment: 9.2, Access and stewardship

Undertaking Global Antimicrobial Stewardship Accreditation Scheme to support hospitals globally with quality improvement to develop and potentially become a Centre of Excellence for AMS.

Theme: Optimising the use of antimicrobials
Outcome: AMR workforce
Commitment: 5.1, Health and Social Care training

Delivering professional educational programmes on the prevention of infection, aligned to AMS.

Theme: Optimising the use of antimicrobials
Outcome: Antimicrobial Stewardship and disposal
Commitment: 4.1, Clinical decision support

Collaborating with UKHSA to implement the TARGET antibiotics toolkit to support primary care providers to effectively utilise AMS interventions.

Theme: Global partner
Outcome: AMR diplomacy
Commitment: 9.2, Access and stewardship, 9.5, Advocacy and engagement

Collaborating with international governments and with World Health Organisation SEARO to present the activities and future direction for dental activities to tackle AMR, and support stewardship.

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Table 8.1. Examples of AMR and AMS activities reported by ESPAUR Oversight Group members' organisations to support progress towards the 2024 to 2029 UK National Action Plan

NAP Outcome and Commitment	Organisation	AMR and AMS Activity to support the UK 2024 to 2029 NAP
Theme: Being a good global partner **Outcome**: AMR diplomacy **Commitment**: 9.2, Access and Stewardship	British Society for Antimicrobial Chemotherapy (BSAC)	The BSAC undertakes the programme initiative Global Antimicrobial Stewardship Accreditation Scheme. The scheme invites submissions from hospitals across the world that would like to be accredited via external review of their AMS activities and receive support with quality improvement to develop and potentially become a Centre of Excellence for AMS.
Theme: Being a good global partner **Outcome**: AMR diplomacy **Commitment**: 9.2, Access and Stewardship, 9.5, Advocacy and engagement	College of General Dentistry (CGD)	The CGD collaborated with international governments and with World Health Organisation SEARO to present the activities and future direction for dental activities to help tackle AMR, including preventing dental infections, IPC during dental procedures and stewardship to ensure appropriate antibiotics use.
Theme: Optimising the use of antimicrobials **Outcome**: AMR workforce **Commitment**: 5.3, Health and social care governance	Care Quality Commission (CQC)	The CQC provided training to inspectors from all sectors across Secondary Care, Primary Care, Adult Social Care, Oral Health and Health and Justice, to inform them of the National Action Plan and how to include good AMR practice in their inspections and assessments of services. CQC have updated general antimicrobial online training resources for all staff.
Theme: Optimising the use of antimicrobials **Outcome**: AMR workforce **Commitment**: 5.2, 5.3, Health and social care workforce, health and social care governance	Department of Health and Social Care (DHSC)	The DHSC AMR Programme monitors human health targets, risks and progress towards milestones of the NAP. The DHSC commissioned the Implementation Programme owners to provide an update ahead of the second Human Health Delivery Board to ensure consistency in programme assurance and support earlier identification of risks to delivery.

NAP Outcome and Commitment	Organisation	AMR and AMS Activity to support the UK 2024 to 2029 NAP
Theme: Optimising the use of antimicrobials **Outcome**: Antimicrobial stewardship and disposal. **Commitment**: 4.1, Clinical decision support	Royal College of General Practitioners (RCGP)	The RCGP continue to collaborate with UKHSA to implement the TARGET antibiotics toolkit to support primary care providers to utilise antimicrobial stewardship interventions in their practices.
Theme: Optimising the use of antimicrobials **Outcome**: AMR workforce. **Commitment**: 5.1, Health and social care training	Royal College of Nursing (RCN)	The RCN delivers professional educational programmes on the prevention of infection aligned to AMS and is being reviewed to expand the programmes provision.
Theme: Optimising the use of antimicrobials **Outcome**: AMR workforce **Commitment**: 5.4, Veterinary workforce knowledge and skills	Veterinary Medicines Directorate (VMD)	The VMD held an AMR Research Symposium which highlighted new insights into antimicrobial resistance and antibiotic use in animals. The symposium facilitated the exchange of veterinary knowledge and skills between attendees from government, academia, and vet groups.

