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English surveillance programme for antimicrobial utilisation and resistance (ESPAUR)

Report 2022 to 2023

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This report is accompanied by an Annexe, infographics, data appendices in the form of spreadsheets, and downloadable slidedecks of the graphs. These can be all accessed from [the ESPAUR web page](#).

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Executive summary

In 2022, with the lifting of pandemic mitigations and the return to pre-pandemic levels of health activity, there were substantial increases in rates of priority pathogens and antibiotic use.

From 2018 to 2022, there was a 11.7% increase in patient episodes of bloodstream infections (BSIs) and/or fungaemia in England. However, over this period, the estimated overall burden of antimicrobial resistance (AMR) infections decreased by 1.6% and priority pathogen AMR BSIs decreased by 4.6%.

The AMR burden in BSI varied markedly across regions in England with the rate of resistant BSIs almost double in the highest (London) compared to the lowest (South West) region.

For *Escherichia coli* and *Klebsiella pneumoniae* causing BSI, there were significant increases in the percentage resistance to piperacillin/tazobactam between 2018 and 2022. Carbapenem resistant Enterobacteriaceae BSI remained low and stable; in 2022, 152 carbapenemase producing Gram-negative sterile site infections were formally notified to UKHSA.

In 2022, the overall crude case fatality rate for 30-day all-cause mortality in patients with priority Gram-negative bacterial BSI was 16.9% with a higher all cause crude case fatality rate for antibiotic resistant BSI (19.1%) compared to those with antibiotic susceptible BSI (16.2%).

While the highest number of BSIs were detected in White ethnic groups; the proportion that were antibiotic resistant was almost double in Asian or Asian British ethnic groups (34.6%) compared to white ethnic groups (18.7%).

From 2018 to 2022, the incidence of candidaemia increased by 22.7% with *Candida albicans* the most frequently isolated at 40%.

Total antibiotic consumption declined by 5.3% between 2018 and 2022, from 18.3 Daily Defined Dose (DDD) per 1,000 inhabitants per day (DID) to 17.4 DID. However, total antibiotic consumption in 2022 increased by 8.4% compared with 2021; this was the first increase since 2014. In 2022, consumption increased in all healthcare settings (general practice, other community settings, hospital inpatient and hospital outpatient) except dental practices (-7.4% compared with 2021) where a sharp rise in antibiotic use occurred between 2019 and 2020.

In 2022, antibiotic prescribing continued to be highest in general practice (80.2%). General practice penicillin prescribing increased by 22.7% between 2021 and 2022; this was associated with higher than usual circulating viral and bacterial infections and an unusual out of season increase in invasive group A streptococcal (GAS) infections and scarlet fever.

Antibiotic use in secondary care, although increased in the past year, remained below 2018 levels. Reductions across the five years have been driven by reductions in outpatient prescribing (-11.8%). Usage per admission of all antibiotic groups decreased between 2018 and

2022, except for anti-*Clostridioides difficile* agents which increased by 70.2%. There was a decline in use of 'Access', 'Watch' and 'Reserve' antibiotics in NHS acute trusts between 2020 and 2021 (-9.8%, -11.1% and -9.9% respectively, in DDDs per 1,000 admissions), with a subsequent increase in 'Access' and 'Watch' rates from 2021 to 2022 (+5.1% and +3.6%, respectively).

Between 2021 and 2022, total antifungal consumption increased to 1.13 Daily Defined Dose (DDDs) per 1,000 population per day, however it remains lower than 2018 by 11.0%.

Primary care antibiotic prescribing remained impacted by the COVID-19 pandemic in 2022. By the end of the 2022 to 2023 financial year¹, 17% of Integrated Care Systems had met the National Action Plan target for reducing total antimicrobial prescribing in primary care. In secondary care, 29% of NHS acute trusts had met the 2022/2023 NHS Standard Contract target to reduce 'Watch' and 'Reserve' antibiotic consumption (as adapted for stewardship in England) by 4.5% from a 2018 calendar year baseline.

As in previous years, the Treat Antibiotics Responsibly, Guidance, Education and Tools (TARGET) website saw the number of views almost double in November 2022 compared to the previous month, coinciding with the TARGET promotional campaign and World Antimicrobial Awareness Week. The significant increase in visits to the TARGET website post campaign highlights the importance of reminding and raising awareness of AMS to health care professionals at certain time points. An example of this would be raising awareness of AMS tools and resources available to primary care clinicians on RTIs before the winter.

The TARGET urinary tract infection (UTI) and respiratory tract infection (RTI) leaflets for the community pharmacy setting were included as part of the 2022 to 2023 Community Pharmacy Quality Scheme (PQS). Data was submitted by more than 8,000 community pharmacies, for 104,142 and 115,094 patients presenting with UTI and RTI symptoms respectively.

During 2022, 13,915 people chose to make an Antibiotic Guardian pledge to help keep antibiotics working.

e-Bug redeveloped the public-facing website to meet web content accessibility guidelines (WCAG) levels, to ensure users with disabilities and/or using assistive technologies can access the content without barriers.

A wide range of new and ongoing research projects were undertaken in the field of healthcare-associated infections (HCAI) and AMR in the last year covering many of the major themes of the UK National Action Plan (NAP) for AMR, including stronger laboratory capacity and surveillance in AMR, human infection prevention and control, and optimal use of antimicrobials. The full set of infographics visualising the main findings from the report is available on the [ESPAUR report web page](#).

¹ Data presented for NHS Quality improvement programmes and Community Pharmacy Quality Scheme (PQS) is by financial year

Chapter 1. Introduction

The 2023 English Surveillance Programme for Antimicrobial Use and Resistance (ESPAUR) report marks a decade of this initiative. ESPAUR continues to measure the consequences of policy and guidance interventions through cohesive surveillance via external stakeholders on antimicrobial consumption, resistance and stewardship across the healthcare economy at a local, regional and national level.

With easing of restrictions and a return to pre-(COVID-19) pandemic levels of health activity, there has been a rebound in community onset infections. Resurgence of antibiotic resistant infection cases emphasises the value of data collated and analysed by ESPAUR in highlighting trends, improving patient safety, clinical practice and progressing towards the UK's 5-year antimicrobial resistance (AMR) National Action Plan (NAP). It is also able to demonstrate the impact of health shocks on AMR and the continued focus that is required for this silent pandemic.

Chapter 2 presents the burden of infection and antibiotic resistant infections in England, with detail on priority pathogens. This year's report also highlights data on AMR burden and carbapenemase producing Gram-negative bacteria in ethnicity and indices of multiple deprivation. In addition, this chapter presents data on infections detected in vulnerable migrants including the increased number of confirmed cases toxigenic *Corynebacterium diphtheriae* among migrants (predominantly cutaneous diphtheria) including multi-drug resistant strains and other recognised skin pathogens including MRSA and GAS.

Chapter 3 highlights the trends in antimicrobial consumption, demonstrating the progress on reducing antibiotic use overall over the last 5 years and the rebound antibiotic use with increased community infections with the easing of social restrictions. This chapter continues to extend the surveillance of antimicrobial consumption to highlight work on antivirals and antifungals.

UKHSA has made progress over recent years to report on factors associated with health inequalities within routine reporting on antimicrobial use and antimicrobial resistance. Data on protected characteristics, such as age and sex, socio-economic status, such as index of multiple deprivation, ethnicity, geographical differences and people in adult social care are currently included within routine reporting in both Chapter 2 and 3 where it is available. However, there remain large gaps in our knowledge of how infection incidence, AMR and antibiotic use differ between populations. These associations are essential to understand to target interventions towards reducing health inequalities in AMR, falling within UKHSA's commitment to deliver more equitable health outcomes.

Chapter 4 outlines the promotion and championing of antimicrobial stewardship (AMS) interventions by UKHSA including the extensive work for primary care with the TARGET

antibiotics toolkit and in secondary care the thematic reviews and updates of the Smart then Focus AMS toolkit.

NHS England designs and administers improvement and assurance schemes promoting prudent use of antimicrobials, to optimise patient outcomes, minimise avoidable exposure to antimicrobials and reduce selection pressure for antimicrobial resistance (AMR). This year the included schemes have been the NHS Oversight Framework for Integrated Care Boards (ICBs), the Pharmacy Quality Scheme (PQS) for community pharmacy, the NHS Standard Contract for acute hospital Trusts and the Commissioning for Quality and Innovation (CQUIN) framework for acute hospital Trusts. Chapter 5 reports on these initiatives.

Chapter 6 highlights public and professional activity with Antibiotic Guardian, activities for World Antibiotic Awareness Week and the e-Bug website for children and educators/

Finally chapter 7, focuses on the work from the two National Institute for Health Research-funded Health Protection Research Units in HCAI and AMR (with University of Oxford and Imperial College London) which continue to produce a wealth of translational research aiming to impact public health practice and policy.

Looking ahead, prioritisation exercises within UKHSA have identified 7 priority areas for our work on AMR: burden estimates, drivers and epidemiology; pathogen characterisation; infection prevention and control; optimisation of antimicrobial use; diagnostics; vaccines and development of antimicrobials and therapeutics. We will continue to work with multi-disciplinary and across international, national, regional and local networks from pharmacological, epidemiological, clinical, behavioural, health economic and microbiological disciplines.

The ESPAUR initiative and progress towards the goals of the AMR NAP would not be possible without the effective collaboration and contributions from the ESPAUR oversight group and broad range of stakeholder organisations. We wish to thank them for their contributions highlighted in the report and congratulate their achievements.

Chapter 2. Antimicrobial resistance (AMR)

Summary

In 2022, with the lifting of pandemic mitigations, and the return to pre-pandemic levels of health care activity, there were rebound increases of infections caused by pathogens including community-onset *Escherichia coli* bloodstream infections (BSIs), *Streptococcus pneumoniae* BSI, invasive group A *Streptococcus*, scarlet fever and *Candida auris* infections.

Total bacteraemia or fungaemia reported

In 2022, there was a 6.0% increase in patient episodes of bacteraemia and/or fungaemia in England compared to 2019.

In 2022, as in previous years, *E. coli* was the most frequently reported cause of monomicrobial BSI (20.9%) followed by *Staphylococcus aureus* (7.7%) with rates of 67.9 and 24.2 per 100,000 population, respectively.

AMR burden

The overall burden of resistance, estimated by the total number of BSI pathogens resistant to one or more critically important antibiotics, decreased by 4.6% between 2018 and 2022, with the largest reduction of 13.3% observed at the start of the pandemic between 2019 and 2020; this reduction was predominantly driven by reductions in the number of *E. coli* BSI.

The AMR burden was highest in London (39.2 per 100,000 population in London) and lowest in the South West (22.8 per 100,000). The highest rate of AMR burden defined BSI pathogens was recorded in the North East (183.8 per 100,000).

Older adults (aged over 64 years) had the highest rate of BSIs caused by resistant pathogens (157.0 per 100,000 in people for over 74 years old and 64.2 per 100,000 for 64 to 74 years old respectively), followed by children aged under one year old (46.5 per 100,000).

Patients infected with a strain resistant to one or more AMR burden-defined antibiotics in 2022 had a higher crude 30-day all-cause case fatality rate (19.1%, n=2,023) compared to those with a susceptible strain (16.2%, n=6,051; p<0.05).

National Action Plan (NAP) ambition

In England, between 2018 and 2022, there was a 1.6% reduction in the total number of antibiotic-resistant infections in England against the ambition of the UK NAP to reduce this by 10% by 2025.

In 2022, the estimated number of deaths due to severe antibiotic-resistant infections was 2,202

Additions to this year's chapter

Ethnicity and indices of multiple deprivation (IMD) data have been included in analyses of both the burden of AMR and the reported number of detected carbapenemase-producing Gram-negative bacteria:

- Ethnicity: the highest rate of carbapenemase-producing Gram-negative bacteria were noted in the Asian or Asian British ethnic group; however, the largest burden in terms of the number of reported carbapenemase-producing Gram-negative bacteria was highest in the white ethnic group, which is related to the population size in each group
- Index of Multiple Deprivation: AMR burden was highest in the most deprived quintile (33.0 per 100,000 population) and lowest in the least deprived quintile (23.4 per 100,000); most deprived populations demonstrated the highest percentage of resistant BSIs at 20.2%; this trend was mirrored in the carbapenemase-producing Gram-negative bacteria (7.2 compared to 3.6 per 100,000) for all reports including invasive and screening samples

New parasitic resistance section focused on antimalarial resistance: the emergence of lumefantrine resistance with the recently described increase in pfk13 variants, poses a threat to therapeutic management of falciparum malaria.

Introduction to Chapter 2

This chapter presents findings from antimicrobial resistance (AMR) surveillance undertaken by the UK Health Security Agency (UKHSA). It reports trends in resistance for the important bacteria or antibiotic combinations recommended for surveillance by the Advisory Committee on Antimicrobial Prescribing, Resistance and Healthcare-Associated Infections (APRHAI) (1), as well as resistance related to fungal infections, sexually transmitted infections (STIs), *Mycobacterium tuberculosis* infections and parasitic infections.

The estimated burden of AMR in England was calculated to monitor progress against the UK Government's National Action Plan (NAP) target of reducing antimicrobial-resistant infections (ARIs) in England by 10% by 2025 (2). The primary data source used was the UKHSA's Second Generation Surveillance System (SGSS, described further in the [data tables for chapter 2](#) (3, 4). Data on ARIs for the period 2018 to 2022 are 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 reviews of key pathogens (defined either as priority organisms for monitoring the effectiveness of AMR strategies, or organisms showing notable changes in epidemiology), stratified by patient age group, biological sex, regional location within England, 30-day all-cause case fatality rate (2022 data only), deprivation index, and ethnicity, are presented within the chapter or its appendices.

AMR Burden is a calculated methodology. The total number of resistant infections is generated by calculating the proportion of each pathogen (*E. coli*, *Klebsiella pneumoniae*, *Klebsiella oxytoca*, *Acinetobacter spp.*, *Pseudomonas spp.*, *Enterococcus spp.*, *S. aureus* and *S. pneumoniae*) that were reported as resistant to one or more specific antibiotics. Please see the [Annexe](#) Table 2.3 for further details.

The 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.

Trends in incidence of priority pathogens causing bloodstream infection

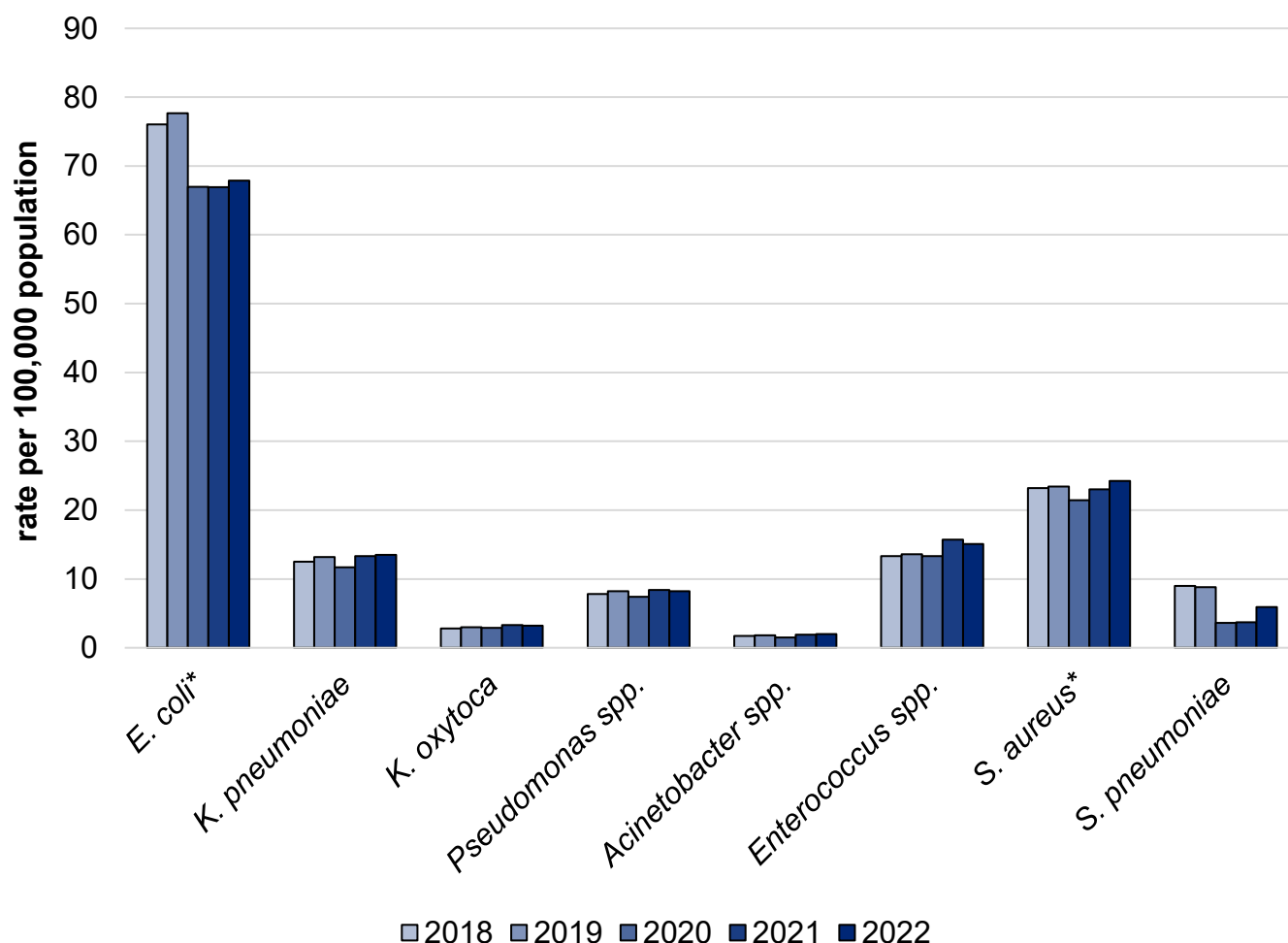
In 2022, there were 163,513 patient episodes of bacteraemia and/or fungaemia (bacteria or fungi isolated from blood) identified through reports received from laboratories in England (see [accompanying data tables](#)); this is a 6.0% increase compared to 2019 (n=154,269) and an 11.7% increase compared to 2018 (n=146,372 episodes); in 2022, 88.4% (n=144,620) episodes were monomicrobial (a single pathogen isolated from blood).

Similar to previous reports (4, 5), the organisms most frequently isolated from monomicrobial bacteraemias were coagulase-negative staphylococci (CoNS; 30.6%), *Escherichia coli* (20.9%)

and *Staphylococcus aureus* (7.7%). Among the 11.6% (n=18,893) of episodes that were polymicrobial (more than one bacterial or fungal species isolated from blood), the most frequently identified organisms were CoNS (15.9%), *E. coli* (13.5%), and unspciated Gram-negative organisms (coliforms; 5.0%). Interpretation of the above data is, however, nuanced as CoNS are common skin commensals and isolation in the blood frequently represents contamination only. Defining significance requires correlation with clinical history, which are not present in routine linked data. For more information on species identified from bloodstream infections (BSIs), refer to the [data and figures appendices](#) for chapter 2.

For many important pathogens (*Acinetobacter* spp., *Enterococcus* spp., *Klebsiella* spp., *Pseudomonas* spp., and *S. aureus*), the incidence of BSI was constant or showed marginal increases between 2018 and 2022 (Figure 2.1). In contrast, the incidence of *E. coli* and *Streptococcus pneumoniae* BSI decreased over this time frame, predominantly in 2020 and 2021, coinciding with the COVID-19 pandemic peak and mainly driven by decreases in community-onset bacteraemias. Although the incidence of BSIs due to these 2 pathogens increased in 2022, they did not reach pre-pandemic levels. More detail on the trends in incidence for *E. coli*, *S. aureus*, *K. pneumoniae* and *Pseudomonas aeruginosa* BSI are available in the [annual epidemiological commentary](#) for these pathogens for which there is national mandatory reporting.

Figure 2.1 Annual incidence rate of key pathogen BSI, per 100,000 population, England 2018 to 2022



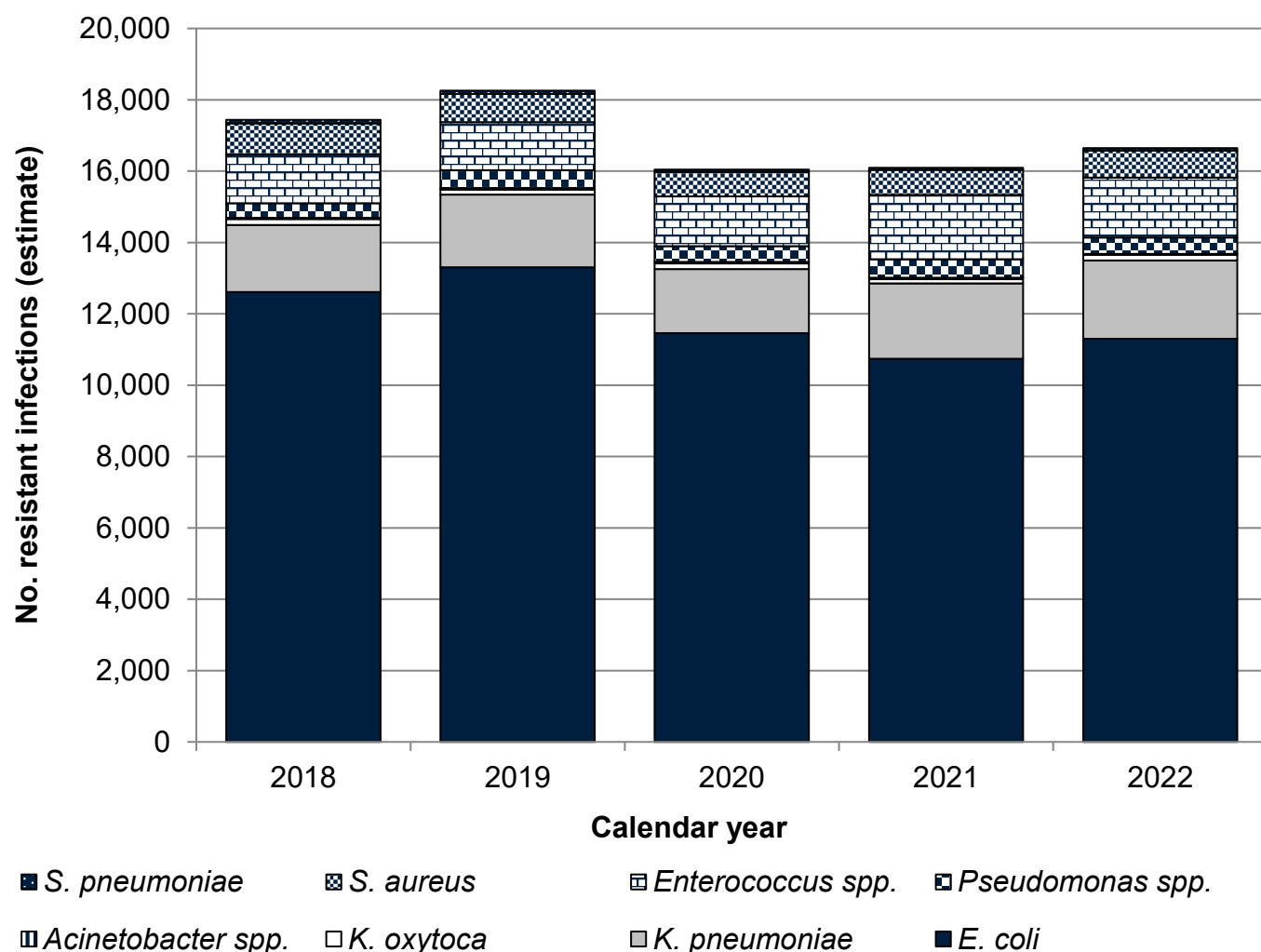
Note in this graph, the asterisk denotes that incidence data for *E. coli* and *S. aureus* incidence are based on mandatory surveillance data, while reporting of the other pathogens is voluntary.

Antibacterial resistance

AMR burden

The burden of resistance, estimated by the total number of priority BSI pathogens resistant to one or more key antibiotics, decreased by 4.6% between 2018 (n=17,437) and 2022 (n=16,643; Figure 2.2). The methodology for this chapter section can be found in [the accompanying Annexe](#).

Figure 2.2 Annual estimated total of the burden of antibiotic-resistant bloodstream episodes, England 2018 to 2022



E. coli dominated the burden of antibiotic-resistant BSIs, comprising 82.0% of the total number of resistant infections in 2022 (with the peak in 2019 at 84.8%), compared to 2.9% for non-fermenting Gram-negative (*Acinetobacter spp.* and *Pseudomonas spp.*) antibiotic-resistant BSI. The burden of resistant BSIs due to common Gram-positive pathogens (*S. pneumoniae*, *S. aureus* and *Enterococcus spp.*) remained relatively unchanged at 15.1% in 2022. Further detail is available in the [data tables accompanying this report](#).

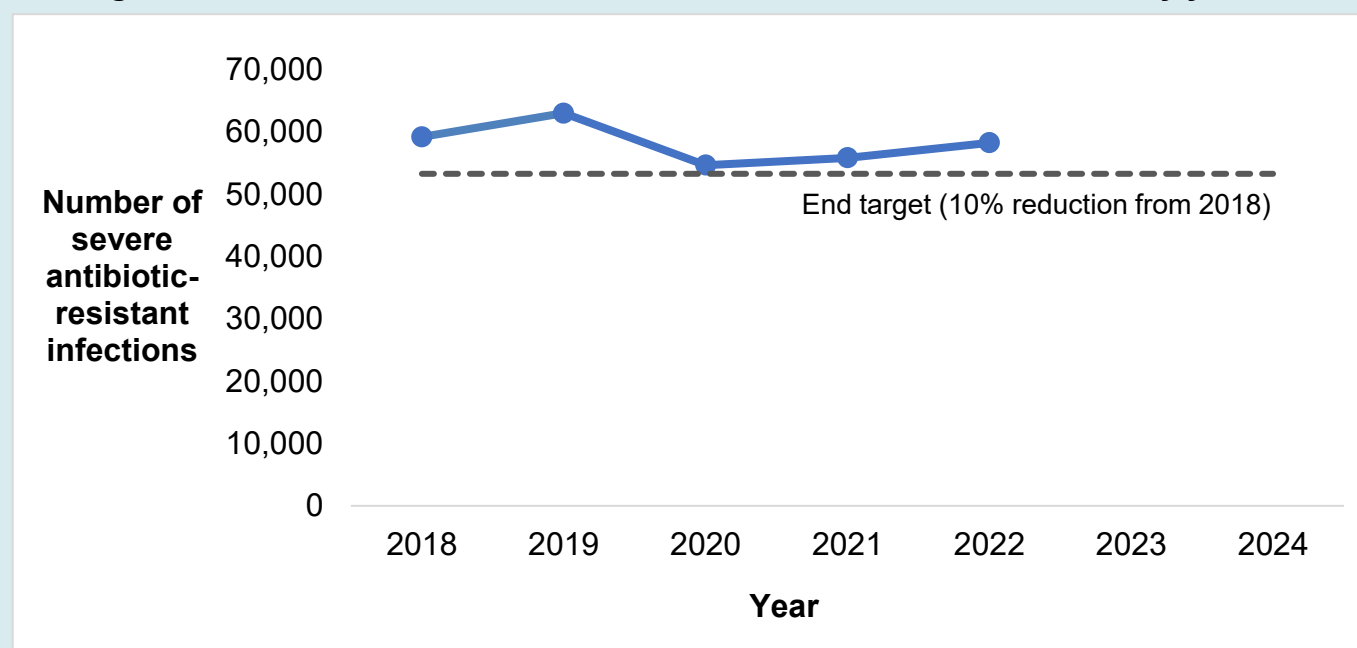


2.1 How is England performing against the 2019 to 2024 National Action Plan (NAP)?

In November 2018, the European Centre for Disease Prevention and Control (ECDC) published a methodology for estimating incidence and attributable deaths due to severe antibiotic-resistant bacterial infections (6). This method calculated a ratio relating the number of antibiotic-resistant BSIs to the number of antibiotic-resistant surgical site infections (SSI), antibiotic-resistant urinary tract infections (UTIs) and antibiotic-resistant respiratory infections, using point prevalence survey data alongside BSI incidence data reported through ECDC surveillance schemes. A corresponding estimate of mortality is also calculated. Details on the derivation of the ratios are available in the ECDC publication (6).

The UK NAP ambition for AMR is to reduce the (estimated) total number of antibiotic-resistant infections in the UK by 10% from the 2018 baseline by 2025 (2). The method of estimation used to monitor resistance is derived from the ECDC method described above. In England, a 1.6% reduction was recorded between 2018 and 2022 (from 59,162 to 58,224; Box Figure 2.1). An initial increase occurred between 2018 and 2019 with a 13.3% observed decline between 2019 and 2020, primarily reflecting a decrease in *E. coli* cases, which has since increased by 6.6% between 2020 and 2022 but remains below pre-pandemic peak (7).

Box Figure 2.1. Estimated number of severe antibiotic resistant infections by year

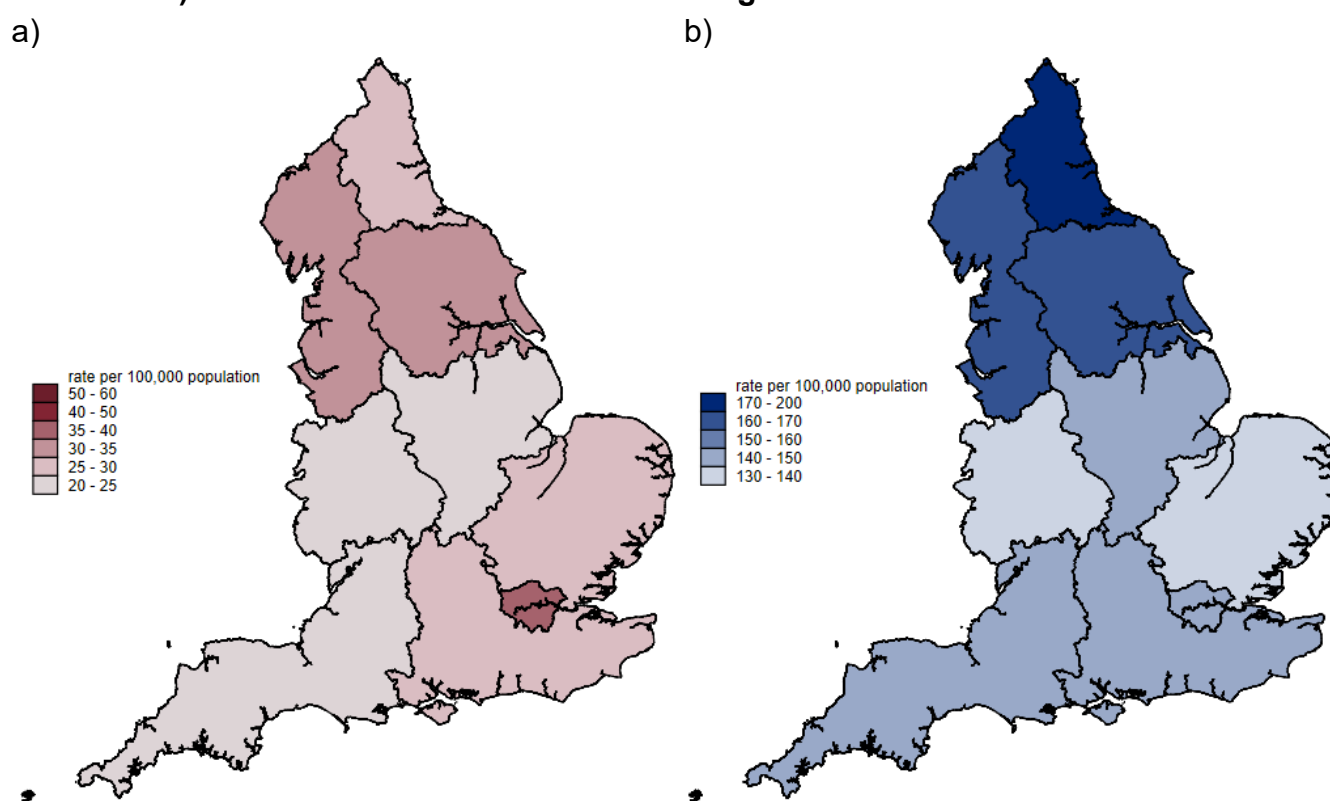


The corresponding estimated number of deaths due to severe antibiotic-resistant infections in 2022 (n=2,202) was lower than the 2019 estimate (n=2,382) but has increased from the COVID-19 pandemic nadir in 2020 (n=2,066). As AMR estimates are dependent on the number of BSIs, trend analysis should be caveated by the overall reduction in incidence seen during the COVID-19 pandemic, potentially due to a change in case mix and hospital admissions (4).

Regional variation in the burden of AMR in BSIs and the incidence of selected AMR Burden pathogens is shown in [Figure 2.3](#). The London region reported the highest AMR burden rate per 100,000 population (39.2) followed by the North West (32.9 per 100,000 population) and Yorkshire and Humber (30.2 per 100,000 population). It should be noted that these rates are lower than those reported in last year's ESPAUR report due to a methodological adjustment (please see [the accompanying Annexe](#)). The lowest AMR burden rate (from BSI) was recorded in the South West (22.8 per 100,000 population).

As shown in Figure 2.3, the burden of AMR and incidence of selected pathogens causing BSI do not always correspond at regional level. Whilst the North East had the highest incidence rate of selected BSI pathogens (183.8 per 100,000 population), the resistance rate (25 to 30 per 100,000 population) was lower than that seen in many other regions. Similarly, London which had the highest burden (rate) of resistance had a relatively low incidence of selected BSI pathogens (140 to 150 per 100,000).

Figure 2.3 Regional variation in rate per 100,000 population of a) the estimated burden of AMR and b) the estimated numbers of BSI in England in 2022



Since 2022, variation in AMR burden from BSIs has been reported by ethnic group ([Table 2.1](#)). The highest number and rate per 100,000 population of BSI episodes (as per AMR burden combinations described in [the Annexe accompanying this report](#)) was recorded in people in a white ethnic group (83.6% of priority BSI episodes; n=68,983) in 2022, of which 18.7% were recorded as resistant to at least one selected antibiotic. The highest percentage resistant was noted in the Asian or Asian British ethnic group (34.6%; n=1,450).

Table 2.1. AMR burden from BSI by ethnic group in England in 2022*

Ethnic group	Rate of BSI per 100,000 ethnic population (n)	Rate resistant per 100,000 ethnic population (n)	Percent resistant (95% confidence intervals)
White	150.7 (68,983)	28.1 (12,870)	18.7% (18.4 to 18.9)
Asian or Asian British	77.1 (4,185)	26.7 (1,450)	34.6% (33.2 to 36.1)
Black, African, Caribbean or black British	94.0 (2,240)	24.0 (570)	25.5% (23.7 to 27.3)
Mixed or multiple ethnic groups	33.4 (558)	6.4 (107)	19.2% (16.0 to 22.5)
Any other ethnic group	25.3 (311)	4.7 (58)	18.7% (14.3 to 23.0)
Not known or Not stated	N/A (1,262)	N/A (190)	15.0% (13.1 to 17.0)

* 4,982 (6.0%) BSI episodes could not be linked to obtain ethnic group information. The percentage resistant in this group was 18.3% (n=911).

In 2022, the AMR burden from BSI differed according to indices of multiple deprivation (IMD), measured by quintile (where 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) ([Table 2.2](#)).

Both the number and rate of resistant BSI, as well as the percentage resistant were significantly higher in the first quintile (most deprived; 33.0 per 100,000, n=3,729; 20.2% resistant) compared to the fifth quintile (least deprived; 23.4 per 100,000, n=2,567; 18.6% resistant) ($p<0.005$).

Table 2.2. AMR burden from BSI by IMD quintile in England in 2022

IMD quintile	Rate of BSI per 100,000 population (n)	Rate resistant per 100,000 population (n)	Percent resistant (95% confidence intervals)
1 (most deprived)	163.3 (18,455)	33.0 (3,729)	20.2% (19.6 to 20.8)
2	146.8 (17,078)	29.2 (3,397)	19.9% (19.3 to 20.5)
3	142.8 (16,399)	28.6 (3,288)	20.0% (19.4 to 20.7)
4	135.0 (15,090)	25.5 (2,846)	18.9% (18.2 to 19.5)
5 (least deprived)	125.9 (13,793)	23.4 (2,567)	18.6% (18.0 to 19.3)

The AMR burden from BSI differed according to age group in 2022 ([Table 2.3](#)). The number and rate of BSIs caused by the AMR Burden pathogens (767.6 per 100,000, n=37,624) was highest in the oldest age group (over 74 years), with the youngest age group (less than one year) having the second highest rate (300.7 per 100,000 population, n=1,742). The number and rate of BSIs was lowest in 10 to 14 year-olds (11.1 per 100,000, n=381). The number and rate of

resistant BSIs was also highest in the >74 year-olds (157.0 per 100,000, n=7,693), with the second highest rate being in those aged 65 to 74 years old (64.2 per 100,000, n=3,574). The lowest rate of resistant BSI was in the 5 to 9 year-old age group (4.8 per 100,000). The 65 to 74 year-old age group had the highest percentage resistant BSI (21.6%), and the 1 to 4 year-olds had the lowest (12.8%).

Table 2.3. AMR burden from BSI by age group in England in 2022

Age group (years)	Rate of priority BSI per 100,000 population (n)	Rate resistant per 100,000 population (n)	Percent resistant (95% confidence intervals)
Under 1	300.7 (1,742)	46.5 (269)	15.5% (13.8 to 17.2)
1 to 4	37.4 (928)	4.8 (119)	12.8% (10.6 to 14.9)
5 to 9	16.0 (536)	2.4 (80)	15.0% (11.9 to 18.0)
10 to 14	11.1 (381)	1.8 (60)	15.9% (12.2 to 19.5)
15 to 44	35.8 (7,755)	6.4 (1,382)	17.8% (17.0 to 18.7)
45 to 64	120.3 (17,541)	23.2 (3,377)	19.2% (18.7 to 19.8)
65 to 74	297.2 (16,543)	64.2 (3,574)	21.6% (21.0 to 22.2)
Over 74	767.6 (37,624)	157.0 (7,693)	20.4% (20.0 to 20.9)
Unknown	N/A (43)	N/A (22)	52.9% (37.9 to 67.9)

Gram-negative bacterial infections

Main messages

In 2022, the proportion of *E. coli* from blood resistant infections remains to most first-line agents remained above 10%. In particular, 41.4% of isolates were resistant to co-amoxiclav, hence its role in empirical sepsis regimens requires careful consideration.

Significant increases in resistance to third-generation cephalosporins (17.4%) and to piperacillin/tazobactam (19.6%) were detected in *K. pneumoniae* causing BSI between 2018 and 2022 ($p < 0.05$).

Resistance of *Pseudomonas* spp. causing BSIs to most clinically-relevant antibiotics remained stable since 2018.

Patients infected with a strain resistant to one or more AMR burden-defined antibiotics had a statistically significant ($p < 0.05$) higher crude case fatality rate (19.1%, n=2,023) compared to those with a susceptible strain (16.2%, n=6,051).

Data presented in this section focuses on the most commonly isolated Gram-negative bacterial pathogens and their phenotypic susceptibility. 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 bacteria is presented later in the chapter.

Resistance trends in BSIs

Between 2018 and 2022 *E. coli* resistance to third-generation cephalosporins and gentamicin remained relatively static at 14.5% and 10.5%, respectively. Significant rises ($p<0.05$) in resistance to piperacillin/tazobactam and amikacin (from 9.0% to 10.5% and from 0.9% to 2.4% respectively), and a significant decrease ($p<0.05$) in resistance to ciprofloxacin and co-amoxiclav (from 19.7% to 17.9%, and 43.4% to 41.4%, respectively) were also detected in *E. coli* BSI. Carbapenem resistance in *E. coli* BSI remained at less than 0.5% ([Figure 2.4](#)). Empirical treatment of suspected bacterial infections requires coverage with antibacterial agents anticipated to be active. It is [recommended](#) that local units intermittently review available BSI epidemiology and resistance patterns to guide local antimicrobial prescribing guidelines taking into account clinical scenarios, predominant patient populations and probability of underlying resistance.

Figure 2.4 Trends in resistance to key antibiotics in *E. coli* and *K. pneumoniae* bacteraemia, 2018 and 2022, England

For this report, ‘third-generation cephalosporins’ refers to cefotaxime, ceftazidime, cefpodoxime and ceftriaxone. ‘Carbapenems’ refers to meropenem or imipenem but, where no result is available for either meropenem or imipenem, ertapenem is used.

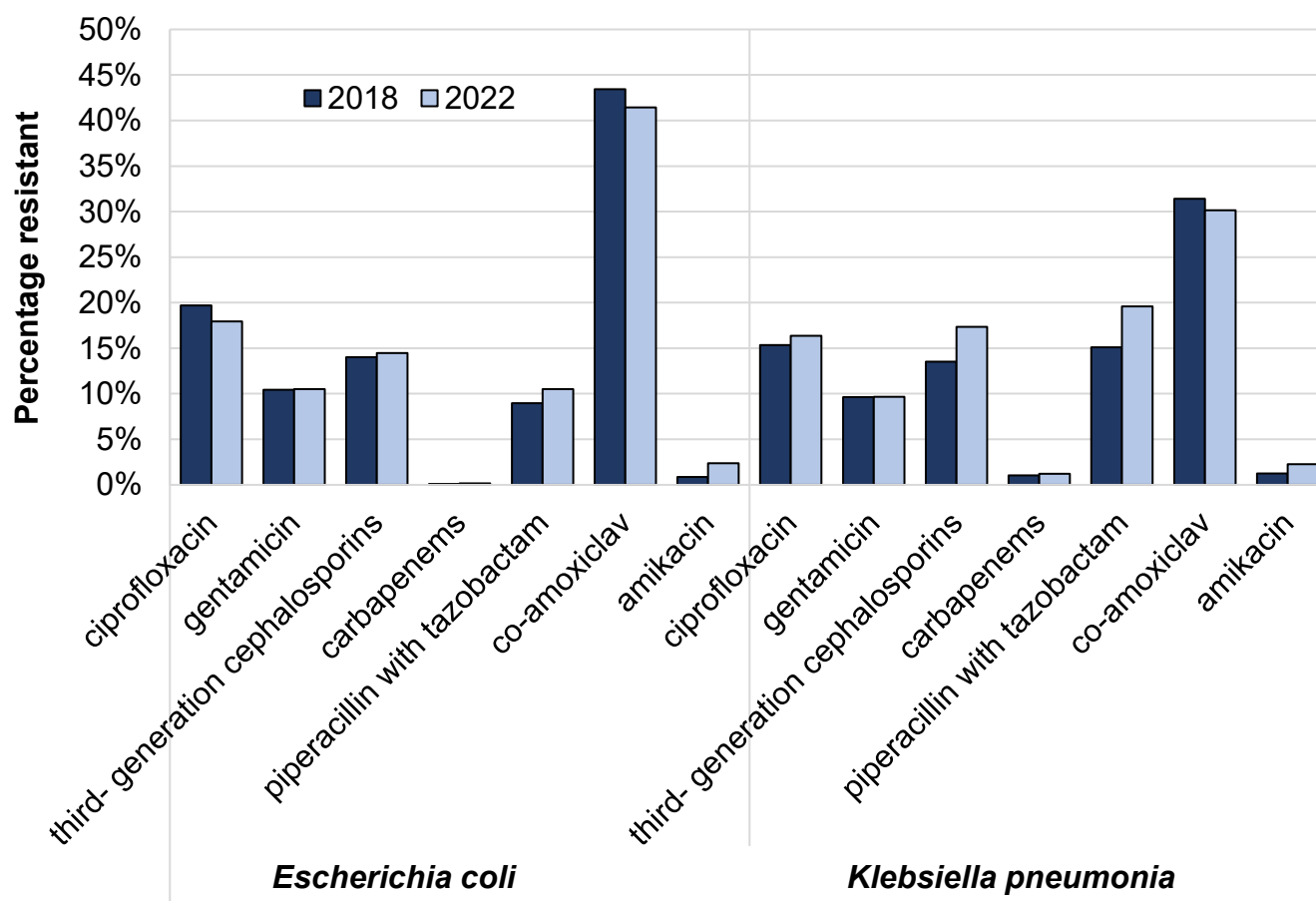


Table 2.4a-b below highlights resistance to common antibiotics often used in combination for *E. coli* and *K. pneumoniae* bacteraemia. Isolates were categorised as 'susceptible' to antibiotic combinations if they were susceptible to either one or both drugs, and as 'resistant' if they were resistant to both individual agents in the combination; only isolates with susceptibility test results for both antibiotics in each combination were included. A total of 96.0% of reported *E. coli* BSI isolates were tested for gentamicin susceptibility, compared with 68.3% against amikacin; this is likely due to variation in testing policies related to local aminoglycoside use.

Table 2.4a. Resistance of common antibiotic combinations in *E. coli* bacteraemia isolates in England, 2022

Antibiotic	Co-amoxiclav	Ciprofloxacin	Third-generation cephalosporins
Gentamicin	8.5%	6.6%	5.1%
Amikacin	2.1%	1.9%	1.6%

Table 2.4b. Resistance of common antibiotic combinations in *K. pneumoniae* bacteraemia isolates in England, 2022

Antibiotic	Co-amoxiclav	Ciprofloxacin	Third-generation cephalosporins
Gentamicin	8.9%	7.7%	7.8%
Amikacin	2.1%	1.9%	1.9%

Resistance to multiple antibiotics increased in *K. pneumoniae* between 2018 and 2022 ([Figure 2.4](#)). Significant increases were seen in resistance to third-generation cephalosporins (13.5% to 17.4%, $p<0.05$), piperacillin/tazobactam (15.1% to 19.6%, $p<0.05$) and amikacin (1.2% to 2.3%; $p<0.05$). Resistance to piperacillin/tazobactam has risen in *K. pneumoniae* BSI annually since 2018. Resistance to carbapenems remained low at 1.2% in 2022 compared to 1.0% in 2019.

Resistance in *Pseudomonas* spp. from BSIs remained stable from 2018 to 2022 for the most commonly used antibiotics. Resistance to gentamicin decreased from 4.6% in 2018 to 2.9% in 2022 ($p<0.05$) ([Figure 2.5](#)). Antibiotic resistance in *Acinetobacter* spp. from BSIs was more fluctuant over the 2018 to 2022 period due to the low annual numbers of isolates reported. In total, 17 carbapenem resistant *Acinetobacter* spp. isolates were detected in 2022.

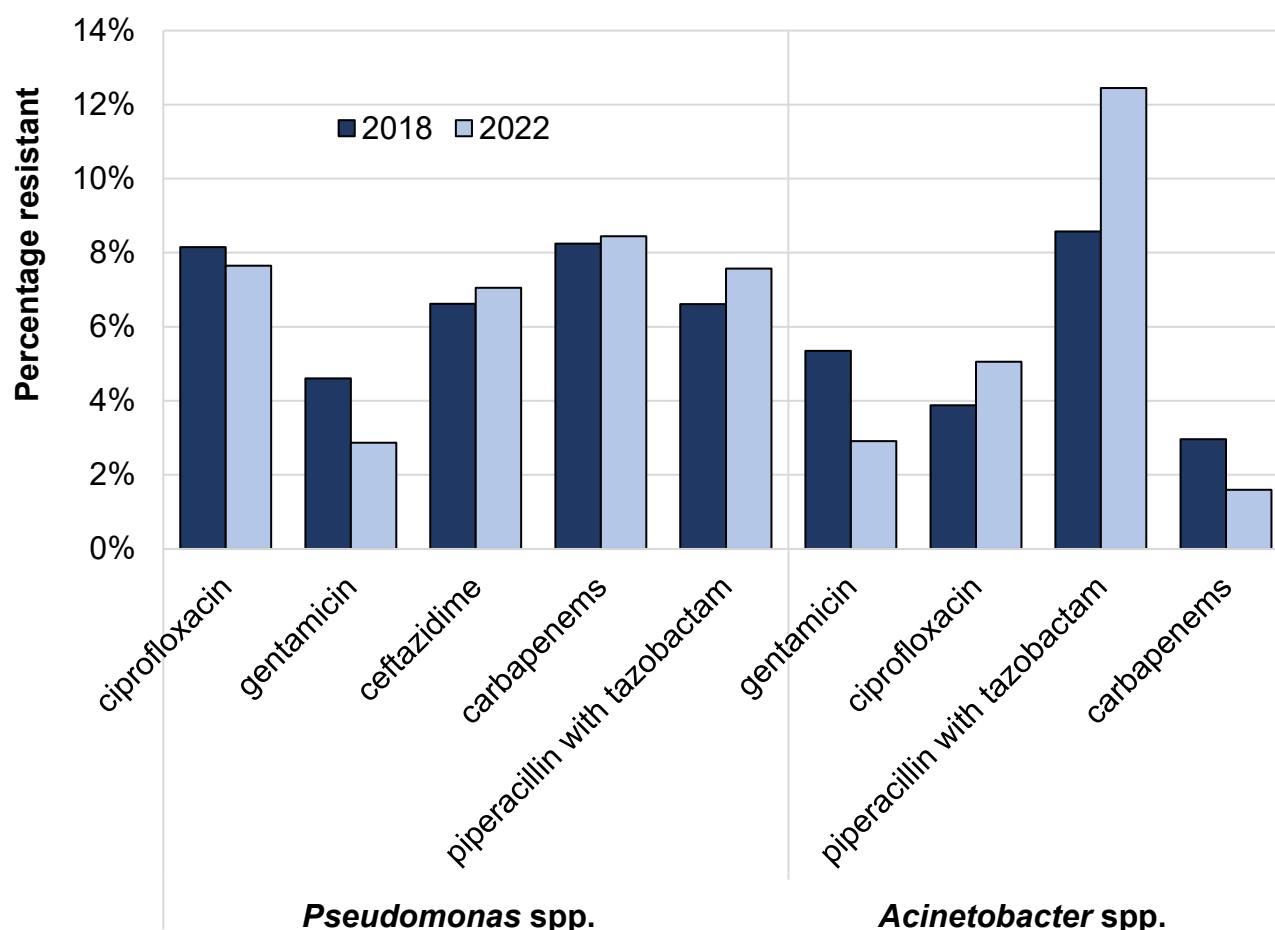
All-cause mortality in Gram-negative BSI

The overall case fatality rate for 30-day all-cause mortality in patients with selected Gram-negative bacterial BSIs (*Escherichia* spp., *Klebsiella* spp., *Pseudomonas* spp., *Acinetobacter* spp.) was 16.9% in 2022 ($n=8,135$); fatality was lowest in children aged 1 to 14 years (3.7%, $n=25$) and highest in adults aged 85 years and over (23.8%, $n=2,449$). Patients infected with a strain resistant to one or more AMR burden-defined antibiotics had a statistically significant ($p<0.05$) higher crude case fatality rate (19.1%, $n=2,023$) compared to those with a susceptible strain (16.2%, $n=6,051$).