Chapter 9. Knowledge mobilisation of ESPAUR report: evaluation of feedback from report users

The annual ESPAUR report and its collation of surveillance and antimicrobial stewardship (AMS) efforts is used widely in the UK. Since its inception, the report has persistently broadened and diversified its content, extending beyond antibiotic resistance, in response to the escalating threat of antimicrobial resistance (AMR) over the past decade. To accompany the annual publication of the ESPAUR report, a webinar is hosted by the UK Health Security Agency (UKHSA) to explore key insights and features of the new report to stakeholders.

Reaching the public, healthcare professionals and industry through media channels is a priority for the UKHSA to raise awareness of the latest AMR and antimicrobial consumption surveillance, research and best stewardship practices. Press coverage reminds people of the scale of the issue, supports behaviour change interventions and ensures the healthcare industry is aware of the latest information on prescribing and disposal that supports a reduction in AMR. Our media-related activity for 2024 to 2025 aligns with the commitments set out in the 2024 to 2029 UK AMR National Action Plan (NAP).

2023 to 2024 webinar survey feedback

Recently, a report was compiled to understand the usage of the ESPAUR report, the professional backgrounds of those who use the ESPAUR report, and to summarise their feedback. The analysis was based on data gathered from a survey completed by attendees of the most recent annual ESPAUR webinar held in 2024 (Figure 9.1). A total of 389 respondents participated in the 2023 to 2024 ESPAUR webinar survey. Descriptive analysis was carried out to summarise responses from report users. Most of the questions and their respective answers were structured in a categorical manner, with some allowing for free text responses. The response rate varied per question, with data analysed for each question out of ‘known’ answers.

The majority of the feedback received from the users of the report was positive, with 92.3% (359 out of 389) in 2023 to 2024 endorsing the ESPAUR report to other stakeholders. The most reported job role of respondents in both surveys was pharmacist, accounting for 33.7% (131 out of 389) of responses, infection prevention and control (IPC) specialist (13.6%, 53 out of 389), and doctor (10.5%, 41 out of 389). This has changed from the 2021 to 2022 and the 2022 to 2023 surveys where the most frequently reported job roles were pharmacist, accounting for 36.8% (137 out of 372) of responses in 2021 to 2022 and 28.6% (116 out of 406) in 2022 to 2023, doctors 14.7% in 2021 to 2022 (55 out of 372), 11.8% in 2022 to 2023 (48 out of 406) and nurses accounting for 12.9% in 2021 to 2022 (48 out of 372), and 18.7% in 2022 to 2023 (76 out of 406).

Infographics, which are used to highlight key messages and statistics in the report, were found to be useful by the majority of respondents (83.9% (219 out of 261)). The 3 most frequently used chapters in the report were the AMR (67.9%, 165 out of 243), AMS (53.9%, 131 out of 243), and antimicrobial consumption (45.3%, 110 out of 243), with some respondents reporting that they accessed 3 or more report chapters (39.9%, 97 out of 243). The most common reasons for accessing the report, were to gather information (18.8% (58 out of 308)), personal learning (10.1% (31 out of 308)), and to share information with others (9.7% (30 out of 308)). The least common reasons for accessing the report were for informing policy (8.8%, 27 out of 308), system working (7.5%, 23 out of 308), for local indicators (7.1%, 22 out of 308), for research (3.2%, 10 out of 308) and for other reasons (1.6%, 5 out of 308). Many respondents (33.1% (102 out of 308)) reported using the report for all of the reasons listed within the survey.

Some free text responses suggested improvements to the report including shortening the report, including an interactive Atlas to show antibiotic consumption via differing geographical levels, and including more information on regional trends data to inform regional action.