For information on other less frequently reported Gram-negative pathogens, please refer to the [health protection reports](#).

Figure 2.5 Antibiotic resistance trends in *Pseudomonas* spp. and *Acinetobacter* spp. bacteraemia, 2018 and 2022, England

Note, in this Figure, 'carbapenems' refers only to meropenem or imipenem as ertapenem is intrinsically only weakly active against these species.



Acquired carbapenemase-producing Gram-negative bacteria

Main messages

In 2022 one in 20 (5%) positive samples were isolated from normally sterile sites, similar to 2021

OXA-48-like enzymes remained the most frequently detected carbapenemase (34.9%) followed by NDM (28.6%) and KPC (28.3%).

In 2022, the crude 30-day all-cause case fatality rate in patients with invasive infections was 30.4% (n=41 out of 135).

Notification data

From 1 October 2020, diagnostic laboratories in England have had a statutory duty to report acquired carbapenemase-producing Gram-negative bacteria isolated from human samples, as well as the results of any antimicrobial susceptibility testing (including negative results) and resistance mechanisms to UKHSA (8). Since October 2020, notifications of acquired carbapenemase-producing Gram-negative bacteria have been published [weekly](#) and [quarterly](#) at national and regional levels. Details on notification definition and de-duplication are available in Chapter 2 of [the Annexe accompanying this report](#).

In 2022, there were 3,315 notifications (from 2,665 persons) of carbapenemase-producing Gram-negative bacteria in England. The majority were identified from screening samples (68.8%), with 4.6% reported from sterile site specimens; 26.6% were identified from 'other' samples, such as urine and the lower respiratory tract. Similar to last year the most frequently detected carbapenemase recorded in England remained OXA-48-like (1,157 out of 3,315; 34.9%) followed by NDM (945 out of 3,315; 28.6%) and KPC (938 out of 3,315; 28.3%). In 2022, the North West and London reported the highest number of acquired carbapenemase-producing Gram-negative bacteria, however, there is considerable regional variation in both the frequency and type of carbapenemases being recorded ([Figure 2.6](#)).

Variation in carbapenemase-producing Gram-negative bacteria was noted by ethnic group ([Table 2.5](#)). In 2022, the highest number were recorded in persons from a white ethnic group (69.6%; n=1,856) with an adjusted rate by ethnicity of 4.1 per 100,000 population; however, the highest rate of carbapenemase-producing Gram-negative bacteria was observed in Asian/Asian British (7.7 per 100,000 population), followed by black African, Caribbean or black British (4.6 per 100,000 population) ethnic groups.

Figure 2.6. Regional notifications per 100,000 population of acquired carbapenemase-producing Gram-negative bacteria by ‘big-5’ carbapenemase in England, 2022

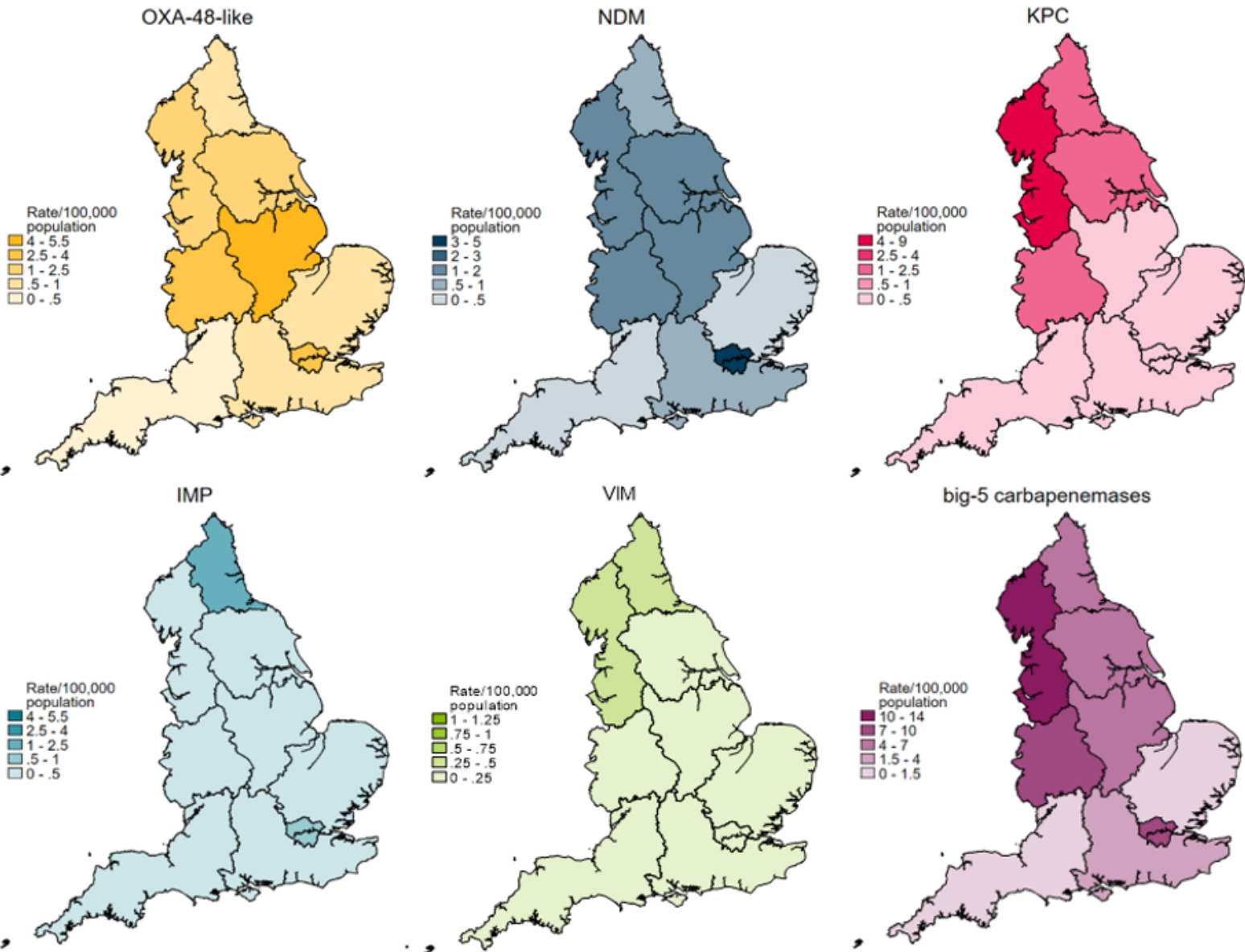


Table 2.5. Carbapenemase-producing Gram-negative bacteria reports by ethnic group in England in 2022*

Ethnic group	Mean age	Number	Percentage (95% confidence intervals)	Rate per 100,000 ethnic population
White	69	1,856	69.6% (67.9 to 71.4%)	4.1
Asian / Asian British	55	418	15.7% (14.3 to 17.1%)	7.7
Black, African, Caribbean, or Black British	59	110	4.1% (3.4 to 5.0%)	4.6
Mixed / multiple ethnic groups	47	26	1.0% (0.6 to 1.4%)	1.6
Any other ethnic group	48	28	1.1% (0.7 to 1.5%)	2.3
Not known or not stated	59	42	1.6% (1.1 to 2.1%)	Not applicable

* 185 (6.9%) Carbapenemase-producing Gram-negative bacteria reports could not be linked to obtain ethnic group information. The mean age in this group was 49 years old.

The rate of carbapenemase-producing Gram-negative bacteria notifications varied by [indices of multiple deprivation \(IMD\)](#), measured by quintile (where 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); the most deprived IMD quintile had a significantly higher rate of 7.2 per 100,000 population, compared with 3.6 per 100,000 population in the least deprived ($p < 0.005$), which mirrors the same pattern observed in the AMR Burden data in [Table 2.2](#). The carbapenemase family identified also varied with deprivation. However, differences may be as a result of variation in CPE mechanisms seen regionally, local screening policies and healthcare-associated outbreaks (further information in the [figures and data appendices accompanying this report](#)).

In 2022, the crude 30-day all-cause case fatality rate in people with acquired carbapenemase-producing Gram-negative bacteria with invasive isolates was 30.4% ($n=41$ out of 135); compared to the 16.9% ($n=8,135$) observed in the Gram-negative AMR Burden pathogens (*Escherichia* spp., *Klebsiella* spp., *Pseudomonas* spp., *Acinetobacter* spp.) mentioned in the previous section. The case fatality rate for acquired carbapenemase-producing Gram-negative bacteria varied by age-group; 0% in children, rising to 34% to 38% in patients aged over 65 years.

The proportion of CPE laboratory notifications originating from invasive samples remains low at 4.6%, with the majority isolated from screening samples. Whilst the 'big 5' carbapenemase families (KPC, OXA-48-like, NDM, VIM and IMP) continue to dominate, there remains marked regional variation in both the number of screens performed, and the frequency and type of carbapenemase being reported. It should be noted that carbapenemase-producing Gram-negative bacteria screening policies vary across the country, which may affect the

ascertainment of reports within these regions as well as the different CPE mechanisms having particular foci in certain areas, possibly linked to protracted outbreaks.

A higher rate of notifications were reported in more deprived areas, and when looked at by ethnicity, the highest population rates were observed in Asian/Asian British.

CPE screening

During 2022, 111 acute trusts reported the results of 420,297 screens for CPE (81% of trusts; see Table 2.5 in [the Annexe accompanying this report](#)). London reported nearly half of all screens in England (47.1%), followed by the West Midlands (14.8%), whereas the lowest proportion of screens were reported by the North East (1.5%) and South West (2.5%). The regional variation in screening may have resulted in ascertainment bias as enhanced testing in certain areas is likely to lead to increased incidence. While the screening of patients remains voluntary and locally risk-assessed, the reporting of screening is mandatory requiring submittance via the [UKHSA HCAI Data Capture System Mandatory Surveillance](#) system. Further work is required to understand variation in screening and non-conformance with mandatory reporting at trust level to ensure CPE prevalence data remains representative across the country. The full list of acute trusts reporting by quarter is available in the [chapter 2 data tables](#) accompanying this report.

Reference laboratory

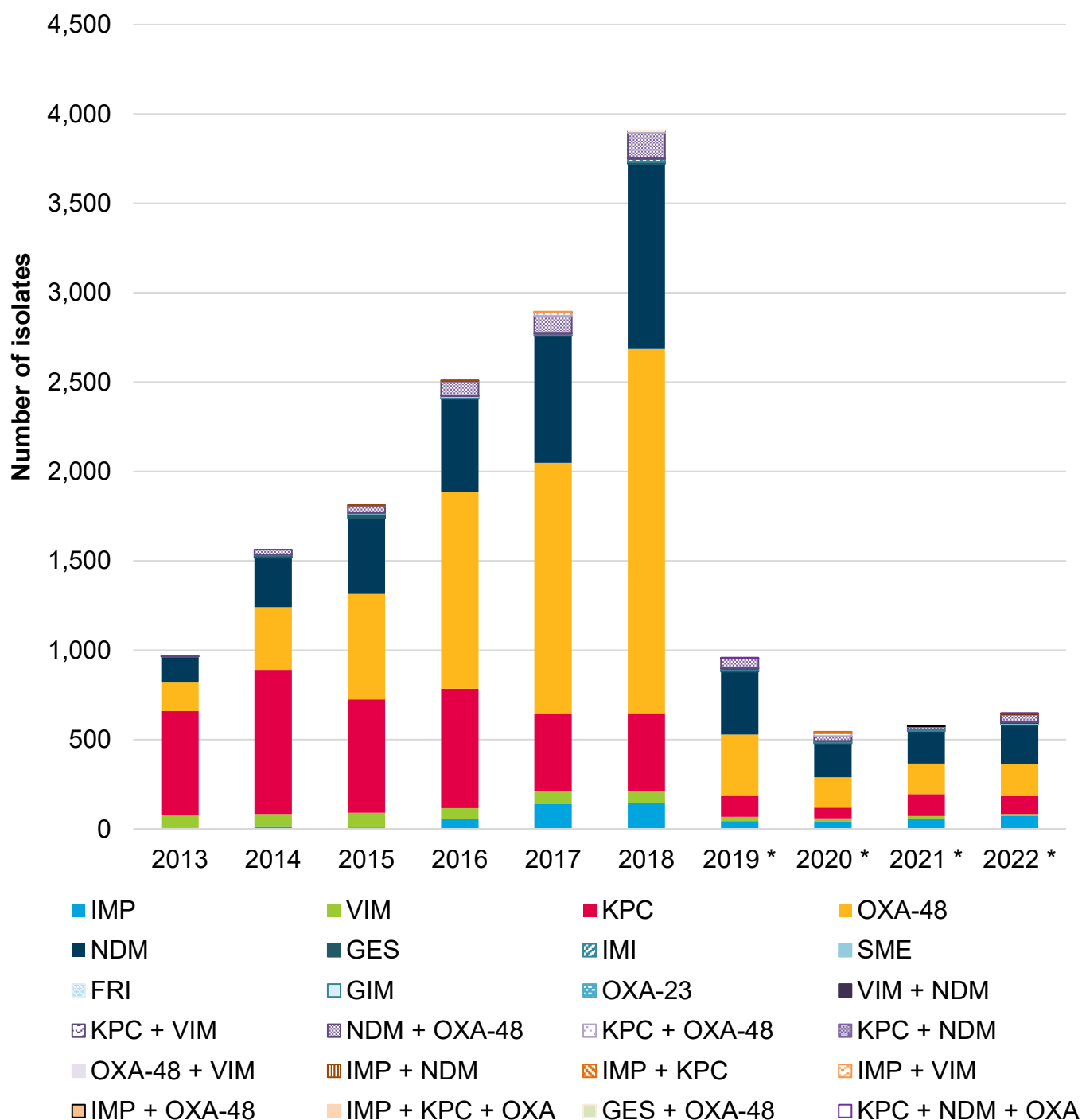
In 2022, 715 (68 from BSI) Enterobacterales referred to the [AMRHAI Reference Unit](#) were confirmed as positive for at least one carbapenemase. The 'big 5' carbapenemase families (KPC, OXA-48-like, NDM, VIM and IMP) and combinations thereof, continue to dominate and account for >98% of CPE. Of the referred carbapenemase-positive isolates, 8% harboured more than one carbapenemase gene ([Figure 2.7a](#)). There has been a slight decrease in the percentage of CPE originating from blood (9.5% in 2022 compared to 11.9% in 2021) ([Figure 2.7b](#)). Data behind the graph are available in the [chapter 2 data table accompanying this report](#).

[AMRHAI](#) have been screening all Enterobacterales sent for investigation of carbapenem resistance with a multiplex PCR targeting all carbapenemase gene families that have been identified amongst submissions (see [the Annexe accompanying this report](#)). Since 2020, this includes the OXA-23-like, OXA-40-like and OXA-58-like acquired carbapenemase genes consistently associated with resistance in *Acinetobacter* spp.

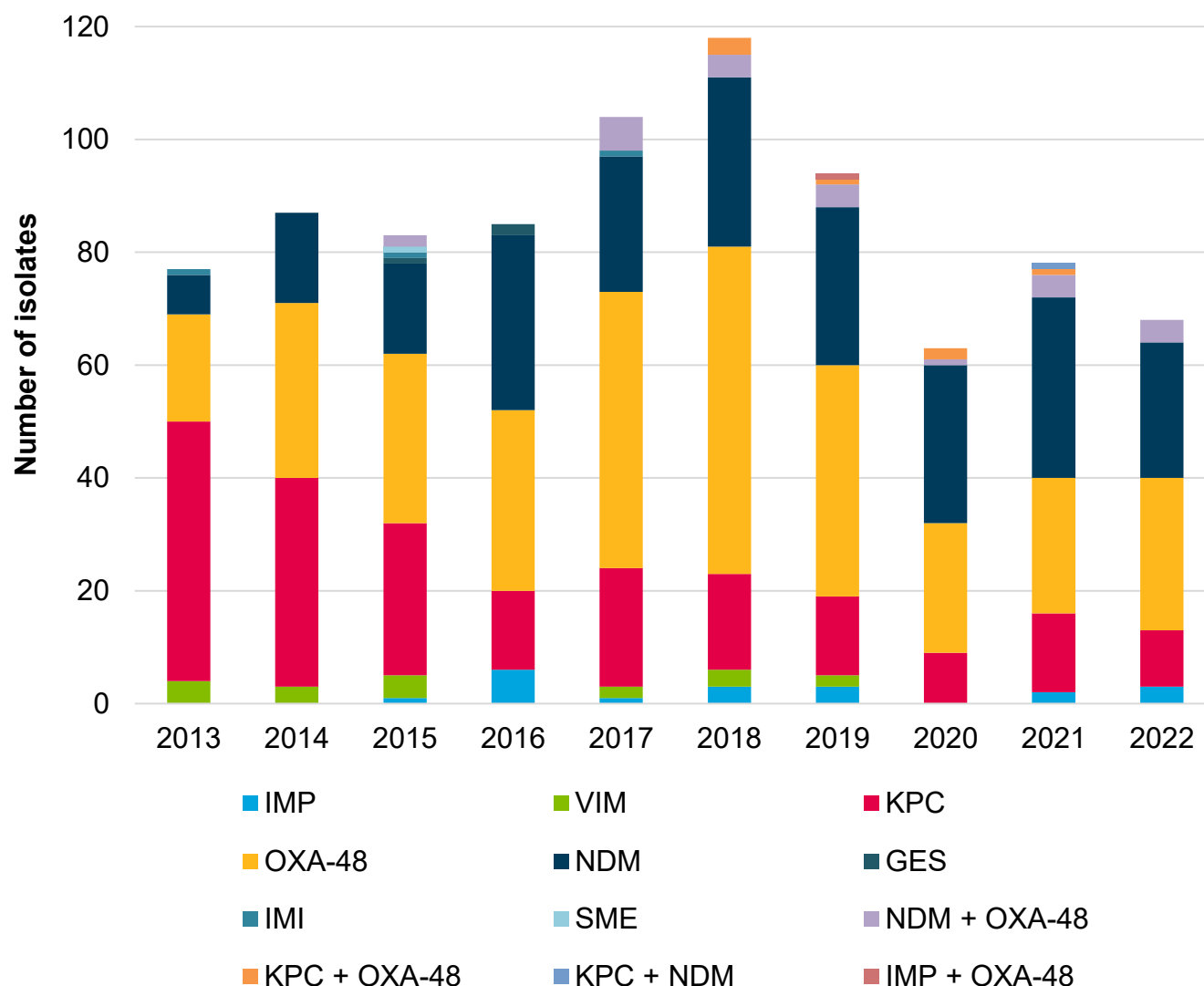
After the first detection in 2021 of an OXA-23 carbapenemase in a *Proteus mirabilis* referred to AMRHAI, OXA-23 was further detected in 2 *P. mirabilis* and in one *E. coli* ([9](#)). OXA-23 was previously reported on the chromosome of *P. mirabilis*, but rarely in *E. coli*. The detection of OXA-23 in Enterobacterales highlights the transmission of OXA resistance genes to genera other than *Acinetobacter* spp. and the limitations of local assays designed only to target the 'big 4' (KPC, OXA-48-like, NDM, VIM) or 5' carbapenemases. Novel carbapenemases in Enterobacterales will usually lead to elevated carbapenem MICs (meropenem above the EUCAST cut-off of 0.12 mg/L) and will test negative for the 'big 4 or 5' carbapenemases on

local testing. Isolates suspected of harbouring [novel carbapenemases](#) or those with unusual beta-lactam resistance patterns should be referred to the reference laboratory for further testing.

Figure 2.7 (a) Number of confirmed CPE isolates referred to the UKHSA's AMRHA Reference Unit (excluding blood cultures), 2013 to 2022



* Following a change to the referral criteria in 2019, submission of confirmed CPE from colonised patients to the AMRHA Reference Unit was no longer encouraged.

Figure 2.7 (b) Number of confirmed CPE blood culture isolates referred to the UKHSA's AMRHAI Reference Unit, 2013 to 2022

For *Pseudomonas* spp., the metallo-carbapenemase enzymes VIM, IMP and NDM continue to dominate but other metallo-carbapenemase enzymes (DIM and SIM) as well as non-metallo carbapenemase families (GES, KPC and OXA-48-like) have been identified (Table 2.6). In 2022, AMRHAI identified the first known instance of GIM carbapenemase in a clinical isolate referred to the Reference Unit (*Pseudomonas putida* group from the urine of an inpatient) ([9](#)).

Table 2.6. Distribution of carbapenemase gene families amongst *Pseudomonas* spp. referred to the UKHSA's AMRHAI Reference Unit from all sources

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)

Year	Carbapenemase gene family				
	VIM	IMP	NDM	GES	Other (number)
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)

AMRHAI also identified the first *Achromobacter* spp. isolate with an acquired carbapenemase (IMP) originating from a breast aspirate. There are only a few reports in the literature of *Achromobacter* spp. with an acquired carbapenemase (either IMP, NDM or VIM); between one to 7 isolates have been identified in China, India, Iran, Italy and Japan ([10 to 13](#)). Meropenem resistance is not uncommon amongst *Achromobacter* spp. referred to AMRHAI, therefore local screening is recommended and only confirmed carbapenemase positive isolates should be referred to the Reference Unit. *Achromobacter*, a non-fermenting Gram-negative bacterium, can cause a broad range of infections in often immunocompromised hosts. Similar to other non-fermenters such as *Burkholderia cepacia* complex, the accumulation of intrinsic and acquired resistance can result in very limited treatment options.

Critical antibiotic resistance in foodborne bacteria

UKHSA's [Gastrointestinal Bacterial Reference Unit](#) routinely performs WGS on Shiga-toxin-producing *E. coli* (STEC), *Salmonella*, *Listeria*, *Shigella* and *Campylobacter* spp. In 2022, 8,717 *Salmonella* spp. isolates, 3,122 Shiga-toxin-producing *E. coli* (STEC) isolates, 1,442 *Shigella* spp. isolates and 146 *Campylobacter* spp. isolates from England underwent WGS analysis. The majority were human isolates (90% for *Salmonella* spp. (7,823 out of 8,717), 99% for STEC (3,080 out of 3,122), 99% for *Shigella* spp. (1,430 out of 1,442) and 90% for *Campylobacter* spp. (131 out of 146)). The AMR determinants were predicted using a validated bioinformatics tool [Genefinder](#). OXA-48-like carbapenemase genes were identified in one monophasic *Salmonella* Typhimurium and *bla*_{OXA-244} was identified in one *Salmonella* Oranienburg. *bla*_{OXA-181} was detected in one human isolate of STEC O103:H2. In 2022, *mcr-1* was identified in 4 patient isolates, 2 were *Salmonella* Kentucky, and one each of *Salmonella* Agona and *Salmonella* Chester. No *mcr* genes were identified among STEC specimens from England.

Tetracycline resistance gene *tet(X)* was identified in 5 patients with *Salmonella* Kentucky in 2022. All isolates were part of the same clonal complex (e-Burst group 56) and within the same 10 single nucleotide polymorphisms (SNP) cluster indicating a common source. No *tet(X)* genes were identified among STEC specimens from England. *tet(X)* genes confer resistance to all tetracyclines, with some variants conferring additional resistance to tigecycline, eravacycline and omadacycline, which are drugs often used in last-line multidrug-resistant regimes.

The implications of critical antibiotic resistance in foodborne bacteria are unclear and need to be studied further. It may be indicative of food or environmental contamination, which is occurring during food processing from farm to fork. Most foodborne bacteria cause self-limiting gastroenteritis and antibiotics are rarely necessary to treat these infections; various treatment

options remain available despite harbouring critical resistance determinants. However, there is concern that these mobile resistance determinants can be transferred from foodborne pathogens to the 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, like urinary tract infections, caused by gut commensals. Thorough cooking of food to piping hot temperatures and maintenance of good kitchen hygiene is one way of reducing acquisition of foodborne infections.

Gram-positive bacterial infections

Main messages

Resistance to clindamycin, macrolide and tetracycline in methicillin-susceptible *S. aureus* (MSSA) from blood isolates increased between 2018 and 2022, with the proportion of isolates resistant currently standing at 18%, 20%, 5% respectively.

Following reductions noted in 2020 and 2021 coinciding with pandemic mitigations, invasive group A *Streptococcus* (iGAS) infections increased in 2022 by 248% compared to 2021. In comparison to pre-pandemic infections, there were 21% more iGAS reported in 2022 than 2019. Previously reported resistance to macrolides and tetracycline declined significantly between 2021 and 2022 coinciding with changes in circulating *emm* strain types in 2022.

There was a steady increase in reported resistance of group B *Streptococcus* between 2013 and 2022 to erythromycin (20% to 39% ($p<0.01$)) and clindamycin (20% to 33% ($p<0.01$)).

Resistance trends in BSIs

In 2022, methicillin-resistant *S. aureus* (MRSA) comprised 5.8% of the total number of *S. aureus* isolates from blood. As shown in [Figure 2.8](#), resistance to antibiotics is higher in MRSA compared with methicillin-susceptible *S. aureus* (MSSA), particularly for macrolides, tetracycline, and clindamycin (53.1% versus 20.0%, 23.3% versus 4.8%, and 45.7% versus 17.8% in 2022 respectively).

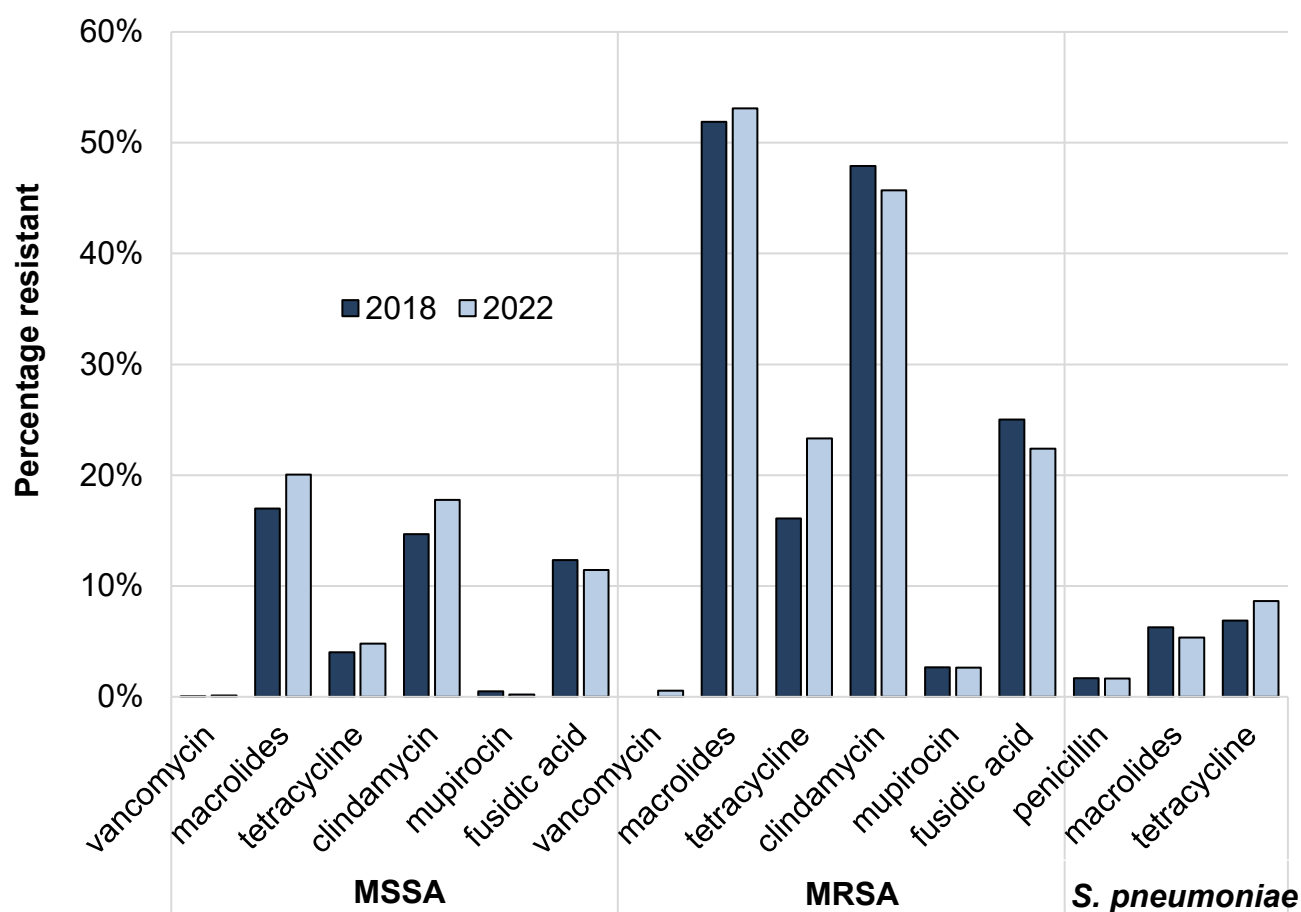
Whilst flucloxacillin remains the drug of choice for MSSA infections, second-line options may be required. Between 2018 and 2022, MSSA causing BSIs showed increased resistance to clindamycin (14.7% to 17.8% resistance, $p<0.05$), tetracycline (4.0% to 4.8%, $p<0.05$), and macrolides (17.0% to 20.0%; $p<0.05$) ([Figure 2.8](#)), with small decreases in resistance to fusidic acid (12.3% to 11.4%, $p<0.05$) and mupirocin (0.5% to 0.2%, $p<0.05$). In MRSA-causing BSIs resistance to macrolides and tetracycline also increased between 2018 and 2022, from 51.9% to 53.1% ($p=0.724$) and from 16.1% to 23.3% ($p<0.05$), respectively.

Data on susceptibility of *S. pneumoniae* causing BSIs is shown in [Figure 2.8](#). The percentage of isolates resistant to tetracycline increased between 2018 and 2022, from 6.9% to 8.6%

($p < 0.05$), whereas macrolide resistance decreased from 6.3% to 5.4% ($p = 0.09$), and penicillin resistance was stable at 1.7% in both 2018 and 2022. Full 5-year trend graphs and tables are available in the [Chapter 2 data tables accompanying this report](#).

Figure 2.8 Antibiotic resistance in meticillin-susceptible *S. aureus* (MSSA), meticillin-resistant *S. aureus* (MRSA) (Note), and *Streptococcus pneumoniae* BSI to key antibiotics, England 2018 and 2022

Note: The *S. aureus* data in this chart is based on voluntary reports of meticillin resistance



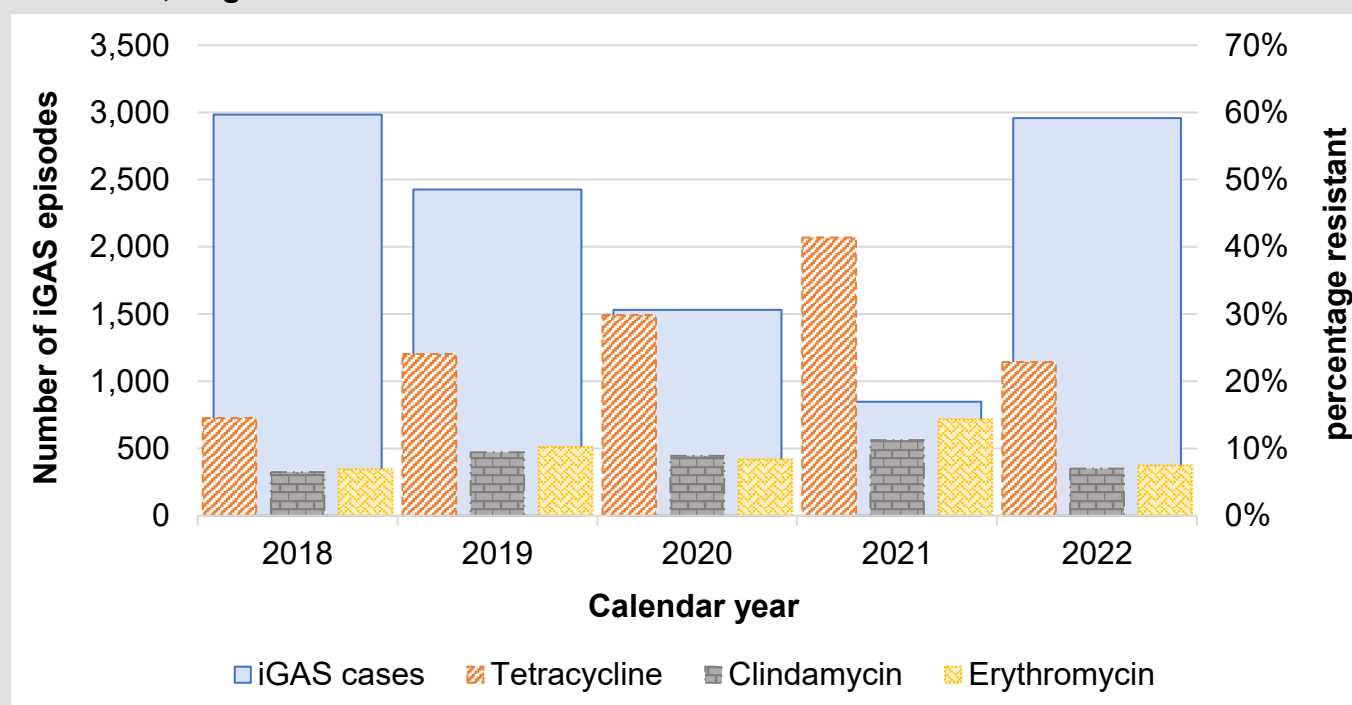
2.2 Trends in antibiotic resistance in invasive group A *Streptococcus* (iGAS) and group B *Streptococcus*

Group A *Streptococcus* (*Streptococcus pyogenes*)

Figure 2.2 shows that between 2021 and 2022 the incidence of iGAS increased by 248%; this increase follows reductions in 2020 and 2021 coinciding with a series of non-pharmaceutical pandemic mitigation measures (reported in the ESPAUR report 2021 to 2022). Out of season patterns (seasonal increases normally occur between February and April) were noted during the [Summer of 2022](#) and again during the [Winter 2022, disproportionately affecting children \(14\)](#). Trends and demographics are discussed in more detail in [seasonal](#) activity reports.

To date, penicillin resistance has never been detected in group A *Streptococcus* (GAS) and penicillin remains the drug of choice. Following a period of increasing tetracycline resistance between 2018 and 2021 (15% to 41%; $p < 0.01$), a 45% decline was noted between 2021 (41%) and 2022 (23%; $p < 0.01$; Box Figure 2.2). Similar declines were noted for clindamycin (11% to 7%; $p < 0.01$) and erythromycin (14% to 7%; $p < 0.01$) between 2021 and 2022. Changes noted in the resistance rates in part are due to changes in the [dominant circulating strain types \(*emm1* and *emm12*\) during 2022](#) (M protein gene encoding the cell surface M virulence protein responsible for *S. pyogenes* M serotypes), with *emm 1* and *emm 12* being less resistant than those reported in the preceding few years ([15](#)). Trends and demographics of GAS are discussed in more detail in the [seasonal](#) and [annual](#) reports.

Figure 2.2. Trends in resistance to key antibiotics in invasive group A Streptococcal infections, England 2018 to 2022



For the treatment of GAS-related pharyngitis and scarlet fever, phenoxymethylpenicillin (penicillin V) remains the first-line. Alternative antibiotic choices should only be used when there is a clear history of allergy to penicillin; [broad -spectrum second-line treatments](#) have an increased side effect profile and are more likely to promote resistance. Details on trends in prescribing of GAS treatment antibiotics are described in [Chapter 3](#) (the AMU chapter), and a summary of investigations into GAS *emm* type specific susceptibility patterns are described in the Research Chapter.

UK public health [guidance on the management of close contacts of iGAS cases in community settings](#) was updated in December 2022, expanding public health action to now include i) patients where GAS has been isolated from a normally non-sterile site in combination with a severe clinical presentation ii) individuals who have a severe clinical presentation consistent with iGAS infection, in the absence of microbiological confirmation of GAS AND either: a) the

clinician considers that GAS is the most likely cause b) there is an epidemiological link to a confirmed GAS case.

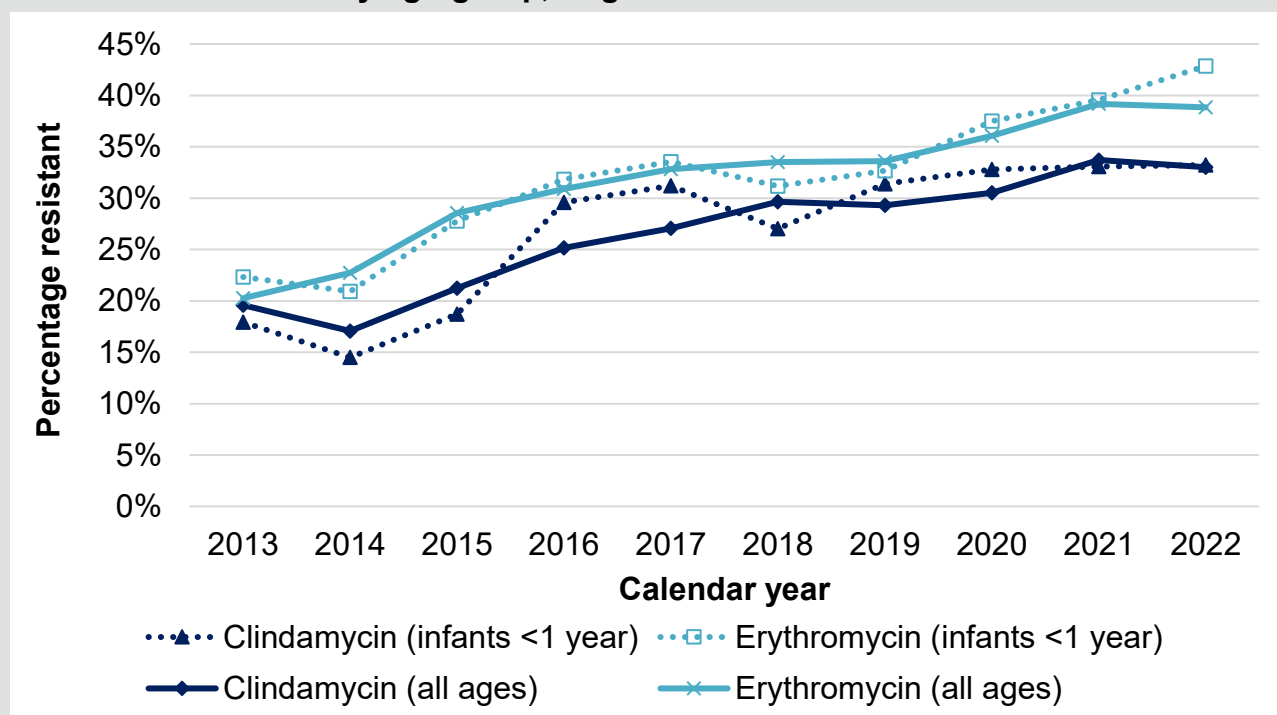
The recommendation for administering antibiotic prophylaxis to iGAS close contacts has been extended to include: pregnant women from ≥ 37 weeks gestation, neonates and women within the first 28 days of delivery, older household contacts (≥ 75 years), individuals who develop chickenpox with active lesions in the 7 days prior to diagnosis of iGAS infection.

Group B *Streptococcus* (*Streptococcus agalactiae*)

For invasive group B *Streptococcus* (GBS) infections, resistance to penicillin remains rare. A single invasive GBS isolate (from 2016), was confirmed as exhibiting resistance to penicillin in the UK, as [previously reported](#).

Between 2013 and 2022 there has been a steady increase in resistance to erythromycin and clindamycin in England, from 20% to 39% ($p < 0.01$) and 20% to 33% ($p < 0.01$), respectively. Some regional variation is noted, but resistance is high in all regions. Box Figure 2.3 shows the rise in resistance by age-group. Primary or adjunct treatment of GBS with macrolides or clindamycin should be guided by susceptibility testing. In 2016, high levels of resistance led to a change in guidance relating to intrapartum antibiotic prophylaxis set out by the [Royal College of Obstetricians and Gynaecologists](#); cephalosporin or vancomycin (depending on the severity of the allergy) are now the drugs of choice in penicillin-allergic women, superseding clindamycin.

Box Figure 2.3. Trend in resistance to erythromycin and clindamycin resistance in invasive GBS infection by age-group, England 2013 to 2022



Laboratories are reminded to refer all invasive group A, B, C and G Streptococcal isolates to the national reference laboratory for surveillance. Those from superficial infections which are

associated with an infection control or cluster investigation should also be referred to the [Staphylococcus and Streptococcus Reference Service](#) at Colindale for typing.

Streptococci exhibiting exceptional resistance phenotypes should be referred to the AMRHA Reference Unit for confirmation; that is, isolates exhibiting resistance to penicillin, cephalosporins, vancomycin, teicoplanin, telavancin, dalbavancin, daptomycin, linezolid, tedizolid, quinupristin-dalfopristin, fluoroquinolones, or tigecycline. Guidance on how to do this is in the [Bacteriology Reference Department user manual](#).

2.3 Special considerations in vulnerable populations: skin lesions and asylum seekers

During summer 2022, it was noted that recently arrived [vulnerable migrants](#) to the UK were presenting with diffuse and varied skin lesions of broad aetiology. Following an increased number of confirmed cases of diphtheria caused by toxigenic *Corynebacterium diphtheriae* among migrants in Europe (predominantly cutaneous diphtheria), enhanced surveillance was undertaken for recently arrived vulnerable migrants with skin lesions. A UKHSA Briefing note in December 2022 asked laboratories in England and Wales to submit to the UKHSA Staphylococcus and Streptococcus Reference Service, Colindale for typing any positive culture of *S. aureus*, regardless of antibiogram, and GAS from symptomatic asylum seekers from any specimen site, including skin lesions, wound sites, or the respiratory tract. Between 25 October 2022 to 6 February 2023, 232 isolates (130 *S. aureus*, 102 GAS) were received corresponding to a total of 174 patients in England.

Assessment of GAS highlighted a diverse range of emm types with the most frequently encountered types (emm 60.1, 11.0 and 104.0) being distinct from circulating UK strains. There were high rates of GAS and *S. aureus* co-infection (35%). Among the *S. aureus* isolates there were high rates of MRSA (45%) and Panton-Valentine Leukocidin (PVL) toxin carriage (10%). This poses challenges for clinical management, particularly empirical treatment regimes. Effective management of such lesions may require complex antibiotic regimes, prescribed following local microbiology and/or infectious diseases specialist advice and guided by susceptibility data. Due to migratory routes, and countries of origin, diagnostic differentials may also include other pathologies such as leishmaniasis and scabies

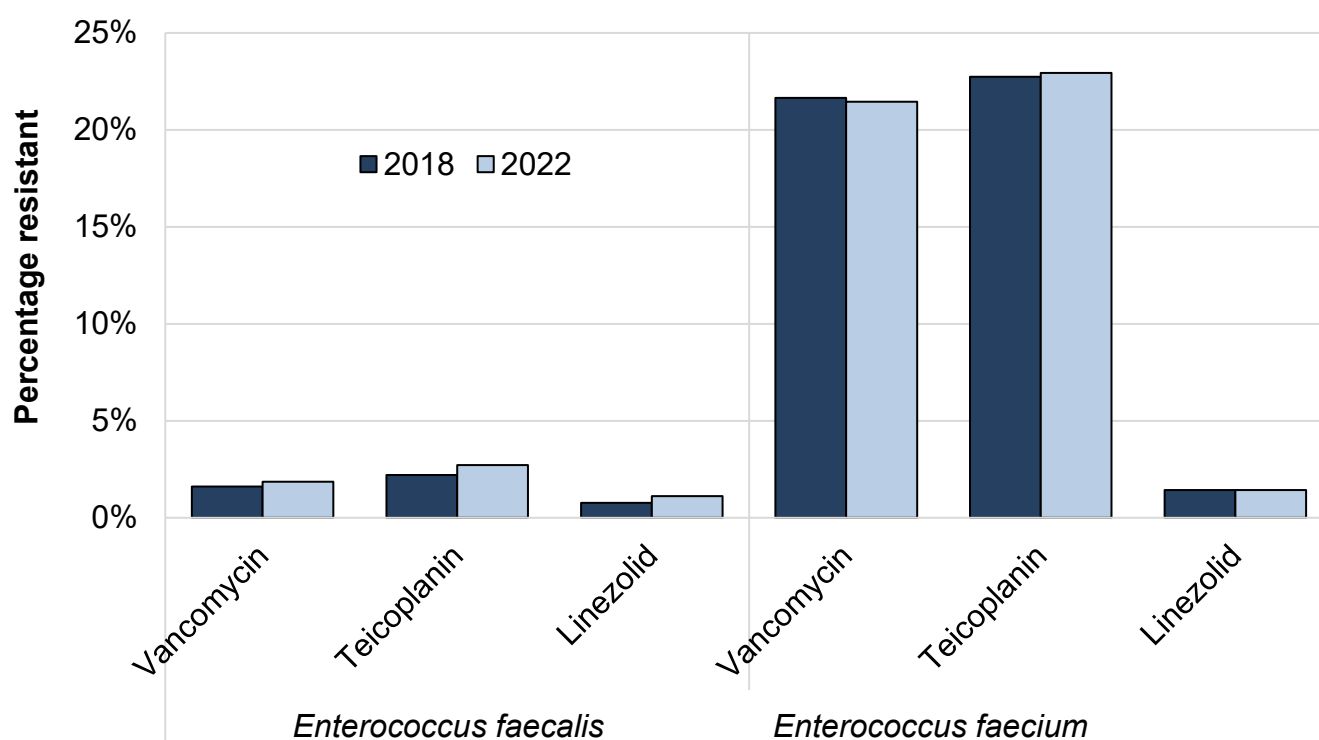
Enterococcus species

Enterococcus faecium remains the predominate *Enterococcus* species causing BSI (45.3%, up from 39.0% in 2018), followed by *E. faecalis* (41.5%, down from 43.7% in 2018), with most of the change occurring during the pandemic period.

Resistance to vancomycin, teicoplanin, and linezolid remained stable in both *E. faecalis* and *E. faecium* over this period (Figure 2.9). Daptomycin resistance in *E. faecalis* remained stable between 0.3% to 0.5%, whereas in *E. faecium* daptomycin resistance decreased from 7.0% to 3.2% ($p < 0.05$). EUCAST does not provide daptomycin clinical breakpoints for *E. faecium* and *E.*

faecalis, but rather lists the breakpoint as ‘Insufficient Evidence’; in-part due to the dosing regimes which far exceed licensed doses. Although daptomycin is increasingly used for enterococcal BSIs and endocarditis, especially in the context of vancomycin resistance, uncertainties remain particularly with the inability of even the highest published doses to achieve adequate exposure against all wild-type enterococcal isolates (16). Although minimum inhibitory concentration (MIC) distributions and epidemiological cut-off values are frequently used to predict likelihood of clinical success, as the local method of susceptibility testing cannot be verified, daptomycin MIC cannot be categorised and therefore caution should be used when interpreting the results. Clinicians wishing to treat enterococcal BSI or endocarditis with daptomycin should familiarise themselves with the uncertainties around testing.

Figure 2.9 Antibiotic resistance in *Enterococcus faecalis* and *Enterococcus faecium* BSI to key antibiotics, England 2018 and 2022



Laboratories are requested to send to the AMRHAI Reference Unit for confirmation any:

1. *S. aureus* isolates exhibiting resistance to ceftaroline, ceftobiprole, vancomycin, teicoplanin, telavancin, dalbavancin, daptomycin, linezolid, tedizolid, quinupristin-dalfopristin, or tigecycline.
2. *E. faecalis* exhibiting resistance to ampicillin/penicillin.
3. *E. faecalis* or *E. faecium* exhibiting resistance to daptomycin, tigecycline, linezolid or tedizolid.
4. *S. pneumoniae* exhibiting resistance to penicillin, cefotaxime/ceftriaxone, meropenem, vancomycin, teicoplanin, telavancin, dalbavancin, daptomycin, linezolid, tedizolid, quinupristin-dalfopristin, fluoroquinolones, or tigecycline.

Guidance on how to do this is in the [Bacteriology Reference Department user manual](#).

Antibacterial resistance in specialist areas

Surveillance of antibiotic resistance in *Neisseria gonorrhoeae*

Results of the Gonococcal Resistance to Antimicrobials Surveillance Programme (GRASP) sentinel surveillance data are described in full in the annual [GRASP report](#).