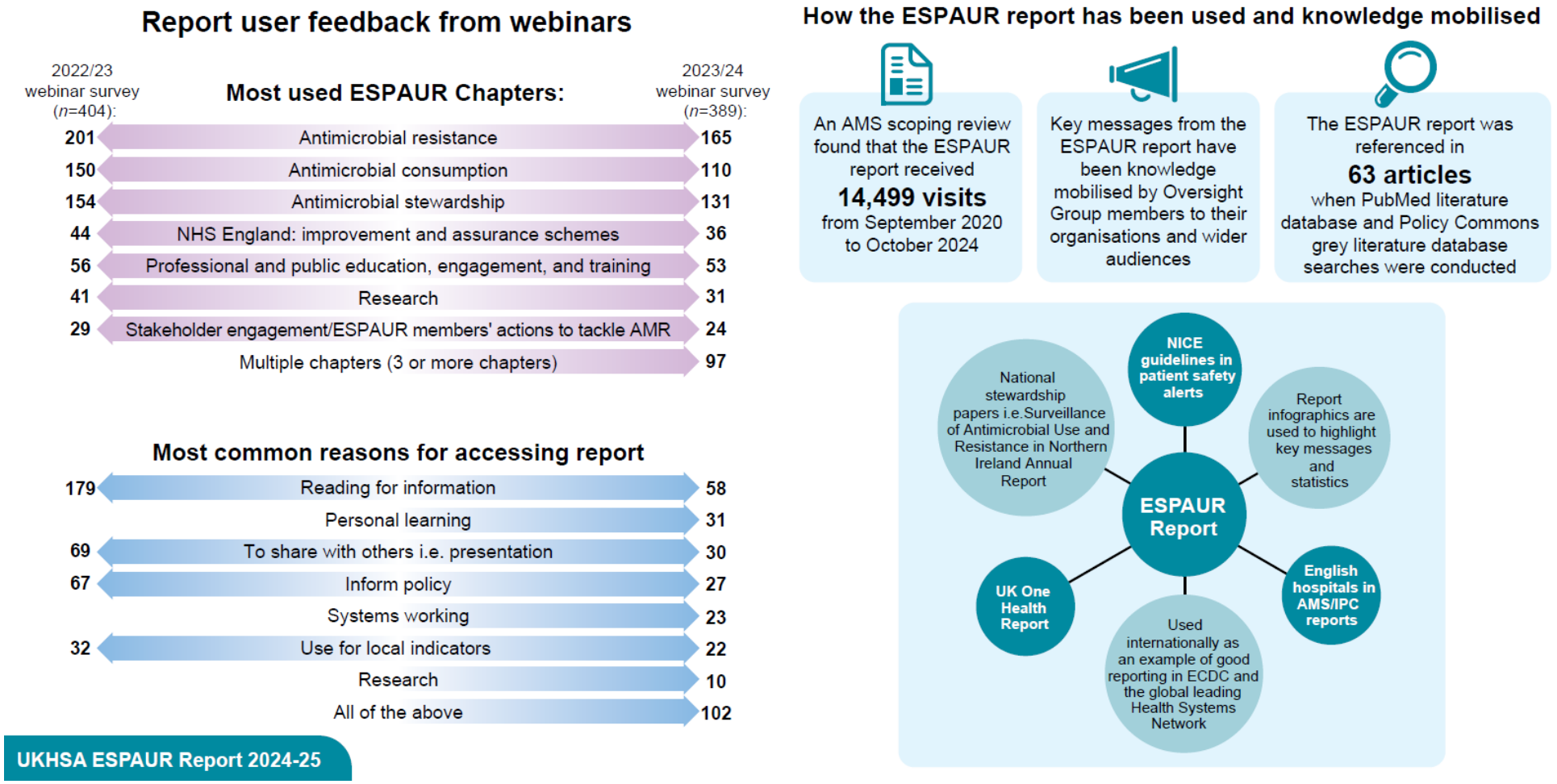
ESPAUR data evaluation

A recent evaluation to determine the extent to which the national AMS tools developed by UKHSA for use in secondary care are being used and implemented, as outlined in the AMS Chapter of this year's report, collected data on the ESPAUR report as part of the first phase scoping review.