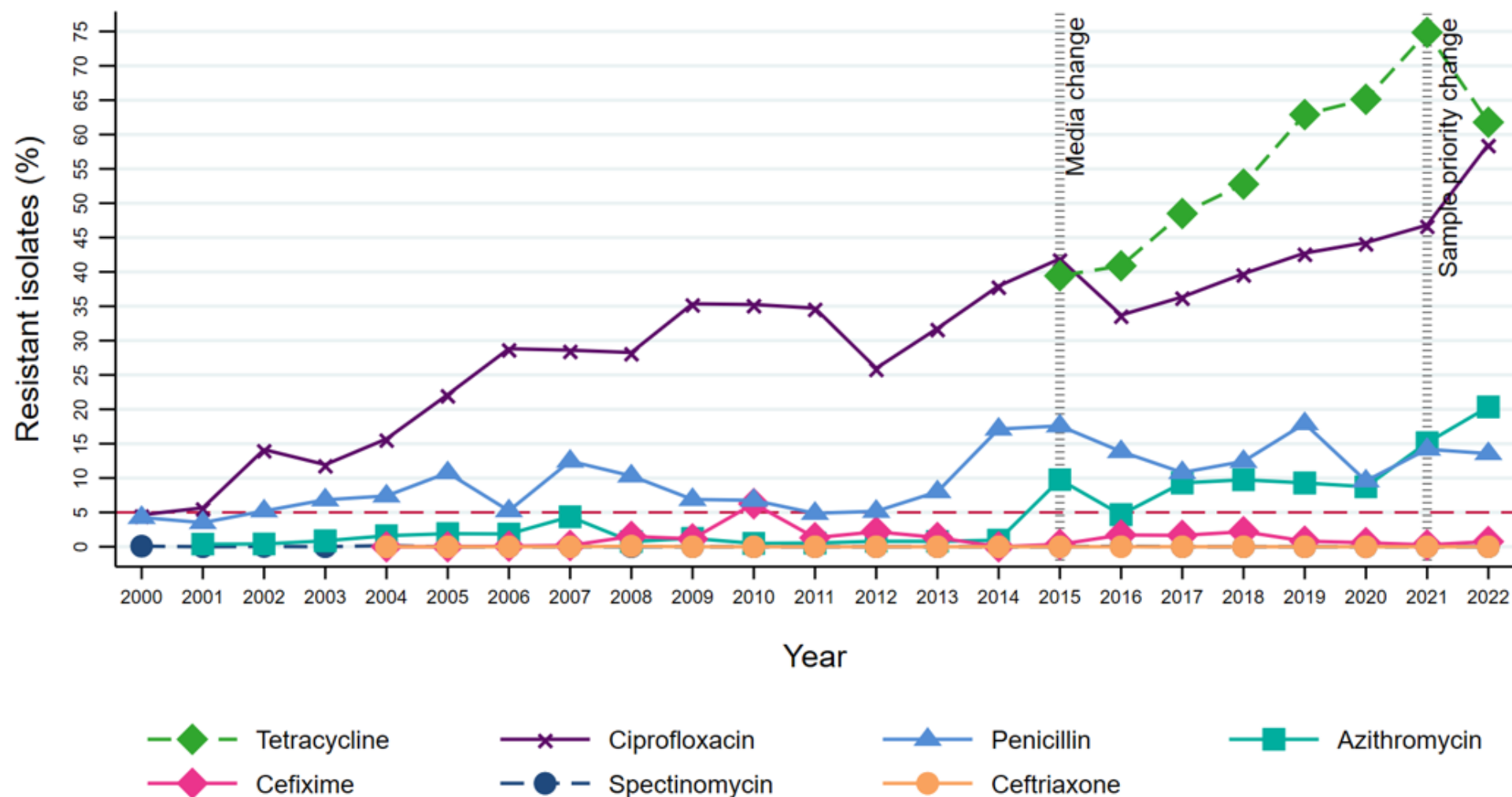
Surveillance of antimicrobial resistance in *Neisseria gonorrhoeae* is monitored through the GRASP, which comprises a suite of surveillance systems to detect and monitor antimicrobial resistance (AMR) in *N. gonorrhoeae* and to record potential treatment failures. Trend data is derived from the national sentinel surveillance system which collects gonococcal isolates from consecutive patients attending a network of 26 participating sexual health services (SHSs) (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 (STIRL) for antimicrobial susceptibility testing and the results are linked to patient demographic, clinical and behavioural data for analysis of antimicrobial susceptibility trends in patient sub-groups.

Between 2021 and 2022, the percentage of isolates with reduced susceptibility to ceftriaxone (MIC >0.03 mg/L), the current first-line therapy, remained low at 0.21% in 2022 compared to 0.07% in 2021. This follows successive year-on-year decreases since a peak of 7.1% in 2018. No instances of ceftriaxone resistance (MIC >0.125 mg/L) were observed in the sentinel programme. However, 14 cases of ceftriaxone resistance were reported between January 2022 to June 2023 upon direct referral from primary diagnostic laboratories, compared to a total of 11 between 2015 and 2021. Most had travel links with the Asia-Pacific region, which has been shown to have the highest prevalence of ceftriaxone-resistant *N. gonorrhoeae* globally ([17](#)). However, as not all partners could be contacted in addition to some cases having no travel links, there may be ongoing local transmission within the UK.

Figure 2.10 describes the trends in tetracycline, ciprofloxacin, penicillin and spectinomycin resistance from 2000, as well as trends in azithromycin resistance from 2001 and cefixime resistance from 2004. Cefixime resistance (MIC >0.125 mg/L) remained low at 0.8% in 2022, however the proportion of isolates having an elevated MIC >0.06 mg/L has doubled each year since 2019. Azithromycin resistance (MIC >0.5 mg/L, previous EUCAST breakpoint used for continuity), and ciprofloxacin resistance (MIC >0.06 mg/L) continue to increase rapidly. Penicillin resistance remained stable with some fluctuation over recent years. Tetracycline resistance (MIC >1.0 mg/L, previous EUCAST breakpoint used for continuity) has decreased for the first time following successive increases since 2016, despite its lack of use as a treatment option for gonorrhoea. As in previous years, no spectinomycin resistance (MIC >64 mg/L) was detected in 2022.

Whole genome sequencing (WGS) was performed on all isolates for the first time in 2022. Of note, over two-thirds of all isolates belonged to 10 multi-locus sequence types. Elevated MICs for cephalosporins were associated with expression of mosaic *penA* alleles, in particular *penA*-34.

Figure 2.10. Percentage of *N. gonorrhoeae* isolates in the GRASP sentinel surveillance system that were resistant to selected antimicrobials, England and Wales, 2000 to 2022†



Note to Figure 10

Due to changes in the diagnostic sensitivity medium used to test antimicrobial susceptibility of sentinel surveillance isolates, MICs for the 2015 to 2022 collections are not directly comparable with those from previous years. Trends from 2000 to 2014 compared to 2015 to 2022 must be interpreted with caution (point of change indicated by vertical dashed black line), particularly for azithromycin and tetracycline (data for tetracycline are only included from 2015 onwards due to this issue) (18). The 5% threshold ($\geq 5\%$ of infections resistant to the first-line therapy) at which the WHO recommends that first-line monotherapy guidelines should be changed is indicated by the horizontal dashed red line. In 2021, pharyngeal isolates were prioritised ahead of all other sites for the first time, resulting in a substantial change in the distribution of specimen sites from 2021 onwards. For continuity, the previous breakpoint of 1.0 mg/L for tetracycline has been retained.

Surveillance of antibiotic resistance in *Mycobacterium tuberculosis* infections

The trends in drug resistance and treatment outcomes of MDR-TB are presented in the [Tuberculosis in England annual report](#).

Antifungal resistance

Main messages

Several taxonomic revisions to species previously classified as *Candida* have been implemented in the period covered by this report. In this report 'candidaemia' refers to bloodstream infections due to species both currently and formerly defined as *Candida*.

The incidence of candidaemia was 4.0 per 100,000 population (n=2,265) in 2022, an overall increase of 22.7% since 2018 (3.3 per 100,000).

Candida albicans was the most frequently isolated *Candida* or former *Candida* species across the 5-year period followed by *Nakaseomyces glabratus*, accounting for 40% and 29% of candidaemia episodes, respectively.

Work is ongoing to consolidate reporting of *Candida* species from multiple sources, particularly for *Candida auris*, a species capable of causing outbreaks within hospitals and often associated with multi-drug resistance.

In 2022, resistance to fluconazole was detected in 1.3% of *C. albicans* and 14.5% of *N. glabratus* isolates.

Trends in incidence and antifungal resistance in candidaemia

The incidence of candidaemia was 4.0 per 100,000 population (n=2,265) in 2022, an overall increase of 22.7% since 2018 (3.3 per 100,000, n=1,828).

Prior to 2020, the incidence of *Candida* spp. BSI was decreasing, with a 0.4% decrease between 2018 and 2019 (3.3 per 100,000 population in 2019; n=1,831). However, between 2019 and 2022 the incidence increased by 23.2%, a 10.5% increase from 2019 to 2020 and then a larger increase of 11.5% from 2020 to 2022. *Candida albicans* was the most frequently isolated *Candida* or former *Candida* species across the 5-year period followed by *Nakaseomyces glabratus* (formerly *Candida glabrata*), accounting for 40% and 29% of candidaemia episodes, respectively.

Candida auris, the fluconazole-resistant and sometimes multidrug-resistant yeast that has been responsible for multiple intensive-care unit (ICU) outbreaks globally including 3 in the UK, continues to cause sporadic infections often in individuals that have recently travelled to areas where it is endemic or who have been transferred from medical facilities in India, Africa or the Middle East. In total 7 *C. auris* isolates were reported to SGSS in 2022 including one BSI.

A total of 37 isolates were referred to the UKHSA National Mycology Reference Laboratory, predominately from the Independent sector, up from a nadir of 5 in 2020 coinciding with the pandemic years, when travel restrictions were in place. Work is ongoing to consolidate reporting from multiple sources. Additional data on *Candida* and former *Candida* species, including recent taxonomic revisions, and regional data on incidence, can be found in [the Annexe accompanying this report](#) and in the [Laboratory surveillance of bloodstream infection \(BSI\) due to *Candida* \(and species formerly part of the *Candida* genus\) in England: 2022](#) health protection report.

Routine laboratory surveillance reports submitted to the UKHSA's SGSS showed that in 2022, 79.9% (1,810 out of 2,265) of *Candida* 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 2.11](#)).

Further detailed trend data, including numbers reported as susceptible or resistant, are available in the [chapter 2 data table accompanying this report](#).

Supplementary analyses on candidaemia cases are available in the [Chapter 2 data tables](#), along with an update from the [UKHSA National Mycology Reference Laboratory \(MRL\)](#) on antifungal susceptibilities in less frequently reported fungal pathogens, and antifungal drug resistance in 2022, a perspective from the Mycology Reference Centre Manchester.

Figure 2.11. Percentage of *Candida* and former *Candida* species combined, and *C. albicans* and *N. glabratus* isolates from blood assessed separately, displaying resistance to antifungals in England, 2018 and 2022

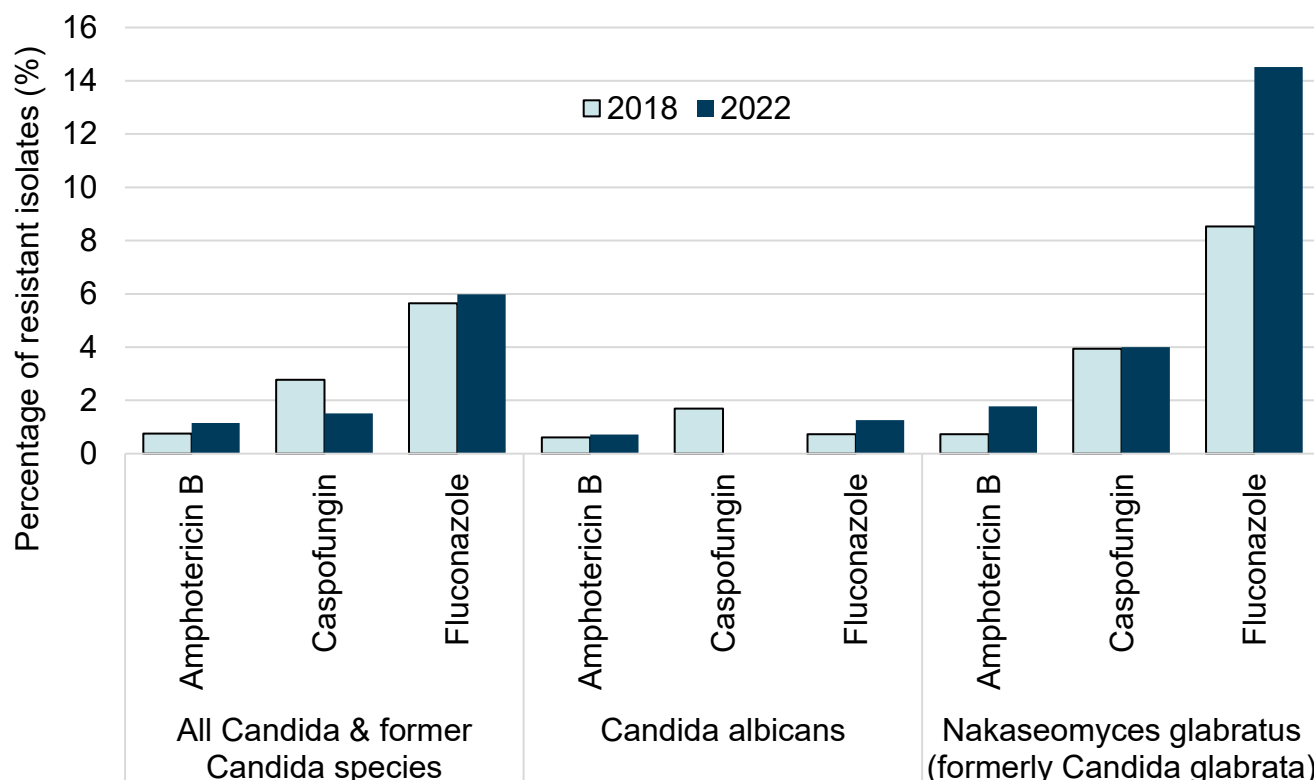


Figure 2.11. depicts the percentage of isolates resistant to 3 antifungals, comparing 2022 with 2018, for *Candida* and former *Candida* species combined, *C. albicans* and *N. glabratus*. In 2022, resistance to fluconazole was detected in 1.3% of *C. albicans* and 14.5% of *N. glabratus* isolates.

Antiviral resistance

Main messages

SARS-CoV-2

From surveillance of genomic data linked to patients, no mutations predicted to confer resistance to the COVID-19 small molecule therapeutics currently in clinical use (nirmatrelvir plus ritonavir (Paxlovid), remdesivir (Veklury), and molnupiravir (Lagevrio)) could be identified

Influenza A

All neuraminidase inhibitor resistant viruses (3 detected during the 2022 to 2023 influenza season) 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

Human immunodeficiency virus (HIV)

Drug resistance prevalence in drug-naïve patients increased from 6.1% in 2015 to 8.5% in 2021, mainly reflecting an increase in resistance to nucleos(t)ide reverse transcriptase inhibitors (NRTIs) from 4.1% to 6.8%. The prevalence of resistance to non-nucleoside reverse transcriptase inhibitor (NNRTI) remained stable, at 1.7% in 2015 and 1.4% in 2021; integrase strand transfer inhibitor (INSTI) resistance usually remained <1% each year

Hepatitis C virus (HCV)

In drug-naïve individuals, resistance-associated substitutions in the NS5A gene of subtype 1a samples increased from 11.1% (3 out of 27) to 18.9% (10 out of 53) between 2016 and 2021 but fell to 7.1% (1 out of 14) in 2022. UKHSA is currently establishing a national HCV genomics surveillance programme for England that will include monitoring of the prevalence of markers of antiviral drug resistance.

Herpes simplex virus (HSV)

Aciclovir resistance was detected in most specimens with HSV-1. A declining trend was noted (from 62% to 56%) over time although longer follow-up data is needed to confirm this. Aciclovir resistance was observed in a minority (33% to 40%) with HSV-2 infection. Foscarnet resistance was detectable in approximately 10% of HSV-1 samples and <10% of HSV-2 samples. Cidofovir resistance was detected in <10% of HSV-1 samples and not detected for HSV-2.

SARS-CoV-2 (COVID-19)

In 2022, a total of 1,057,537 SARS-CoV-2 sequences generated from patients sampled in England and linked to the UKHSA epidemiological surveillance systems were of sufficient sequence quality for genomic surveillance of resistance to COVID-19 therapeutics. A subset of these sequences (n = 25,793) were linked to patients for whom treatment requests were recorded in the Blueteq database. No mutation predicted to confer resistance to the COVID-19 small molecule therapeutics currently in clinical use (nirmatrelvir plus ritonavir (Paxlovid), remdesivir (Veklury), and molnupiravir (Lagevrio)) could be identified from surveillance of the genomic data. Mutations in the spike protein of Omicron variants are known to reduce susceptibility to sotrovimab (Xevudy), however, no novel mutations affecting susceptibility to any greater degree were identified.

UKHSA is also investigating concerns about potential mutations induced by the use of molnupiravir.

More information on COVID-19 therapeutics is presented in [Chapter 3](#).

Influenza virus

During the 2022 to 2023 influenza season (samples collected between week 40 in 2022 and week 20 in 2023) more than 2,500 viruses were screened by whole genome sequencing for antiviral susceptibility. Analysis of 1,540 A(H3N2) viruses by sequencing found 3 viruses with neuraminidase inhibitor (NAI)-resistant markers. Two viruses had the well characterised E119V amino acid substitution in neuraminidase (NA) which causes oseltamivir resistance; both were recovered from patients who had received oseltamivir treatment. In one of these 2 individuals a virus with a transient population of the R292K amino acid substitution emerged, causing reduced susceptibility to zanamivir as well as oseltamivir, despite not having received zanamivir treatment. The third resistant virus had a deletion of amino acids 244 to 247 in the NA, which causes reduced susceptibility to both oseltamivir and zanamivir and was recovered from a patient treated initially with oseltamivir and subsequently with zanamivir.

Of 823 A(H1N1)pdm09 NA sequences analysed, 2 oseltamivir-resistant viruses, both with the H275Y amino acid substitution, were detected from oseltamivir-treated individuals. No viruses with known markers of resistance to neuraminidase inhibitors were detected in 147 influenza B NA sequences analysed.

No viruses with known markers of resistance to baloxavir marboxil were detected in 1,234 A(H3N2), 623 A(H1N1)pdm09 and 107 influenza B Polymerase A (PA) sequences analysed.

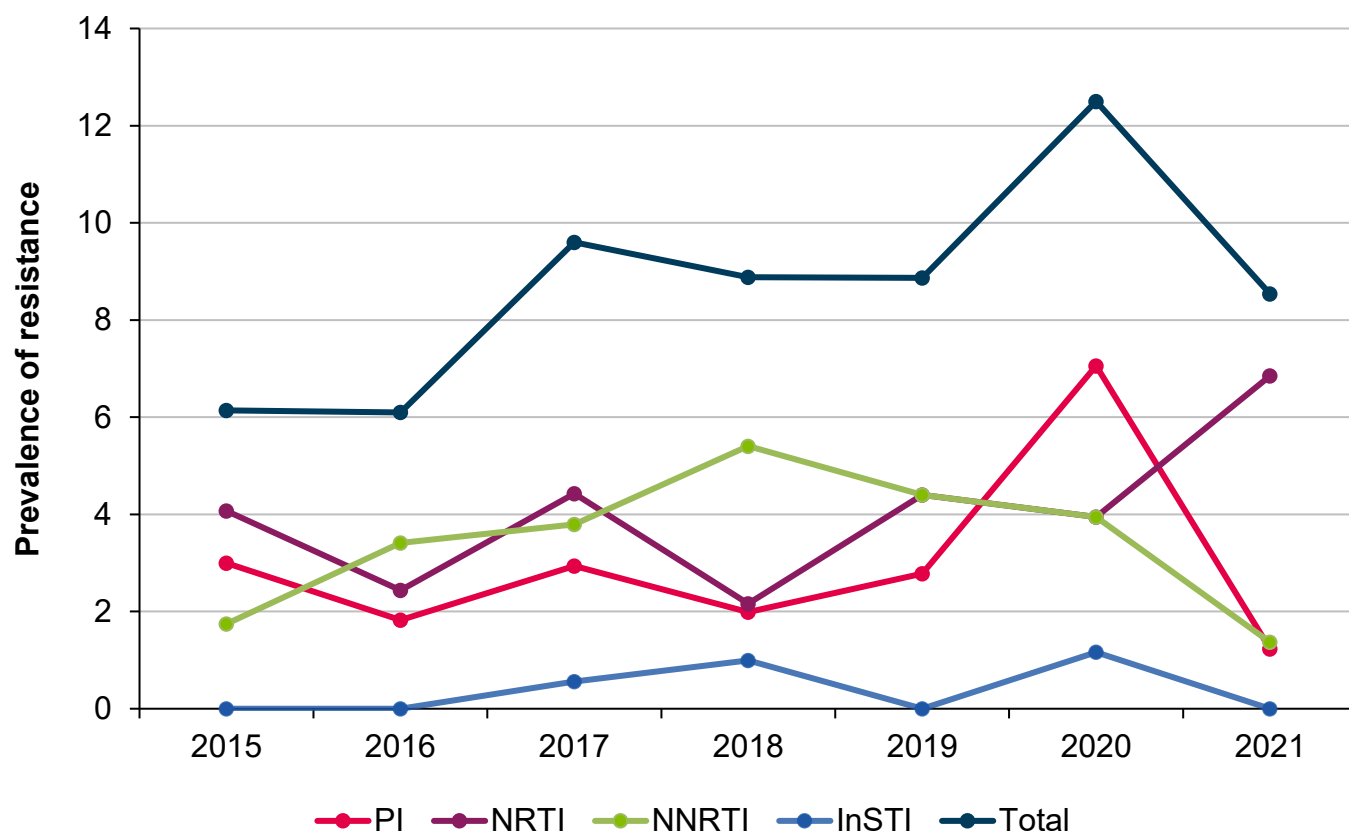
All NAI-resistant viruses emerged in immunocompromised individuals during NAI treatment, highlighting the vulnerable nature of these patients, and the need for close monitoring and low threshold of suspicion of resistance if viral load persists. Baloxavir has regulatory approval in the UK but is not marketed for use currently outside of an approved research protocol. There may be scope for compassionate use, against NAI-resistant viruses in specific clinical contexts. This continues the ongoing trend of very low resistance to NAIs and baloxavir, globally ([19](#)).

Results are reported weekly, in the [weekly national flu report](#) during the active influenza season and in the [annual flu reports](#).

Human immunodeficiency virus (HIV)

In the INITiO study, which aims to survey the prevalence of resistance to integrase strand transfer inhibitors (INSTIs) among treatment-naïve subjects in the UK, samples from approximately 1,200 randomly selected patients with recently-acquired (<4 months) HIV-1 and no history of antiretroviral drug treatment, were submitted for HIV whole genome sequencing in the UKHSA's Antiviral Unit ([Figure 2.12](#)).

Figure 2.12. Prevalence of resistance to antiretrovirals within the INITiO study – antiretroviral-naïve individuals with recently-acquired HIV-1*



* Unlike previous years, sequences were included at both >20% (minimum read depth of 30) and 2% to 20% (minimum read depth 100) variant frequency PI (protease inhibitor); NRTI (nucleos(t)ide reverse transcriptase inhibitor); NNRTI (non-nucleoside reverse transcriptase inhibitor); InSTI (integrase strand transfer inhibitor).

Drug resistance prevalence in this drug-naïve population increased from 6.1% in 2015 to 8.5% in 2021, reflecting an increase in NRTI resistance from 4.1% to 6.8%. The prevalence of NNRTI resistance remained stable at 1.7% in 2015 and 1.4% in 2021. PI resistance declined from 3.1% to 1.2% over this period. InSTI resistance usually remained <1% each year.

With regard to potential resistance against current pre-exposure prophylaxis (PrEP) agents, there were 7 cases of M184I/V in reverse transcriptase (RT) within drug-naïve individuals between 2015 to 2021; 4 out of 7 M184I/V cases were in 2021. No cases of K65R were observed.

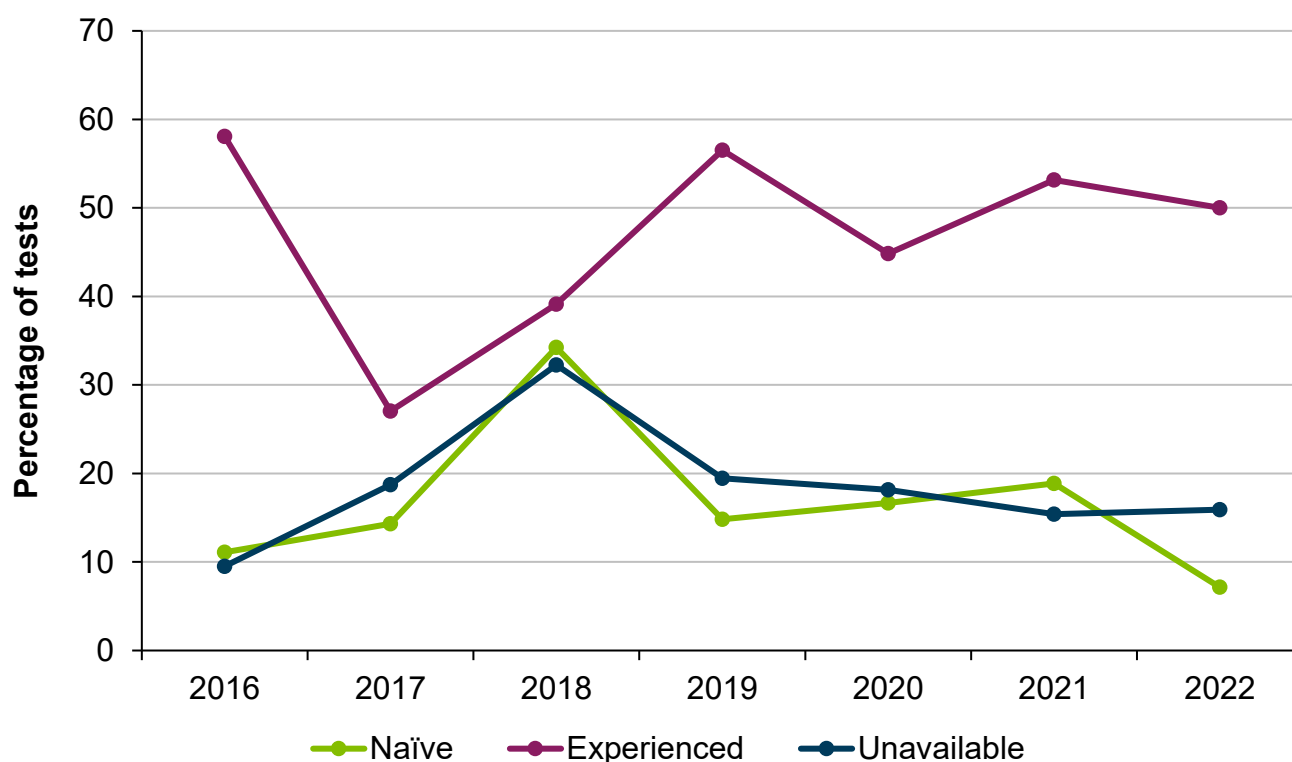
HIV resistance data availability are limited as the UK national HIV drug resistance database is no longer active, following discontinuation of Medical Research Council funding. However, UKHSA intends to relaunch the database in 2023.

Hepatitis C virus (HCV)

[Figure 2.13](#) shows the prevalence of resistance to HCV direct-acting antiviral (DAA) drugs, where testing was performed for resistance-associated substitutions in the NS5A gene of subtype 1a. Samples from 2,789 patients with HCV were tested between 2016 and 2022 in England, Wales and Northern Ireland (as reported by the UKHSA's Antiviral Unit). In drug-naïve individuals, resistance increased from 11.1% (3 out of 27) to 18.9% (10 out of 53) between 2016 and 2021 but fell to 7.1% (1 out of 14) in 2022. It is unclear whether this trend reflects a true decline in transmitted resistance prevalence over time, or an artefact due to low numbers of samples with treatment history available. The prevalence of NS5A resistance in treatment-experienced individuals remains high.

UKHSA is currently establishing a national HCV genomics surveillance programme for England, which seeks to use leftover blood samples collected as part of routine care in patients with HCV infection, for whole genome sequencing. Results will be linked to the HCV Treatment Registry and outputs will include monitoring of the prevalence of antiviral drug resistance as well as viral subtype distribution, in support of the HCV elimination program.

Figure 2.13. The percentage of tests where resistance-associated substitutions were detected in the NS5A gene for HCV subtype 1a (source Antiviral Unit, UKHSA)



Herpes simplex virus (HSV)

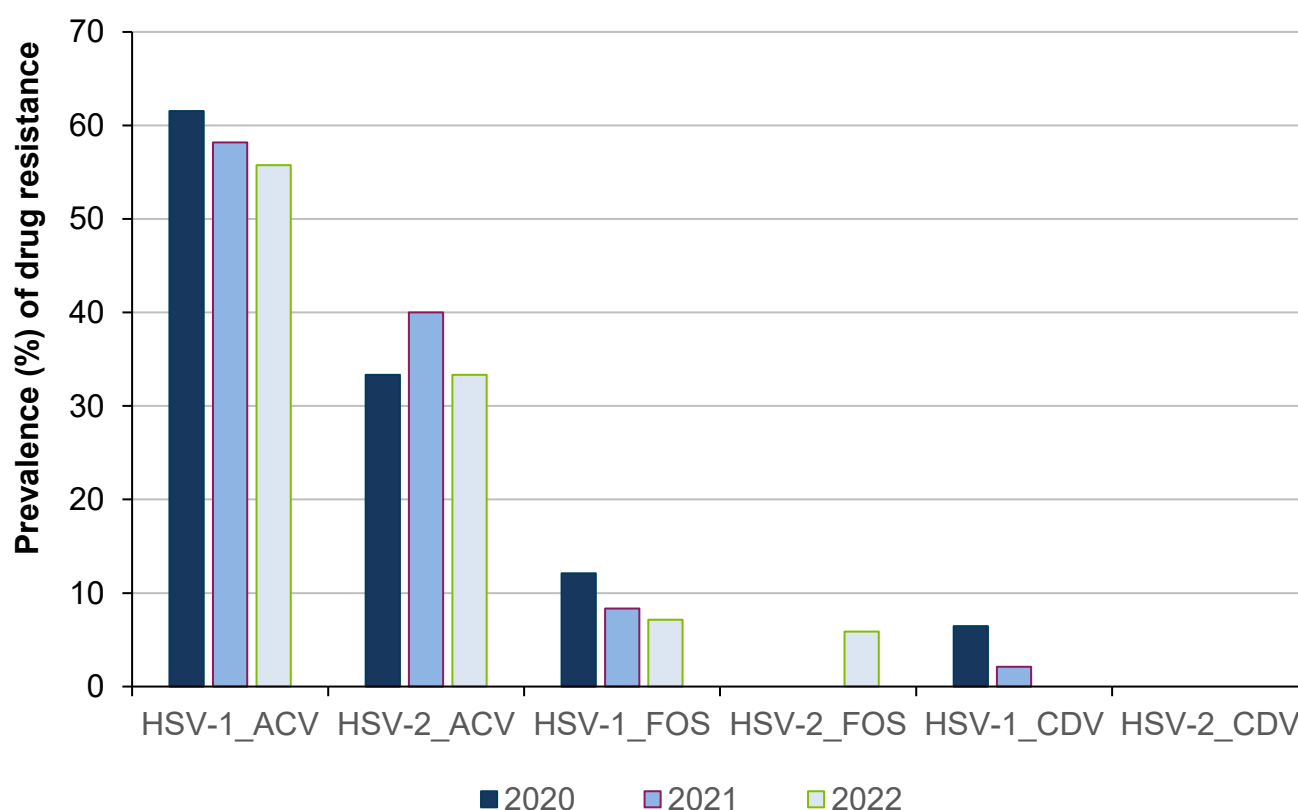
The prevalence of drug-resistant HSV-1 and HSV-2 between 2020 and 2022 in samples from patients with known disease, received in the UKHSA's Antiviral Unit, is shown in [Figure 2.14](#). In

total, 84, 120 and 117 samples were received in 2020, 2021 and 2022, respectively. Most samples came from individuals with underlying immunosuppression.

Aciclovir resistance was common in samples of patients with HSV-1 referred to the UKHSA's Antiviral Unit ([Figure 2.14](#)). A declining trend was noted (from 62% to 56%) over time although longer follow-up data is needed to confirm this. Aciclovir resistance was observed in a minority (33% to 40%) with HSV-2 infection. Foscarnet resistance was detectable in approximately 10% of HSV-1 samples and <10% of HSV-2 samples. Cidofovir resistance was detected in <10% of HSV-1 samples and not detected for HSV-2.

As most cases were immunosuppressed and many had received multiple courses of different antiviral classes, they do not represent the majority of cases treated with antivirals

Figure 2.14. Prevalence of drug resistant HSV-1 or HSV-2 in patients with known HSV disease, from samples received in the UKHSA's Antiviral Unit, 2020 to 2022



Parasitic resistance

Main messages

In sub-Saharan Africa, the source of 94% of UK imported malarias, the efficacy of oral artemisinin combination therapy (ACT) has remained high since implementation in 2004. However, waning efficacy of ACTs has been seen in some malaria-endemic countries in south-east Asia, characterised by slow parasite clearance after treatment with artemisinin. Of the 32 treatment failures investigated in the period 2016 to 2022, 2 *Plasmodium falciparum* isolates carried propeller domain mutations in the *pfk13* locus.

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.

Plasmodium falciparum accounts for 85% of all malaria cases (approximately 1,500 cases) imported into the UK annually. It is the most clinically severe among the 5 *Plasmodium* species that infect humans, and is also the one which accounts for the vast majority of drug-resistant malaria parasites. Over the last 40 years, chloroquine has been abandoned for the treatment of *P. falciparum* malaria, resistance to pyrimethamine-sulfadoxine (Fansidar®) has become widespread and mefloquine resistance is well established in some geographical areas, especially Southeast Asia.

In the UK, clinical management of uncomplicated *P. falciparum* malaria is with oral artemisinin combination therapy (ACT). In sub-Saharan Africa, the source of 94% of UK imported malarias, the efficacy of ACTs has remained high since implementation was undertaken there from 2004. However, waning efficacy of ACTs has been seen in some malaria-endemic countries in south-east Asia, characterised by slow parasite clearance after treatment with artemisinin. Resistance to artemisinin, which was first reported in 2008 ([20](#)), is associated with certain mutations in the propeller domain of the *P. falciparum* kelch protein K13 ([21](#), [22](#)). Although African parasites are known to carry polymorphisms in the *pfk13* gene which encodes this protein, these were generally not associated with reduced artemisinin susceptibility *in vitro* or treatment failure *in vivo*. However, recent investigations in Rwanda and Uganda have described emerging *pfk13* genotypes with polymorphisms R561H, C469Y or A675V that are associated with slow post-artemisinin clearance *in vivo* ([23](#), [24](#)), and reduced susceptibility *in vitro*.

In the period 2016 to 2022, of 32 treatment failures investigated in the UK, 2 *P. falciparum* isolates carried propeller domain mutations in the *pfk13* locus. The second case, presenting in 2022 and acquired in Uganda, experienced recrudescent *P. falciparum* parasitaemia after 2 separate courses of ACT treatment (with artemether-lumefantrine), thus displaying clinical treatment failure. Genotyping confirmed the presence of the A675V variant of *pfk13* in parasite-positive peripheral blood samples. Equally concerning is that these parasites displayed significantly reduced susceptibility to lumefantrine *in vitro*, suggesting that partner drug selection

has directly impacted *P. falciparum* populations in Uganda. In addition, a contemporary isolate of Ugandan origin also derived from a UK malaria patient with post-artemether-lumefantrine recrudescence, but not harbouring a *pfk13* propeller domain mutation, showed equally significant reduction in susceptibility to both artemisinin and lumefantrine. 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.

It is likely that in African *P. falciparum*, mutations in *pfk13* are insufficient on their own, to cause clinical failure in artemether-lumefantrine-treated patients, but that additional parasite adaptation to reduce susceptibility to lumefantrine is a necessary additional phenotypic feature.

Dihydroartemisinin-piperaquine, an alternative oral ACT with a different partner drug, is listed in the British National Formulary as artemimol with piperaquine phosphate and should be considered instead of artemether-lumefantrine where there is a suspicion that the latter might not be effective (for example, in *P. falciparum* strains acquired in Uganda).

In contrast to the overuse of antibiotics, there is significant underutilisation of antimalarial prophylactic drugs by travellers from the UK visiting malarious areas. In 2021, where the history of chemoprophylaxis was known, 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 preventive advice. The UKHSA Malaria Reference Laboratory is actively engaging with relevant groups of travellers better to communicate the message and improve uptake.

UK participation in international surveillance of AMR

The fifth WHO [global antimicrobial resistance and use surveillance system \(GLASS\) report](#) was published in December 2022, and included data from the UK, covering blood and urine isolates from 2019, and a description of the current status of AMR surveillance nationally.

Long-term goals of GLASS include supporting the development of surveillance approaches that include epidemiological, clinical, and population-level data to allow calculation of AMR rates in the population, and the coordination of global surveillance systems on AMR in humans, animals, food, and the environment for the investigation of drivers of AMR development.

Replacing the ECDC European Antimicrobial Resistance Surveillance Network (Ears-Net) submission for the UK for 2021 AMR data, was a submission to the WHO Central Asian and European Surveillance of Antimicrobial Resistance (CAESAR) network for inclusion in their [report in 2023](#).

Main AMR resources and reports

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 using much of the data referred to in this report and the listed resources are documented in the Research chapter ([Chapter 8](#)) 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](#)
- [Fingertips: AMR local indicators](#)
- [UK One Health report: Antibiotic use and antibiotic resistance in animals and humans](#)
- [Tuberculosis in England: national quarterly reports](#)
- [The gonococcal resistance to antimicrobials surveillance programme GRASP](#)

Future actions

Antibacterial resistance:

- informing the future 2024 to 2029 AMR NAP discussions to shape the targets and deliverable measures to reduce AMR
- investigate in more detail the relationship between health inequalities, deprivation, ethnicity, geography, patient demographics and AMR
- monitor developing AMR in novel antimicrobial agents matched with molecular resistance, particularly in carbapenem-resistant Gram-negative bacteria
- coordination of the 2023 national healthcare-associated infections and antimicrobial usage point prevalence survey. The analysis of the results aims to capture a snapshot of AMR in hospital-acquired infections and prescribing in the post COVID-19 pandemic period

Antifungal resistance:

- following the reestablishment of the ESPAUR antifungal sub-group, the focus is to strengthen the reporting of fungal infections
- undertake a review of fungal infections and antifungal resistance in different specimen groups

Antiviral resistance:

- prepare for baloxavir susceptibility surveillance (whole genome sequencing of influenza virus positive clinical samples, with analysis of the PA gene for known markers of resistance) – phenotypic testing is under development

- expand respiratory syncytial virus whole genome sequencing program of the winter season, which will provide baseline data in support of future antiviral and vaccine surveillance activities
- establish a national HCV genomics surveillance programme for England in 2023

Antiparasitic resistance:

- support the UKHSA Malaria Reference Laboratory to actively engage with relevant groups of travellers to better communicate the prophylaxis message and improve uptake

Chapter 3. Antimicrobial consumption

Main messages

Antibiotics

Total antibiotic consumption in 2022 exhibited an increase of 8.4% compared with 2021, and remained below pre-pandemic 2019 levels.

In 2022, consumption increased in general practice, other community settings, hospital inpatients and hospital outpatients. The exception was dental practices (-7.4% compared with 2021), where a sharp rise in antibiotic use occurred between 2019 and 2020.

All settings continued to have antibiotic consumption (using defined daily dose (DDD) per 1,000 inhabitants per day (DID) rates) below pre-pandemic levels, apart from dental and other community settings. Increase in antibiotic consumption in the community is most likely related to increased healthcare demands in 2022 rather than shifts in provision of services alone.

Total antibiotic consumption increased in 2022 across the majority of antibiotic classes, however remained lower than in 2018, apart from first and second-generation cephalosporins (+8.7%), anti-*Clostridioides difficile* agents (+64%, $p<0.05$) and other antibacterials (+12.4% $p<0.05$).

The greatest absolute increase was seen in penicillins (excluding formulations with β -lactamase inhibitors) which increased by 0.82 DID between 2021 and 2022; related to increased usage of amoxicillin (+21.9%), and phenoxymethylpenicillin (+41.5%), at least in part driven by the GAS infection rates in 2022.

In 2022, the primary care setting accounted for 80.2% of all antibiotics prescribed. Although by DID primary care antibiotic use in 2022 remained below the 2019 DID, use by items per 1,000 population were slightly higher in 2021 (1.68) than pre-pandemic 2019 (1.66 items per 1,000 inhabitants per day) emphasising need for continued focus on reducing inappropriate antibiotic use.

Primary care penicillin prescribing increased by 23% between 2021 and 2022; likely related to increased circulation of influenza, respiratory syncytial virus, and group A streptococcal (GAS) infection following changes in social mixing due to the COVID-19 pandemic.

The large increase seen in general practice antibiotic use in 2022 is likely linked to the GAS outbreak in late 2022; increases were seen across all age groups, but especially amongst younger ages (0 to 4 and 5 to 14 years).

Antibiotic use in secondary care, although increased in the past year, remained below 2019 levels; reductions across the 5 years have been driven by reductions in outpatient prescribing (-11.8%), although there were increases between 2021 and 2022 (+6.3%).

The largest absolute increases in secondary care antibiotic use were for penicillins and tetracyclines; proportionally, the greatest increase were in anti-*C. difficile* agents (+19.5%), exceeding pre-pandemic 2019 levels, reflecting the rise in CDI.

Between 2021 and 2022 use of piperacillin/tazobactam in secondary care and across all trust types continued to increase (+4.3%); use in 2022 exceeded 2019 levels.

Antibiotic use between 2021 and 2022 by secondary care specialty increased within accident and emergency (+11.1%), orthopaedics (+76.5%) and 'other' (+5.6%). These same specialist groups, along with intensive care units, prescribed more than they did in 2019.

Antifungal

Systemic antifungals use decreased by 11.0% from 2018 to 2022, driven by reduced use in the community (-12.1%, from 0.14 to 0.12 DID); there was a large decrease in 2020, as a result of the COVID-19 pandemic, with usage since increasing.

Terbinafine, the most frequently prescribed antifungal in the community, was the only antifungal to show an increase in community use between 2020 and 2021 (+11.6%, 0.6 to 0.67 DID).

Total consumption of systemic antifungals in NHS acute trusts decreased by 7.7% from the COVID-19 related peak in 2020, suggesting that 2022 antifungal prescribing and admissions were returning to pre-pandemic levels.

Posaconazole secondary care prescribing increased markedly in 2020 (+46% compared with 2019) and remains at the increased rate in 2022.

Antiviral

In 2022, there was a total of 108,786 Blueteq treatment requests for COVID-19 therapeutics in England; the rate of requests fluctuated with transmission of SARS-CoV-2 in the population and changes in testing and guidance.

Information on antiviral usage for hepatitis C was published in the UKHSA Hepatitis C annual report; the report highlighted an increase of 24.6% in treatment initiations between 2020 and 2022; with re-engagement of services between this time.

Antiparasitic

Data on antiparasitic agents is difficult to interpret without information on prescription indication, as some of these agents have several purposes.

Among agents used to treat malaria, the most frequently prescribed was quinine (0.56 DID in 2021) although it can be used for other indications.

There was a decreasing trend (-29.5%) in DID between 2018 and 2022 in the use of quinine, with no substantial change in trend with the COVID-19 pandemic.

Introduction to Chapter 3

This chapter presents data on antimicrobial consumption in England in 2018 to 2022, in primary and secondary care, and includes surveillance data nearly 3 years on since the COVID-19 pandemic was declared. Antibiotic prescribing settings include general practice (GP), dental practice, out-of-hours services, and hospital inpatient and outpatient services (see Chapter 3 of [the Annexe accompanying this report](#) for more details).

Antimicrobials (which include antibiotics, antivirals, antifungals and antiparasitics) are medicines used to stop or slow the spread of microorganisms causing infection. Antimicrobials are fundamentally different to all other medicines, in that, their use not only impacts the individual patient and helps to save lives but has implications to the population. While antimicrobial resistance is a natural phenomenon, antimicrobial use exerts selective pressure and is a modifiable driver of antimicrobial resistance. Efforts have been focused on improving appropriate use of antimicrobials, in order to maintain the efficacy of antimicrobials we have.

The UK's 5-year National Action Plan (NAP) has an ambition to reduce total UK antimicrobial consumption in humans by 15% by 2024, from a 2014 baseline (2). Surveillance and 'information for action' are required to ensure progress towards these national targets, to understand antimicrobial consumption trends at a national level, and better understand which antimicrobial stewardship (AMS) or interventions may be most effective. This chapter exemplifies the importance of robust data access and active monitoring of trends in antimicrobial usage, over time (including unusual periods, such as the COVID-19 pandemic), and across different prescribing settings.

Methods can be found in the [Annexe](#). Data and figures presented in this chapter are available in the [Chapter 3 data table spreadsheet](#) and the downloadable [figures slidedeck](#).

Antibiotic consumption

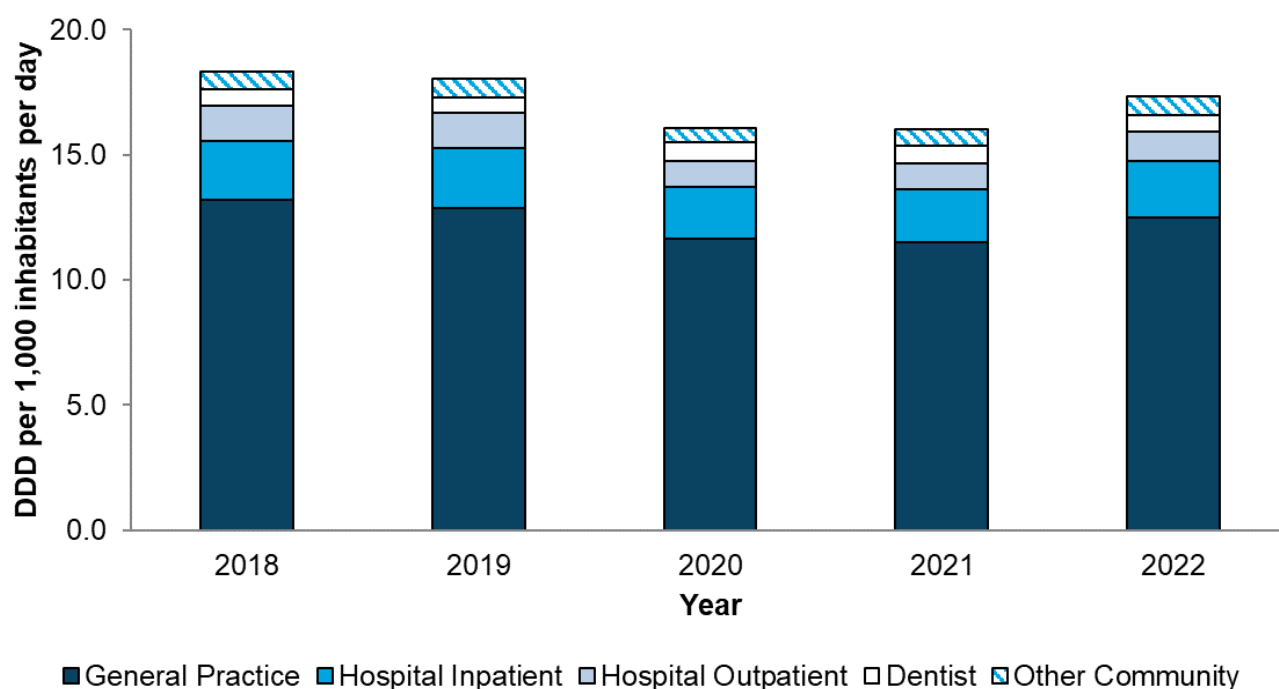
Total antibiotic consumption

In England, total antibiotic consumption declined by 5.3% between 2018 and 2022, from 18.3 Daily Defined Dose (DDD) (25) per 1,000 inhabitants per day (DID) to 17.4 DID ([Figure 3.1](#)). As noted in the previous ESPAUR publication, there was a decline of 10.9% between 2019 and 2020, coinciding with the start of the COVID-19 pandemic. In addition to changes in service delivery (fewer face-to-face consultations in primary care and fewer hospital admissions,

particularly during the first year of the COVID-19 pandemic), there were several other factors which altered prescribing behaviours or demand. These included increased infection prevention measures by health care professionals and the general population, including social distancing decreasing infection rates; changes in the case mix of patients consulting in primary care (reduction in appointments for the very young) as well as those admitted into hospital (with delayed and cancelled elective procedures and increases in more acutely ill patients and admissions to intensive care and high dependency units) and altered patterns of transmission of infections (for example, national and local social restrictions measures, wearing of masks impacting circulation of pathogens). With services resuming and easing of restrictions, consumption trends reflected this change. In 2021 compared with 2020, total antibiotic consumption continued to decline, albeit to a lesser extent of 0.4%.

The post-pandemic period also saw changes in the seasonality of infections. From mid-September 2022, there were unusual out-of-season increases seen in invasive group A streptococcal (GAS) infections and scarlet fever. Alongside the GAS incident, the winter period of 2022 also had unusual patterns and increased amount of co-circulating viral infections (respiratory syncytial virus, influenza and hepatitis related to adeno-associated virus), such infections are frequently associated with inappropriately antibiotic prescribing ([26](#), [27](#)). Indeed, likely related to the unprecedented increase in infections and reduced immunity since the COVID-19 restrictions, total antibiotic consumption in 2022 increased by 8.4% compared with 2021, although notably, this remained 3.8% below pre-pandemic 2019 levels.

Over the past 5 years, most antibiotics in England were prescribed in general practice, with this trend continuing in 2022 (72.1% of overall prescribing, 12.5 DID). The subsequent percentages of prescribing in 2022 occurred in hospital inpatients 13.1% (2.3 DID), hospital outpatient 6.7% (1.2 DID), other community settings 4.4% (0.77 DID) and dental practices 3.7% (0.64 DID) ([Figure 3.1](#)). During the initial pandemic period (2019 compared to 2020), consumption rates decreased across all settings apart from dental practices. The latest 2 years (2021 and 2022), however, have shown an increase in antibiotic consumption across all settings apart from dental practices (-7.4%, 0.69 to 0.64 DID in 2021 to 2022; dental practice rates were already elevated during the COVID-19 restrictions). Antibiotic use remains lower compared with pre-pandemic 2019 rates across all settings, apart from dental practices (0.61 DID in 2019) and community settings (0.73 DID in 2019).