This evaluation found that the ESPAUR report had received 14,499 visits to the website from September 2020 to October 2024 (Figure 9.1). Searches on PubMed literature database and the Policy Commons grey literature database found 63 articles referencing the report. These papers showed widespread use of the ESPAUR report in English hospitals, usually through referencing in annual AMS/IPC reports. There is also evidence of wider use across the UK, including references within NICE guidance, in a patient safety alert, and in national stewardship papers, such as the Surveillance of Antimicrobial Use and Resistance in Northern Ireland Annual Report and the UK One Health Report. There is also evidence of impact internationally, including references to the ESPAUR report as an exemplar of reporting in papers from France, New Zealand, the European Centre for Disease Prevention and Control, and the global Leading Health Systems Network.

Additional information about user perceptions of the barriers and facilitators to the use of the ESPAUR report will be collected as part of a survey within phase 2 of the evaluation and is planned to be published as a peer reviewed article.

Figure 9.1. ESPUAR report user feedback from 2023 to 2024 webinar survey and ways which the ESPAUR report has been used



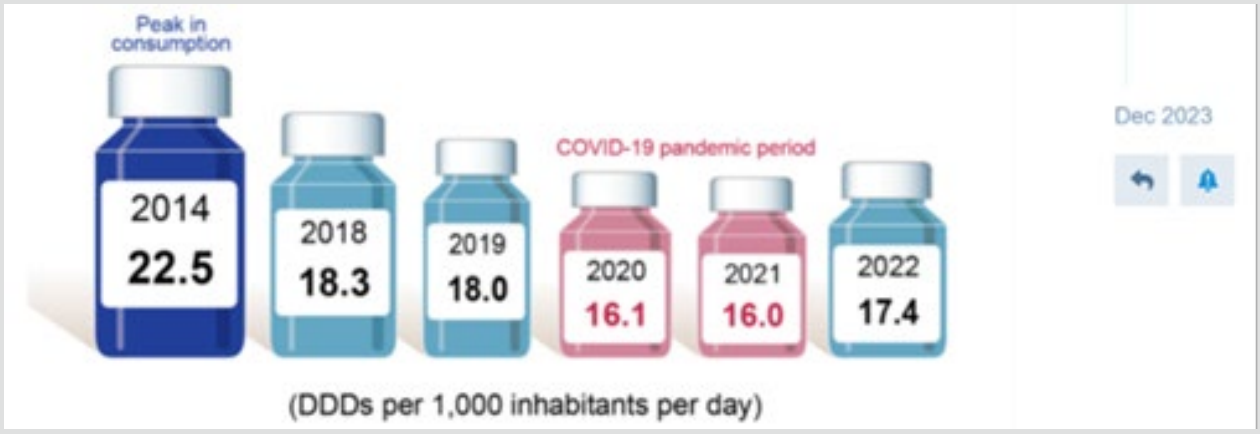
ESPAUR report knowledge mobilisation

ESPAUR Oversight Group members were encouraged to reach out to different audiences to disseminate the key messages from the report and to provide tailored messages for their groups. An example of how the ESPAUR report was knowledge mobilised by an ESPAUR Oversight Group member to the RCGP Special Interest Group (SIG) in response to an Oversight Group action is included below.

Box 9.1 An example of knowledge mobilisation of the ESPAUR report by an ESPAUR Oversight Group member

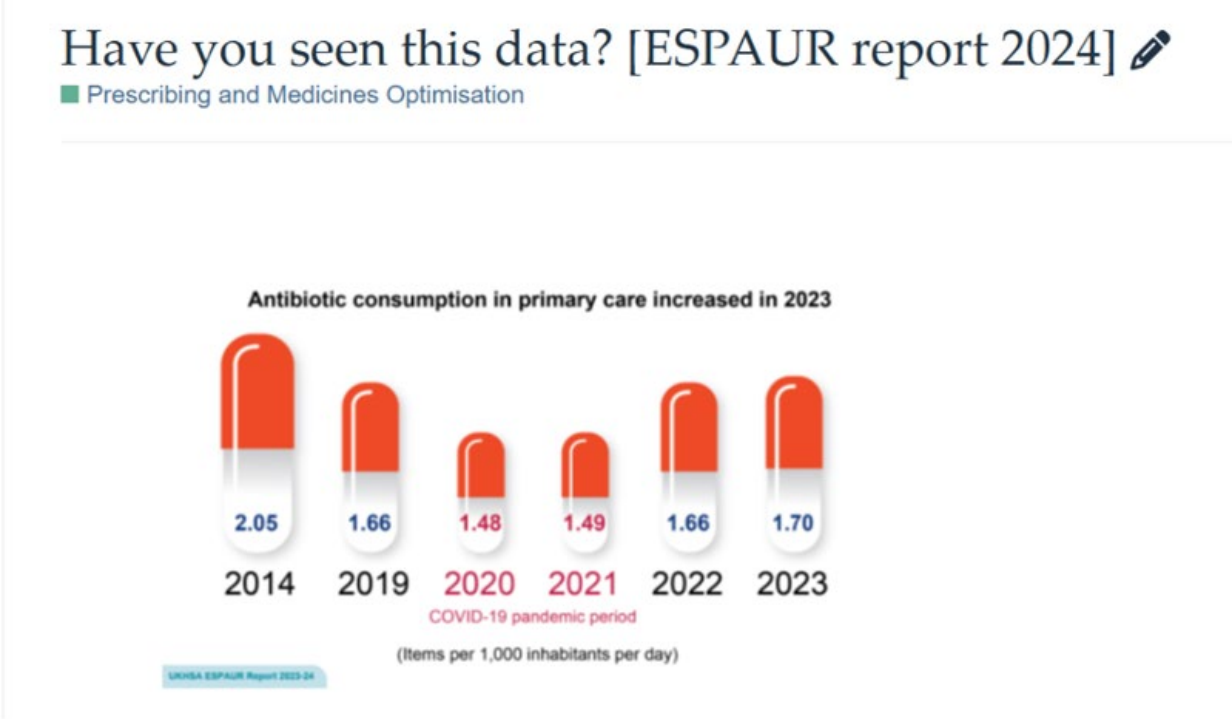
Knowledge Mobilisation of the 2022 to 2023 ESPAUR Report: RCGP Special Interest Group Forum Post:
English surveillance programme for antimicrobial utilisation and resistant (ESPAUR) report 2022 to 23 published today. Covers all thing antimicrobial (prescribing and resistance rates, stewardship activities and national frameworks). Findings include:
Estimated number of deaths due to severe antibiotic-resistant infections was 2.202
6.0% increase in patient episodes of bacteraemia and/or fungaemia in England compared to 2019.
As in previous years, *Escherichia coli* was the most frequently reported cause of monomicrobial bloodstream infections (20.9%) followed by Staphylococcus aureus (7.7%)
[…so UTI management is key].
AMR rates were higher in the most deprived quintile and in Asian or Asian British ethnic groups. A total of 41.4% of *E. coli* bloodstream infections were resistant to co-amoxiclav.

England primary care antibiotic consumption:



This graphic from the ESPAUR report 2023 shows total consumption of antibiotics presented across the 5 years studied, from 2018 to 2022. Consumption has steadily decreased across the years. Vast reductions noted in 2020 (from 18 in 2019 to 16.1 DDDs per 1,000 inhabitants per day in 2020). Data in 2022 showed an increase in trends to 17.4 DDDs per 1,000 inhabitants per day.

ESPAUR report: RCGP Special Interest Group Prescribing and Medicines Optimisation Forum Post 2025