Figure 3.1 Total antibiotic consumption by setting, expressed as DID, England, 2018 to 2022

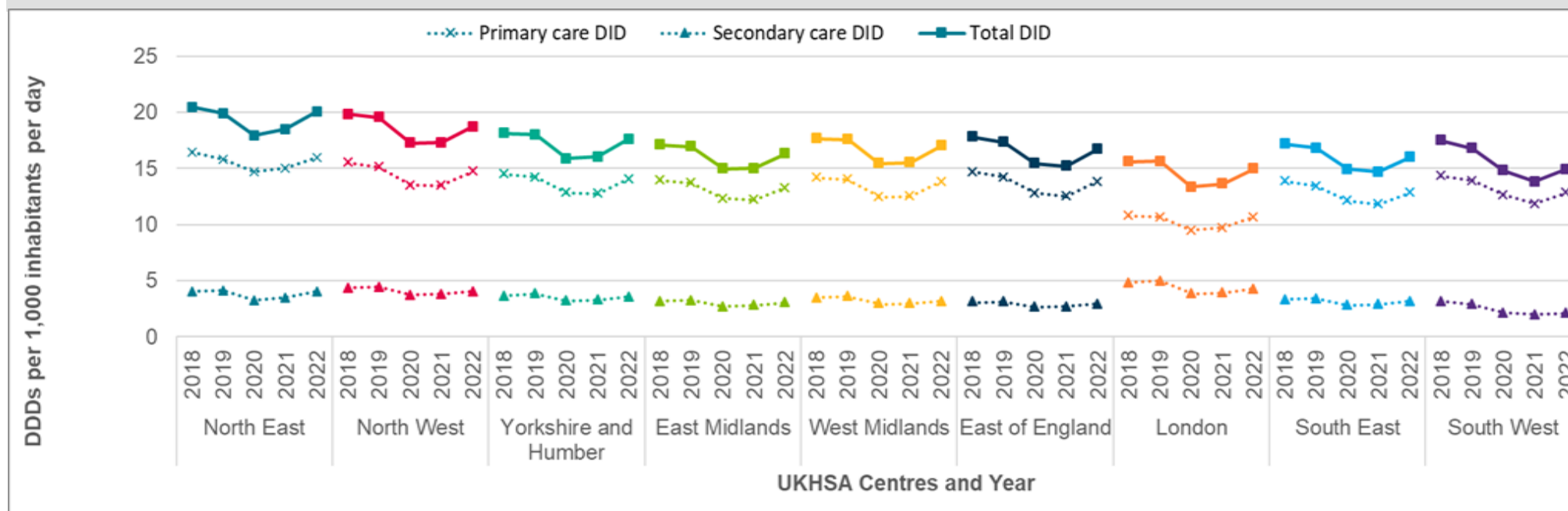
3.1. Regional variation in antibiotic consumption in England

Total DIDs have consistently been greatest within the North East and North West of England, and lowest in London (Figure 3.1.1). Compared to the other regions, London presents much lower primary care prescribing, the lowest seen across the 5 years, and the highest secondary care antibiotic use. As the largest proportion of antibiotic consumption is accounted for within primary care and total DIDs are often dictated by changes in primary care trends, this may explain the lower total trends seen in London. Further work is planned to understand the role of additional factors, such as age, sex, and area-level deprivation in regional prescribing differences. Access to healthcare services may differ in London (patients are often in closer proximity to secondary care services than rural areas or other regions and primary care waiting times are longer), case-mix of patients or population differ as do infection and consultation rates, and there are also variations in independent sector access (likely greater in London, and subsequently greater antibiotic prescribing that is not captured here. Our surveillance and access to independent sector data is currently limited). Furthermore, patients in London may be more likely to access care at primary care settings other than general practices, such as walk-in centres and urgent treatment centres, and the usage data for these settings currently represents a gap in surveillance (where antibiotics are supplied under Patient Group Direction rather than on prescription).

Prior to the COVID-19 pandemic, total antibiotic prescribing trends had shown a year-on-year decreasing trend across all UKHSA centres in England. The COVID-19 pandemic saw regional reductions in the rate of total DIDs as well as across settings (primary and secondary care DIDs) (Figure 3.1.1). Increases have since been seen in primary and secondary care between 2021 and 2022 for all regions. Between 2021 and 2022, total DIDs and primary care increases

were greatest within the East of England (+9.9% and +10.5% respectively), whilst the highest rates within secondary care were in the North East (15.3%). Consumption levels by UKHSA regions and both primary and secondary care remain lower than pre-COVID-19 levels (that is, sustained lower antibiotic consumption compared to 2019), apart from primary care consumption for the North East (1.3% increase compared with 2019 levels) and primary care consumption in London (+0.2%).

Figure 3.1.1. Total, primary and secondary care antibiotic consumption in UKHSA centres, expressed as DID, 2018 to 2022 (excludes dental practice data)



(Primary care data does not include dental care prescribing as dental data at the UKHSA region-level were not available at time of production for the entire duration assessed. The order of UKHSA centres presented is based on geographic location from North to South of England.)

Antibiotic group

Table 3.1 displays the antibiotic groups with the highest total consumption in England. In 2022, penicillin, excluding β -lactamase-inhibitor combinations (BLIs), remained the most used antibiotics groups in England, accounting for 32.7% of total consumption and 5.67 DIDs. This was followed by tetracyclines (25.8%, 4.47 DIDs), and 'macrolides, lincosamides and streptogramins' (13.8%, 2.39 DIDs).

The period between 2021 and 2022 saw an increase in the use of all antibiotic groups, with the exception of oral metronidazole, where consumption decreased by 3.1% ($p<0.05$) (Table 3.1). The greatest absolute incline was seen in penicillins (excluding β -lactamase inhibitors) with an increase of 0.82 DID between 2021 and 2022; this was primarily related to increased usage of amoxicillin (+0.53 DID, + 21.9%), phenoxymethylpenicillin (+0.28 DID, +41.5%) and piperacillin/tazobactam (0.007 DID, +8.6%), between 2021 and 2022. Notably, piperacillin/tazobactam use increased slightly since the supply shortages in 2017. Increased penicillin use in 2022 is likely related to decreased immunity and exposure to infections during the COVID-19 pandemic which may have underpinned the increased transmission in co-circulating infections; namely influenza, respiratory syncytial virus (RSV), and GAS infection. GAS infections were at unprecedented circulation levels in late 2022 and led to a marked elevation in scarlet fever and invasive GAS infections, with subsequent exacerbated demand for antibiotics and operational impact on healthcare services ([14](#)).

For the classes which increased, antibiotic consumption remained lower than 2019 levels and lower than the beginning of the 5 years, apart from first and second-generation cephalosporins (increase of 8.7% between 2018 and 2022), anti-*C. difficile* agents (+64%, $p<0.05$) and other antibacterials (+12.4% $p<0.05$, see Chapter 3 of the [Annexe accompanying this report](#) for full definition). Increased use of anti-*C. difficile* agents is likely related to noted increases in hospital-onset *C. difficile* infections, as reported in [Increased use in anti-Clostridioides difficile agents](#) ([28](#)). Use of nitrofurantoin (included within the 'other antibacterials' group and is recommended as a switch from trimethoprim) increased over the 5 years, with greater increases seen from 2020 to 2022. This increased use in 2022 compared with 2021 was seen across all settings, with increases of 10.5% ((+0.1 DID) in general practice, 23.6% (+0.013 DID) in other community, and 19.8% (+0.009 DID) and 9.2% (+0.003 DID) in hospital inpatient and outpatient respectively.

The top 3 antibiotics prescribed in primary care in 2022 were amoxicillin (penicillin excluding β -lactamase inhibitor; 2.69 DIDs), doxycycline (tetracycline; 2.28 DIDs) and lymecycline (a tetracycline is often used for treatment of acne; 1.41 DIDs). Within secondary care the 3 most widely used antibiotics were co-amoxiclav (penicillin with inhibitor combinations; 0.57 DID), doxycycline (tetracycline; 0.46 DIDs) and flucloxacillin (penicillin excluding β -lactamase inhibitor; 0.44 DIDs).

Table 3.1 Total antibiotic consumption by antibiotic groups, expressed as DID, 2018 to 2022

Antibiotic Group	2018	2019	2020	2021	2022	Trend	p-value
Penicillins (excluding β -lactamase inhibitors)	5.901	5.719	4.748	4.852	5.674		0.517
Penicillins (β -lactamase inhibitor combinations only)	1.125	1.113	1.004	1.020	1.073		0.312
First and second-generation cephalosporins	0.244	0.239	0.238	0.248	0.265		0.155
Third, fourth and fifth-generation cephalosporins	0.080	0.080	0.071	0.068	0.074		0.177
Carbapenems	0.053	0.052	0.047	0.048	0.049		0.199
Tetracyclines	4.619	4.754	4.353	4.331	4.470		0.250
Macrolides, lincosamides and streptogramins	2.878	2.736	2.353	2.206	2.392		0.073
Sulfonamides and trimethoprim	0.853	0.780	0.751	0.737	0.757		0.099
Quinolone antibacterials	0.565	0.513	0.462	0.448	0.456		0.035 ⁺
Anti- <i>Clostridioides difficile</i> agents [^]	0.004	0.004	0.004	0.005	0.007		0.026 ⁺
Oral metronidazole	0.308	0.300	0.305	0.287	0.278		0.034 ⁺
Other antibacterials*	1.554	1.607	1.620	1.648	1.747		0.014 ⁺

Notes to Table 3.1

+ Statistically significant p-value for trend from 2018 to 2022

[^] Anti-*Clostridioides difficile* agents: oral vancomycin and fidaxomicin

* Other antibacterials (ATC 3rd level pharmacological subgroup 'J01X') include: glycopeptide antibacterials, polymyxin, steroid antibacterials, imidazole derivatives, nitrofurantoin derivatives, other antibacterials (full list in chapter 3 of [the Annexe accompanying this report](#)).

Increase in antibiotic usage in the private sector in England, April 2019 to March 2023

Surveillance of antimicrobial consumption across all healthcare sectors is required to better understand total consumption trends in England, to monitor changes or shifts in prescriber settings, and identify areas requiring focused AMS efforts. Healthcare seeking behaviours have changed subsequent to the COVID-19 pandemic, with reports of an increase in the demand for private healthcare services.

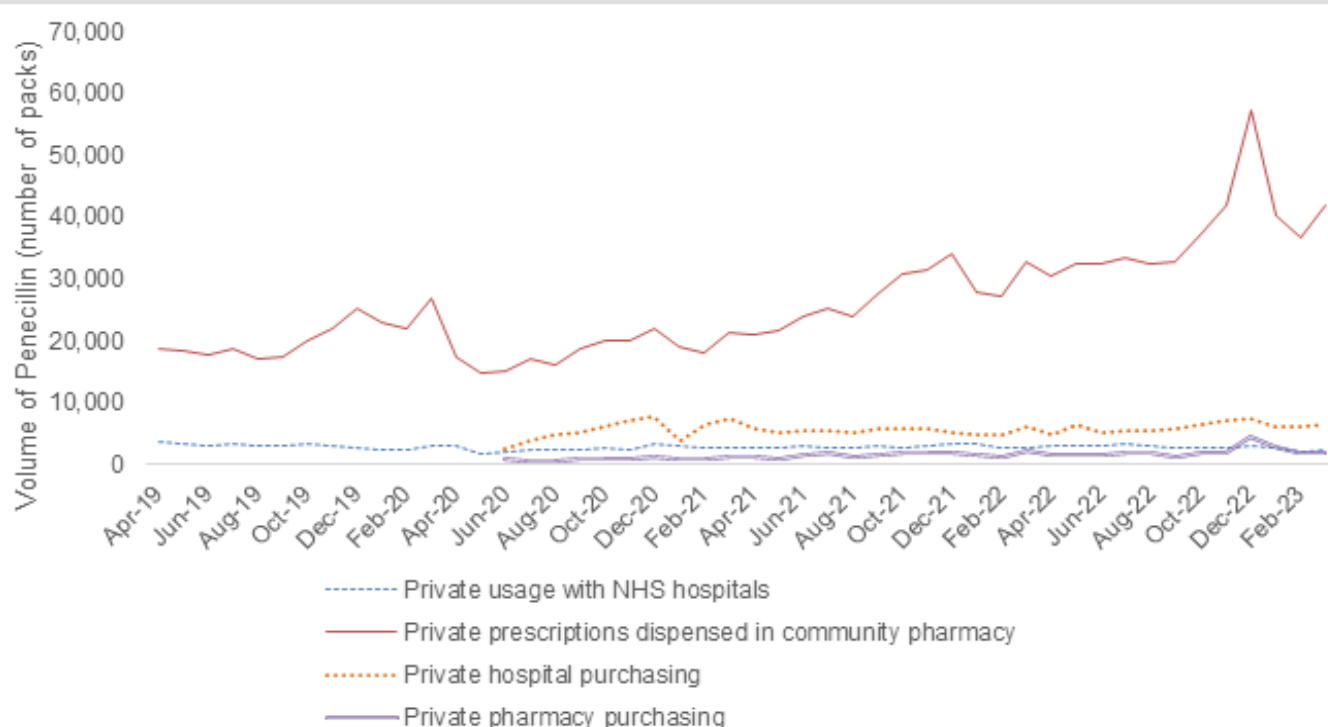
IQVIA collects data on antimicrobial usage across the private sector covering sales into private hospitals and private pharmacies, private prescriptions dispensed in community pharmacies and, private usage in NHS facilities. Volume data (number of packs) were extracted for all penicillin antibiotics (ATC J01C) for private prescriptions dispensed in community pharmacies and to private patients in the NHS between April 2019 and March 2023, and for sales into private hospitals and private pharmacies between June 2020 and March 2023. Though usage by private hospitals/pharmacies and private patients in the NHS remained stable, an increasing trend in private prescriptions dispensed by community pharmacies was observed over the most recent years (median number of packs per month 2019 = 18,819, median number of packs per

month 2022 = 32,667; 73.6% increase). However, to put into context, this is approximately 1% of the packs dispensed by NHS prescriptions in 2022.

A sharp peak in prescribing between October 2022 and February 2023 was also observed for private prescriptions dispensed by community pharmacies, which coincided with the high rates of circulating respiratory viruses and the incidence of GAS infections experienced that winter.

The observed increase in dispensing of private prescriptions by community pharmacies illustrates the need for continued surveillance of private sector antibiotic prescribing, and more detailed studies required to investigate this further.

Figure 3.1.2. Private sector dispensing of penicillins in England, April 2019 to March 2023



Data sources

- 'Sales into private hospitals and private pharmacies' IQVIA Supply Chain Manager (SCM), March 2023
- 'Private prescriptions dispensed in community pharmacy' IQVIA Prescription Based Services (PBS) March 2023
- 'Private usage within NHS hospitals' IQVIA Hospital Pharmacy Audit (HPA) March 2023

Antibiotic prescribing in primary care (items by population)

Total antibiotic use in primary care

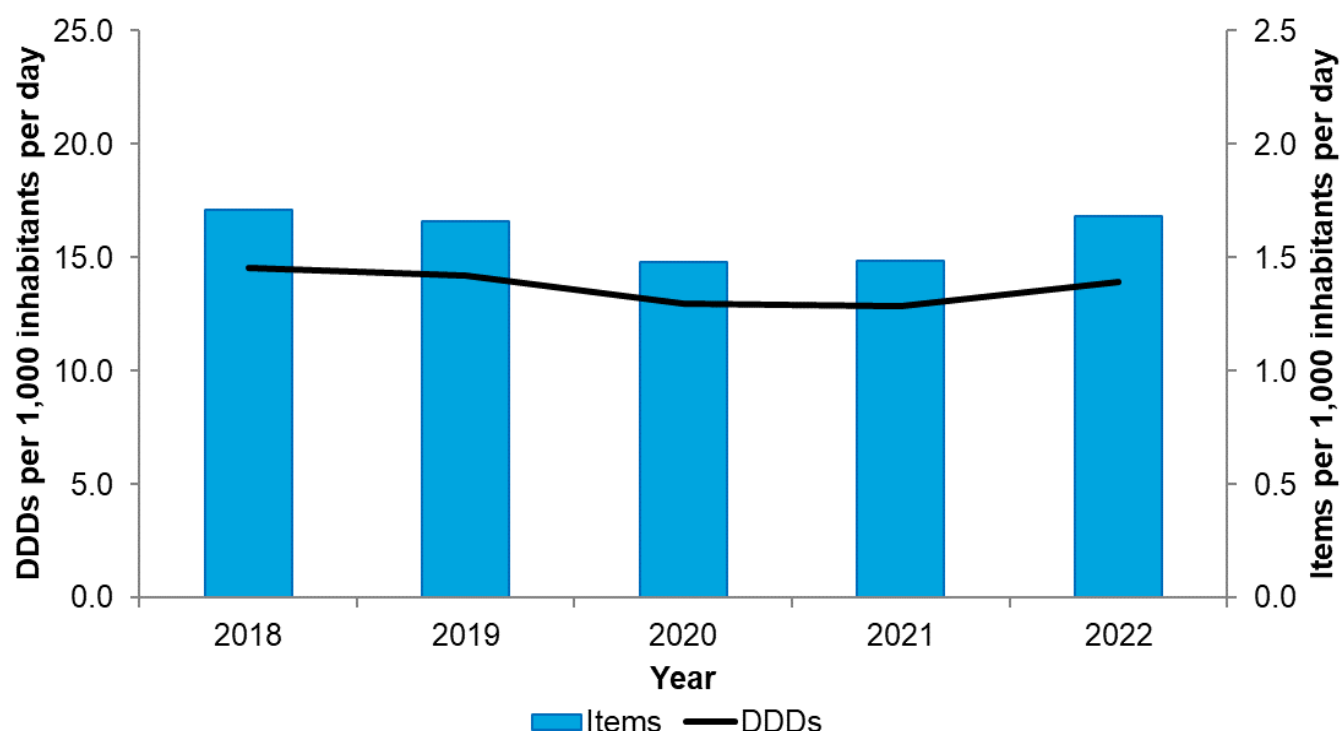
In 2022, the primary care setting accounted for 80.2% of all antibiotics prescribed. Antibiotic prescribing within the primary care settings declined between 2018 to 2022, from 1.71 to 1.68 items per 1,000 inhabitants per day, a decrease of 1.7% (Figure 3.2). The largest declines

occurred following the start of the COVID-19 pandemic, between 2019 and 2021. Despite a decrease since 2018, there was an increase of 13.0% (from 1.49 to 1.68 items per 1,000 inhabitants per day) in primary care antibiotic usage between 2021 and 2022. This incline in primary care antibiotic consumption levels, despite being less than 2018 rates, is at levels greater than the past 3 years, higher than 2019 and pre-COVID-19 (2019: 1.66 items per 1,000 inhabitants per day), emphasising the need for continued efforts to reduce inappropriate avoidable antibiotic use.

As social and healthcare activities in England began reverting to pre-pandemic practice between 2021 and 2022, there was a rise in antibiotic prescriptions in general practice and other community settings (14.7% increase from 1.25 to 1.44 items per 1,000 inhabitants per day, and 20% from 0.095 to 0.115 items per 1,000 inhabitants per day, respectively). These rates were slightly above those observed in 2019 (1.42 and 0.109 items per 1,000 inhabitants per day, respectively).

Meanwhile, there was a 7.6% decline in antibiotics used in dental practices between 2021 to 2022 (0.141 to 0.130 items per 1,000 inhabitant day, respectively). Despite this decrease, the rates remained above pre-pandemic levels in 2019 (0.129 items per 1,000 inhabitant day).

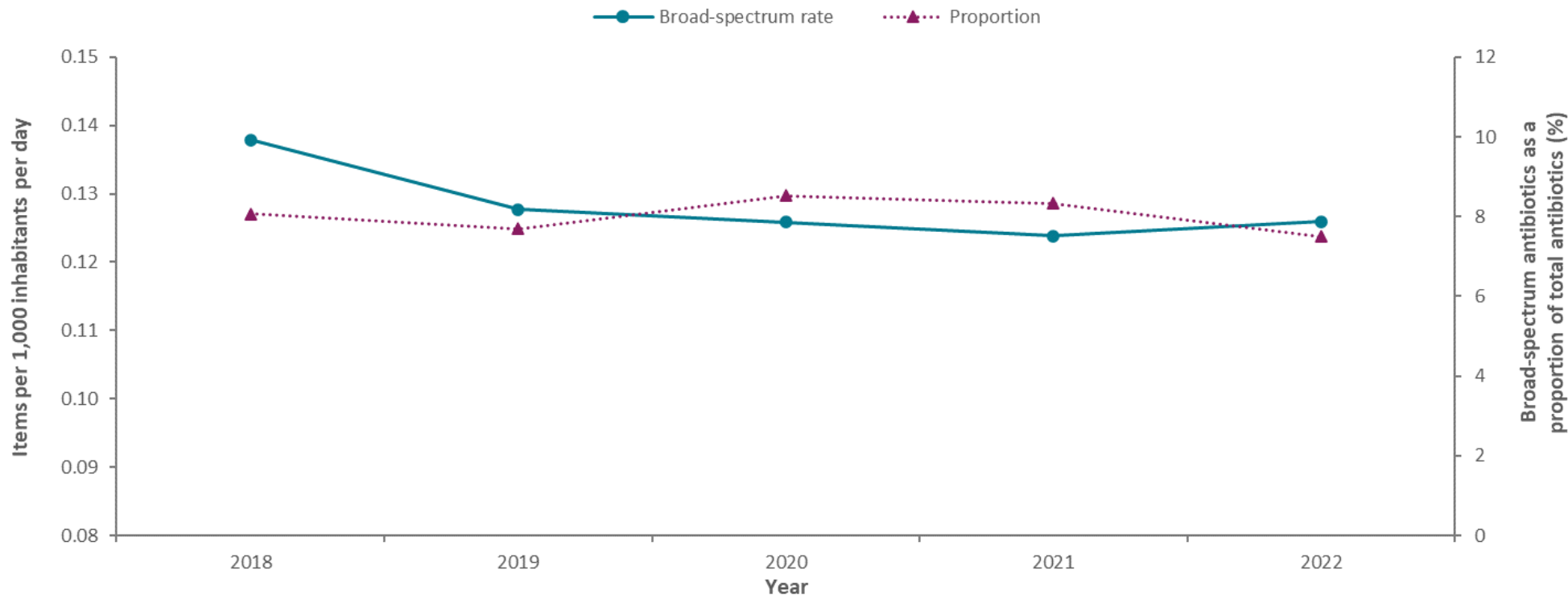
Figure 3.2 Total antibiotic consumption in primary care, expressed as DDDs and items per 1,000 inhabitants per day, England, 2018 to 2022



3.2. Broad-spectrum primary care antibiotic consumption

Broad-spectrum antibiotics used in primary care include co-amoxiclav, cephalosporins, and quinolones. They are commonly used to treat acute respiratory infections (including bronchitis, rhinitis, sinusitis and their sequelae) (29). From 2021 to 2022, there was a very slight rise in broad-spectrum antibiotic prescribing in primary care of 1.7% (from 0.124 to 0.126 items per 1,000 inhabitant per day), although usage remained below pre-pandemic 2019 levels (0.128 items per 1,000 inhabitant per day). Similarly, stable trends are visible when assessing broad-spectrum antibiotics as a proportion of total primary care antibiotics, with a very slight increase in percentages between 2020 and 2021 and most recently, a decrease between 2021 to 2022 (from 8.3% to 7.5%).

Figure 3.2.1. Broad-spectrum antibiotic consumption in primary care, expressed as items per 1,000 population and a percentage of total antibiotic use, England, 2018 to 2022





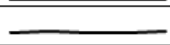
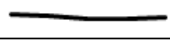
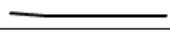



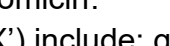
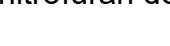


General practice prescribing

There was an overall decrease (-2.1%) in total antibiotic items prescribed in the GP setting between 2018 and 2022, from 1.47 to 1.44 items per 1,000 inhabitants per day. There was a marked decrease of 12.5% between 2019 and 2020 as the country entered the COVID-19 period, although prescribing subsequently increased from 1.25 to 1.44 items per 1,000 inhabitants per day between 2021 and 2022.

Penicillins remain the most commonly prescribed antibiotic group within the general practice setting (accounting for 48.4% of all antibiotic prescriptions in 2022), followed by tetracyclines (15.8%), other antibacterials (13.8%), and 'macrolides, lincosamides and streptogramins' (10.7%). General practice penicillin prescribing decreased by 2.2% between 2018 and 2022 (Table 3.2). There was a large decrease (-20.2%) between 2019 to 2020 (0.68 to 0.54 items per 1,000 inhabitants per day), and a large increase (22.7%) between 2021 and 2022 (0.57 to 0.69 items per 1,000 inhabitants per day), reaching levels greater than those seen in pre-pandemic 2019. Penicillins demonstrated the greatest absolute increase during this period, and as mentioned previously, this is likely related to an unusual increase in circulating GAS during 2022.

Table 3.2. Antibiotic items prescribed by GP, expressed as items per 1,000 inhabitants per day, England, 2018 to 2022

Antibiotic Group	2018	2019	2020	2021	2022	Trend	p-value
Penicillins (excluding β -lactamase inhibitors)	0.649	0.623	0.487	0.512	0.641		0.672
Penicillins (β -lactamase inhibitor combinations only)	0.061	0.056	0.055	0.053	0.054		0.034 ⁺
First and second-generation cephalosporins	0.037	0.035	0.037	0.038	0.040		0.099
Third, fourth and fifth-generation cephalosporins	0.000	0.000	0.000	0.000	0.000		0.005 ⁺
Carbapenems	0.000	0.000	0.000	0.000	0.000		0.078
Tetracyclines	0.205	0.212	0.195	0.197	0.227		0.564
Macrolides, lincosamides and streptogramins	0.174	0.165	0.141	0.134	0.153		0.192
Sulfonamides and trimethoprim	0.097	0.084	0.081	0.077	0.079		0.064
Quinolone antibacterials	0.030	0.025	0.024	0.022	0.021		0.009 ⁺
Anti-Clostridioides difficile agents [^]	0.000	0.000	0.000	0.000	0.000		0.018 ⁺
Oral metronidazole	0.027	0.026	0.025	0.023	0.023		<0.001 ⁺
Other antibacterials [*]	0.187	0.194	0.199	0.193	0.198		0.200

Notes to Table 3.2

+ Statistically significant p-value for trend from 2018 to 2022.