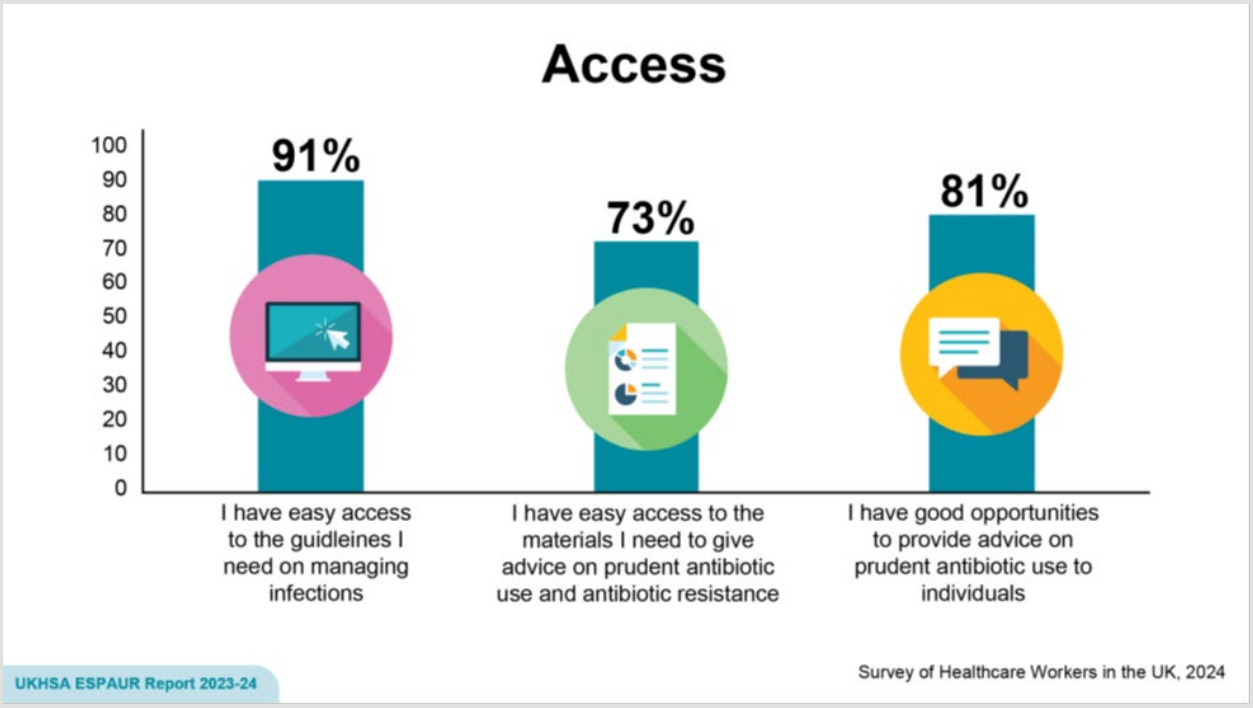
This graphic from the ESPAUR report 2024 shows primary care consumption of antibiotics across the 5 years studied, from 2019 to 2023, measured as items per 1,000 inhabitants per day. Consumption saw a large decline in 2020 and 2021 due to the COVID-19 pandemic. Antibiotic consumption subsequently increased to 2019 levels in 2022 and a further increase in 2023 (1.7 in 2023 compared with 1.66 items per 1,000 inhabitants per day in 2022).

End of accessible text.

1. 2014 to 2019 Antibiotic volumes dispensed had reduced but now total antibiotic prescribing is higher than pre-pandemic level, and CDI levels are rising (back to 2010 to 2011 levels)
2. *E. coli* bloodstream infection resistant to co-amoxiclav remains higher at 42.9% (and 15.8% to third-generation cephalosporins)
3. People in more deprived communities are prescribed considerably more antibiotics than least deprived quintile and that variation is increasing

A slightly more detailed version was shared with the RCGP SIG meeting and discussed:
ESPAUR Report 2023 to 2024
Have people come across this data?
1. CDI levels are rising (back to 2010 to 2011 levels) and total antibiotic prescribing is higher than pre-pandemic levels

2. Healthcare Professionals Knowledge and Attitudes survey
Barriers to providing advice or resources on antimicrobial stewardship: time was reason for 28% of the multidisciplinary group.



This graphic from the ESPAUR report 2024 shows HCPs access to resources identified from a survey of healthcare workers in the UK conducted in 2024. The image contains a bar graph with 3 bars. The left bar shows 91% of HCP agreed or strongly agreed that they have easy access to the guidelines they need on managing infections. The middle bar shows 73% of HCPs agreed or strong agreed that they have easy access to the materials they need to give advice on prudent antibiotic use and antibiotic resistance. The right bar shows 81% of HCPs agreed or strongly agreed that they have good opportunities to provide advice on prudent antibiotic use to individuals.

Use and implications of national surveillance reports for clinicians: reflections from a consultant microbiologist

UKHSA's recently published Infectious diseases impacting England: 2025 report highlights the need for robust surveillance of key infectious conditions to address health inequalities in our nation.

UKHSA already collects and collates a huge amount of data that clinicians can use. However, often there are challenges in sharing local data across different sections within health economies, which can impact on patient management and the ability to effect change. These are most commonly down to inequalities in the systems used to capture and share data:

Electronic patient records

Electronic patient records (EPR) can be useful tools in communicating results and details of medications given during any patient episode. However, there are challenges with using EPR.

Patients within the centres of large conurbations with multiple NHS hospitals (for example inner-city Birmingham, London and so on) will often seek healthcare from more than one of these hospitals. Most EPRs cannot or do not share information with other EPRs which can hinder patient care due to lack of up-to-date information for all healthcare providers.

Not all hospitals have EPR. Not only can this adversely impact the sharing of data with other trusts, but it can also hinder the sharing of data within the hospital itself due to a lack of transparency of data outside of infection departments. Often data must be obtained by interested parties and stakeholders by way of official reporting mechanisms (for example infection prevention and control committees) or for the purposes of audit or service development.

Primary and secondary care may have different electronic record systems. If they are incompatible with regard to data sharing, then primary care clinicians will not see laboratory results and antibiotics administered in secondary care and vice versa. This can lead to adverse outcomes for patients, ranging from the inconvenience of having to have repeat blood tests to suboptimal antibiotic therapy due to a lack of knowledge regarding recent antibiotic therapy and/or antibiotic susceptibility results for cultured bacteria.

Inequalities in data capture and sharing

Inequalities in data capture and sharing can also cause unnecessary extra workload for clinicians if they have to contact other clinicians for example in other trusts or primary or secondary care to obtain the required data. The Royal College of Pathologists' infection sciences workforce report highlighted that there were 20.3% and 14.6% full time equivalent vacancies for consultant level posts in medical microbiology and medical virology respectively (153). Likewise, the Royal College of General Practitioners' 2024 workforce survey showed that 6 out of 10 job-seeking GPs were struggling to find vacant posts (154). This is on a background of an increasing inability of patients to get appointments due to the workload placed on those GPs in posts. Improving data sharing could reduce excess workload on already overloaded clinicians.

Mandatory healthcare surveillance reporting systems

Mandatory healthcare surveillance reporting systems, such as those utilised by infection prevention and control and for notification of infectious diseases, also adds to clinicians' workloads. Often the required information must be obtained from more than one speciality.

Differential ability of individuals to access and share their own health record

Disparities in digital access for patients could also be exacerbated by differential ability of individuals to access and share their own health record.

UKHSA’s report clearly highlights the infections where healthcare inequalities exist, for example in deprived areas and in some ethnic minority groups. The challenge for clinicians in primary and secondary care is to address these on a background of funding and workforce constraints as well as a lack of data transparency within their local healthcare economies.

There is no easy solution to this problem; having one common EPR across all healthcare providers requires funding and a robust IT infrastructure that will need to be maintained. In addition, communication and teamworking between primary and secondary care needs to be strengthened, with the support of the Integrated Care Boards (ICBs). However, how we collect, collate and share data between NHS healthcare providers and institutions does need to be urgently reviewed if we are committed to addressing healthcare inequalities due to infection within the UK.

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Chapter 2. Antimicrobial resistance

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Chapter 3. Antimicrobial consumption

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Chapter 4. Antimicrobial stewardship

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Chapter 5. NHS England: improvement and assurance schemes

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Chapter 8. ESPAUR oversight group members' activities and actions to tackle AMR – mapping to the National Action Plan

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Chapter 9. Knowledge mobilisation of ESPAUR report: evaluation of feedback from report users

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About the UK Health Security Agency

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