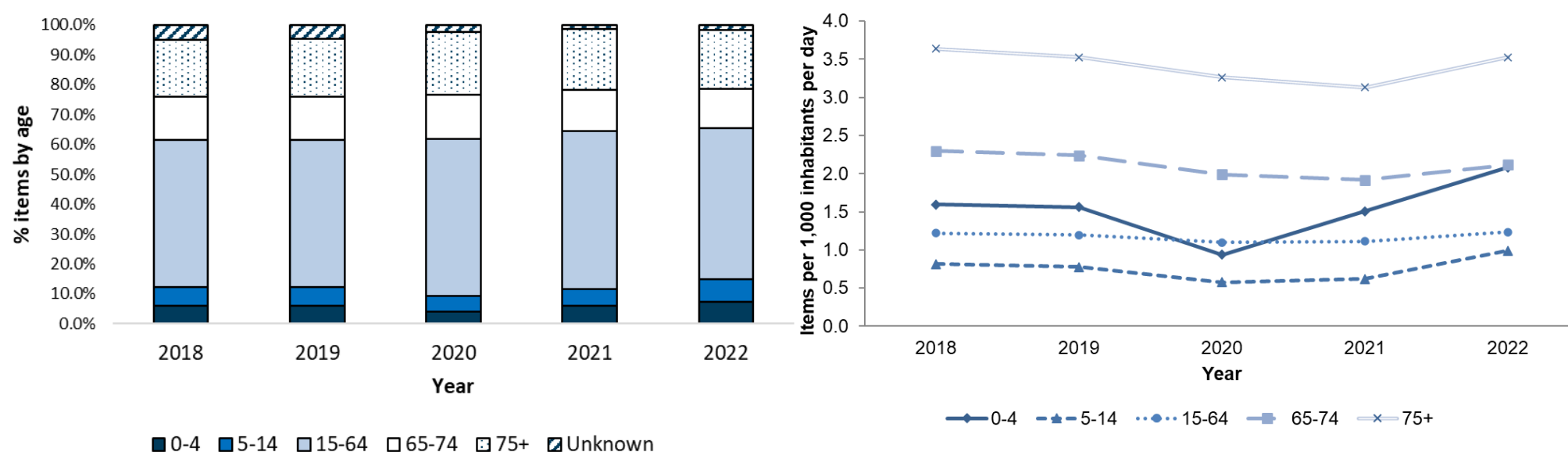
[^] Anti-Clostridioides difficile agents include: oral vancomycin and fidaxomicin.

^{*} Other antibacterials (ATC third level pharmacological subgroup 'J01X') include: glycopeptide antibacterials, polymyxin, steroid antibacterials, imidazole derivatives, nitrofurantoin derivatives, other antibacterials.

Pre-pandemic, the prescribing of antibiotic items in general practice was on a downward trend across all age groups. The COVID-19 pandemic saw vast reductions in antibiotic use across all ages, and most evidently in children aged 0 to 4 years and 5 to 14 years; -39.9% (from 1.56 to 0.94 items per 1,000 inhabitants per day) and -25.9% (0.78 to 0.57 items per 1,000 inhabitants per day), respectively ([Figure 3.3 a](#)). This trend subsequently increased in 2021 for the age categories of 0 to 4, 5 to 15 and 15 to 64 years. The age groups 65 to 74 and 75 years and above both saw continued reductions in items prescribed between 2020 and 2021. Antibiotic prescribing increased across all age groups between 2021 and 2022, substantially so for those aged 0 to 4 years (1.51 to 2.08 per 1,000 inhabitants per day, +38.1%) and 5 to 14 years (0.62 to 0.99 per 1,000 inhabitants per day, +59.7%). Antibiotic prescribing rates were higher than 2019 pre-pandemic across all age groups, apart from patients aged 65 to 74 years.

The percentage of patients receiving prescriptions across the age groups was greatest within the 15 to 64 age category (50.6% in 2022), and lowest across the 0 to 4 and 5 to 14 (7.2% and 7.6% in 2022, respectively) ([Figure 3.3 b](#)).

Figure 3.3 a) Percentage of items, and b) items per 1,000 inhabitants per day, in general practices by age group, England, 2018 to 2022



Assessing increased respiratory tract infection (RTI) antibiotic prescribing during the group A *Streptococcus* outbreak in 2022

Between November and December 2022 there was a surge of invasive group A *Streptococcus* (iGAS) infections in children under 15 years in England. On 9 December (week 49) 2022, interim clinical guidance was introduced for diagnosis and treatment of children with suspected GAS infections.

A national ecological study of prescribing of antibiotics commonly used for treatment of RTIs (amoxicillin, azithromycin, cefalexin, clarithromycin, clindamycin, co-amoxiclav, erythromycin and phenoxymethylpenicillin [penicillin V]) during this period has been completed. The findings indicate prescribing of respiratory antibiotics increased in all age groups, with a peak in prescribing in week 49 in ages 0 to 14, coinciding with publication of clinical guidelines which advised a lower threshold for antibiotic treatment of sore throat and encouraged penicillin V use. Prescribing of penicillin V for 0 to 14 year olds also peaked in week 49, and was 4.9 and 6.1 times higher than the same week in 2019 and 2021, respectively. Use of penicillin V then decreased, likely due to widely reported stock shortages, with subsequent increases in alternate RTI antibiotics. Prescribing of amoxicillin for 0 to 14 year olds peaked in week 50 and was 150% and 221% higher than week 50 in 2019 and 2021, respectively.

This study required timely acquisition of data to provide rapid surveillance on antimicrobial consumption. Timely surveillance can inform more precise predictions on shortages and agile public health interventions.

Other community prescribing

Antibiotic prescribing in other community settings has shown a 20.4% increase between 2021 and 2022 (from 0.095 to 0.115 items per 1,000 inhabitants per day). The 2022 rate was higher within this setting than pre-pandemic and 2018 (0.107 items per 1,000 inhabitants per day); please refer to the [Annexe](#) for settings included here. The rise in prescribing seen both here and in general practice is suggestive of increased healthcare demands in 2022 rather than shifts in provision of services alone.

Items prescribed in out-of-hours primary care centres accounted for 49.9% of 'other community' prescribing in 2022 and exhibited an increase of 13.7% from 2021 to 2022 (0.050 to 0.057 items per 1,000 inhabitants per day). In 2022, out-of-hours, urgent care, community hospitals and custody had higher rates than 2019.

Dental prescribing

Following the COVID-19 pandemic, an initial increase in dental antibiotic prescribing was seen in 2020, although the trend subsequently declined in 2021 and 2022 (-7.6% between 2021 and 2022; 0.141 to 0.130 items per 1000 inhabitants per day). Despite this, antibiotics prescribed within the dental setting still surpass pre-pandemic 2019 rates (0.129 items per 1,000 inhabitants per day).

Dental antibiotics most commonly prescribed in 2022 were amoxicillin (66.7%), metronidazole (28.2%) and erythromycin (2.1%), all 3 of which showed a declining trend in 2022 (Table 3.3). Between 2018 and 2022 there was an upsurge in the use of clarithromycin (+41.5%, from 0.0004 to 0.006 items per 1,000 inhabitants per day), although its overall use is low in this setting.

Study assessing the impact of COVID-19 national restrictions on dental antibiotic dispensing trends and treatment activity

A recent published study assessed the associated impact of COVID-19-related national restrictions in England on dental antibiotic dispensing and described changes in appointments and modes of delivery of care ([30](#)).

Interrupted time series analyses were undertaken to measure the associated change in antibiotic dispensing in England using NHS Business Services Authority (NHSBSA) ePACT2 data. This analysis found that between January 2016 and February 2020, there was a decreasing trend in antibiotic dispensing (-0.02 per 1,000 population per month, $p < 0.05$), and a subsequent increase of 0.98 per 1,000 population ($p < 0.05$) in March 2020. Hence, dental antibiotic prescribing significantly increased with the national COVID-19 restrictions, when service delivery was altered with the closure of dental practices and introduction of remote consultations. There were sustained impacts, with the peak in antibiotic use observed between June and July 2020, once the restrictions were eased.

Although prescribing was showing a downward trend by the end of the study period (July 2021), it had not returned to pre-pandemic counterfactual levels. A stable trend in dental treatment plans (FP17 data) was seen pre-COVID-19, with a sharp decline coinciding with the restrictions. By July 2021, the end of the study period, dental treatment plans had not yet returned to the higher pre-pandemic levels.

This study highlights that teledentistry was likely associated with inappropriate antibiotic prescribing during the pandemic, and stresses the importance of continued AMS and prudent use of antibiotics in dentistry.

Antibiotic prescribing in secondary care (DDD by admissions)

Total antibiotic use in secondary care

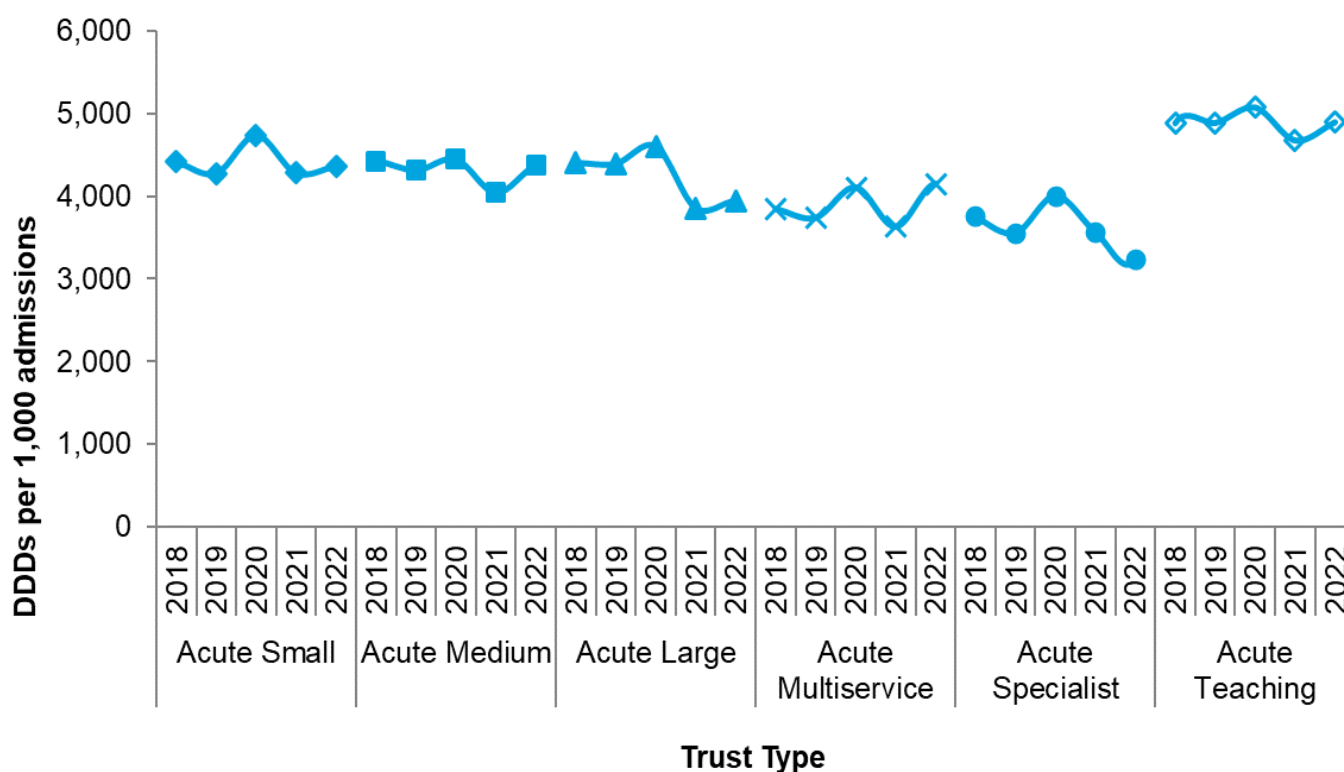
Antibiotic use in NHS acute hospital trusts, measured using hospital admissions as the denominator, decreased by 2.9% between 2018 and 2022 (from 4,593 to 4,458 DDDs per 1,000 admissions). This was driven by reductions in outpatient prescribing which decreased by 11.8% (from 1,687 to 1,488 DDDs per 1,000 admissions) during that period, whereas inpatient prescribing increased by 2.2% (from 2,906 to 2,970 DDDs per 1,000 admissions).

Between 2021 and 2022, overall antibiotic use in secondary care increased by 4.3% (from 4,276 to 4,458 DDDs per 1,000 admissions). There was a 6.3% increase in outpatient

prescribing (from 1,400 to 1,488 DDDs per 1,000 admissions) although the prescribing rate in 2022 remained lower than that seen in 2019 (1,633 DDDs per 1,000 admissions). Prescribing to inpatients showed a 3.3% increase (from 2,877 to 2,970 DDDs per 1,000 admissions), with the rate in 2022 exceeding that seen in 2019 (2,916 DDDs per 1,000 admissions).

The incline in antibiotic use between 2021 and 2022 was noticeable in all acute trust types (see the [Annexe](#) for definitions) apart from acute specialist trusts where prescribing decreased by 9.3% (from 3,571 to 3,237 DDDs per 1,000 admissions) (Figure 3.4). The increases were particularly pronounced among acute multiservice (14.3%, 3,635 to 4,154 DDDs per 1,000 admissions) and acute medium (4,042 to 4,371 DDDs per 1,000 admissions) trusts. Antibiotic use in all acute trust types, apart from acute specialist trusts, surpassed pre-pandemic levels. There are 2 hospital admissions data points missing between 2018 to 2022 (for one acute specialist and one acute large trusts, see the [Annexe](#) for further details)

Figure 3.4. Antibiotic prescribing, by trust type, expressed as DDDs per 1,000 admissions, England, 2018 to 2022



[Table 3.3](#) shows antibiotic usage (DDD per 1,000 admissions) by antibiotic group from 2018 to 2022. In 2021, penicillins had the highest use in secondary care, accounting for 42% of acute trust antibiotic consumption. This was followed by tetracyclines at 14%, macrolides at 10%, other antibacterials (specified in [Table 3.3](#)) at 9%, with the remaining groups comprising less than 10% of all antibiotics.

Between 2018 and 2022 there was a significant increasing trend observed in prescribing for anti-*C. difficile* agents (+70.7%, absolute difference of 2.87 DDDs per 1,000 admissions), and a significant decrease in 'macrolides, lincosamides and streptogramins' (-25.4%, absolute decrease of 156.38 DDDs per 1,000 admissions) ([Table 3.3](#)).

Antibiotic use for all antibiotic groups increased between 2021 and 2022, apart from use of carbapenems and aminoglycosides. The largest absolute increases observed during this period were for penicillins (excluding β -lactamase inhibitors) which increased by 69.5 DDDs per 1,000 admissions (+7.3%), penicillins (β -lactamase inhibitor combinations only) by 42.2 DDDs per 1,000 admissions (+5.1%) and tetracyclines by 23.8 DDDs per 1,000 admissions (+3.9%). Proportionally, the greatest increase between 2021 and 2022 were in anti-*C. difficile* agents (+19.5%), exceeding pre-pandemic 2019 levels. Increased use of anti-*C. difficile* agents, as mentioned previously, may be related to noted increases in hospital-onset *C. difficile* infections (28).

Table 3.3 Antibiotic consumption in trusts by antibiotic group, expressed as DDDs per 1,000 admissions, England, 2018 to 2022

Antibiotic Group	2018	2019	2020	2021	2022	Trend	p-value
Penicillins (excluding β -lactamase inhibitors)	1108.2	1082.5	1056.0	948.0	1017.5		0.105
Penicillins (β -lactamase inhibitor combinations only)	805.7	802.5	881.7	820.4	862.6		0.300
First and second-generation cephalosporins	94.7	92.2	100.7	95.4	103.7		0.179
Third, fourth and fifth-generation cephalosporins	97.4	94.4	108.5	91.4	96.3		0.837
Carbapenems	64.6	62.4	71.8	65.7	63.9		0.891
Tetracyclines	606.6	684.7	697.7	615.5	639.3		0.981
Macrolides, lincosamides and streptogramins	616.6	558.1	561.6	451.4	460.2		0.022+
Sulfonamides and trimethoprim	237.3	234.1	279.8	263.3	276.8		0.108
Quinolone antibacterials	310.7	289.2	309.6	277.0	289.6		0.293
Anti- <i>Clostridioides difficile</i> agents [^]	4.1	4.3	5.3	5.8	6.9		0.003+
Oral metronidazole	112.9	109.4	111.5	99.0	101.8		0.077
Aminoglycosides	150.8	146.3	156.2	138.0	129.1		0.133
Other antibacterials*	371.5	377.5	415.0	393.8	399.4		0.231

Notes to Table 3.4

+ Statistically significant p-value for trend from 2018 to 2022.

[^] Anti-*Clostridioides difficile* agents include: oral vancomycin and fidaxomicin.

* Other antibacterials (ATC third level pharmacological subgroup 'J01X') include: glycopeptide antibacterials, polymyxin, steroid antibacterials, imidazole derivatives, nitrofurantoin derivatives, other antibacterials.

AWaRe – Access, Watch and Reserve

In 2017, WHO introduced the AWaRe classification in which antibiotics are categorised into 3 groups, designated Access, Watch and Reserve. The 'Access' group comprises antibiotics where there is a need to improve availability to patients, particularly in countries where availability is currently limited. The 'Watch' group comprises antibiotics which should be monitored in terms of potential increases in resistance. While the 'Reserve' group comprises 'last resort' broad-spectrum antibiotics, where inappropriate use should be minimised to reduce selective pressure for emergence and spread of resistance. Adapted WHO AWaRe categories are used in England ([31](#)), with several national- and trust-level antibiotic consumption targets based on these ([2](#), [32](#)). In 2022, NHS England launched the Standard Contract 2022 to 2023 which sets targets for trusts to reduce their use of 'Watch' and 'Reserve' antibiotics by 4.5% compared to their 2018 baselines ([33](#)). Nationally published Fingertips indicators for monitoring the progress at NHS acute trust level are available for AWaRe antibiotics ([34](#)).

There was a decline in use of all 'Access', 'Watch' and 'Reserve' antibiotics in NHS acute trusts, antibiotics between 2020 and 2021, with a subsequent increase from 2021 to 2022. In 2022, the most commonly prescribed antibiotics belonged to the 'Access' category (2,293 DDDs per 1,000 admissions), accounting for 51.4% of secondary care antibiotic use. 'Watch' antibiotics were the second most commonly prescribed (45.2%; 2,017 DDDs per 1,000 admissions) and 'Reserve' antibiotics represented 3.0% (132.4 DDDs per 1,000 admissions). Antibiotics that did not fit into any of the AWaRe categories, labelled as 'Other', constituted 0.4%.

The above AWaRe consumption rates were calculated using hospital admissions as the denominator. It should be noted that the impact of the COVID-19 pandemic, during which time there were significant changes in hospital admissions and the case-mix of patients, would have contributed to changes in AWaRe consumption rates. Additionally, it is important to note that 2 hospital admissions data have been masked between 2018 to 2022, relating to missing hospital admissions data (detailed in the [Annexe](#)), which may have impacted these trends.

Over the past 5 years, there was a decrease of 1.2% in carbapenem consumption from 64.6 to 63.9 DDDs per 1,000 admissions ([Table 3.3](#)). However, there was a sharp increase between 2019 and 2020 (15.1%), likely due to the increased use of meropenem during the early stages of the COVID-19 pandemic (increased from 52.0 to 59.4 DDDs per 1,000 admissions between 2019 to 2020) following its inclusion within NICE hospital-acquired pneumonia (HAP) guidelines ([35](#)). Carbapenem consumption decreased in 2020 and continued to decline across all trust types between 2021 to 2022, except for acute medium and acute specialists which increased by 4.2% (from 49.9 to 52.0 DDDs per 1,000 admissions) and 2.3% (61.4 to 62.8 DDDs per 1,000 admissions) respectively.

In 2017, there was a global shortage of piperacillin/tazobactam. Since then, use has increased from 86.8 to 115.0 DDDs per 1,000 admissions from 2018 to 2022 (32.4%), with most marked increases year-by-year between 2019 and 2020 (21.3%, from 94.6 to 114.8 DDDs per 1,000 admissions), seen across all trust types within this time period. This is likely because piperacillin/tazobactam was included within both the [NICE guideline: antibiotics for pneumonia](#)

[in adults in hospital](#) (NG139, Sep 2019) and the [COVID-19 rapid guideline: antibiotics for pneumonia in adults in hospital](#) (NG173, May 2020). Between 2021 and 2022, use of piperacillin/tazobactam continued to increase by 4.3%, with the majority of trust types showing continued increases over this period (apart from acute multiservice and specialist trusts, which decreased slightly). Use of piperacillin/tazobactam across all trust types in 2022 exceeds use of pre-pandemic 2019 levels; acute small, large and medium were substantially higher than 2019 levels (36.7%, 20.0% and 18.7% increase respectively), as well as compared with 2020 (+6.2%, 5.2% and 6.5%). Piperacillin/tazobactam use has been steadily increasing since the 2017 supply shortage ([36](#)), however the increase in 2022 does not exceed rates in 2016, pre-shortages (135.4 DDDs per 1,000 admissions) ([4](#)).

Following the piperacillin/tazobactam shortage in 2017 and the implementation of AMS schemes which aimed to reduce the use of unnecessary broad-spectrum antibiotics, there was an increase in usage of alternative antibiotic options. Increases between 2018 and 2022 were observed in many cephalosporins and quinolones ([Table 3.3](#)). In 2020 compared with 2019, the COVID-19 pandemic saw usage increase further across these antibacterials, following consistently low consumption, particularly with the recently licenced cephalosporin with β -lactamase inhibitor combination ceftazidime/avibactam (+39.9%) (launched in England in 2017, used for management of multidrug-resistant Gram-negative bacterial infections) and ceftolozane/tazobactam (42.8%). Usage decreased during this period only for ceftazidime which decreased by 12.4% (from 17.3 to 15.1 DDDs per 1,000 admissions). Following the pandemic year elevated consumption rates, 2021 saw a decreased use for all quinolones and cephalosporins assessed, apart from ceftazidime/avibactam (which continued to increase, +28.1%). This has since declined in 2022, although remains substantially above 2019 or pre-pandemic levels (see the [Annexe](#) for further data).

The use of colistin in secondary care had been on a slight upward trend pre-pandemic, with an increase between 2018 and 2019 from 23.5 to 24.6 DDDs per 1,000 admissions. There was an increase of 28.4% between 2019 and 2020 (to 31.6 DDDs per 1,000 admissions), with a subsequent decreasing trend, with rates in 2022 (24.3 DDDs per 1,000 admissions) dropping below 2019 levels. The prescribing rate for colistin was highest among acute specialist trusts (2022: 56.9 DDDs per 1,000 admissions). The decreasing trend seen in 2022 to below 2019 levels was evident across all trust types, with the exception of acute Teaching trusts, which although had decreased to 46 DDDs per 1,000 admissions since 2020 incline, remained 5.5% higher than 2019 (43.6 DDDs per 1,000 admissions).

Speciality prescribing

Prescribing data for specialist groups in secondary care is presented in [Table 3.4](#). Within the specialist groups, intensive care units (ICUs) continue to have the highest antibiotic usage, with 62.2 defined daily doses (DDDs) per ICU admission during the 2021 to 2022 financial year. The next highest antibiotic usage was observed in accident and emergency (AE) and non-specific outpatient departments, with 21.4 DDDs per speciality admission. Between 2018 and 2022, most speciality groups showed a decrease in antibiotic use, except within AE and non-specific outpatient departments (increased from 14.8 to 21.4 DDDs per admission, +44.8%),

orthopaedics (2.9 to 4.6 DDDs per admission, +56.6%), and 'other' (4.1 to 5.0 DDDs per admission, +21.0%). Antibiotic use between 2021 and 2022 increased within these 3 specialties (AE: +11.1%, 19.3 to 21.4 DDDs per admission; orthopaedics: +76.5%, 2.6 to 4.6 DDDs per admission; Other: 5.6%, 4.7 to 5.0 DDDs per admission). In 2022, these same 3 specialist groups, as well as intensive care units, prescribed at higher levels compared to 2019 pre-pandemic use (+53.2%, 56.6%, 20.9% and 10.7% respectively).

Table 3.4 Percentage of all antibiotic prescribing attributed to piperacillin/tazobactam, carbapenems and colistin in secondary care by speciality, expressed as DDDs per speciality admission, England, 2021 to 2022

Specialist group	DDDs per admission	Piperacillin/tazobactam	Carbapenems	Colistin*
Intensive Care Unit	62.2	5.9%	5.3%	0.1%
AE/Non-specific Ambulatory Department	21.4	1.0%	0.3%	0.1%
Specialist Medicine	4.5	2.9%	2.0%	1.9%
General Surgery	3.6	2.8%	1.3%	0.0%
Geriatrics	3.2	4.7%	1.8%	0.1%
Orthopaedics	3.2	2.8%	1.3%	0.0%
Obstetrics and Gynaecology	2.2	0.8%	0.4%	0.0%
Paediatrics	2.1	1.6%	1.4%	2.1%
General Medicine	2.1	3.6%	1.5%	0.1%
Specialist Surgery	1.8	1.6%	1.3%	0.6%
Other	5.0	2.4%	1.5%	0.0%

* Colistin: both parenteral and inhaled routes were included.

Surveillance of antibiotic consumption and resistance in *Neisseria gonorrhoeae*

Surveillance of AMR in *Neisseria gonorrhoeae* and results of the Gonococcal Resistance to Antimicrobials Surveillance Programme (GRASP) are described in full in the annual online GRASP report and summarised within [Chapter 2: Antimicrobial Resistance \(AMR\)](#). Trend data is derived from the national sentinel surveillance system, including data on antibiotic consumption. Prescribing data collected through the sentinel surveillance system demonstrated excellent compliance with the UK guidelines, with 97.7% of individuals receiving the recommended first-line therapy of ceftriaxone 1g IM monotherapy. The update to UK guidelines in 2019, which replaced dual therapy (ceftriaxone 500 mg IM and azithromycin 1g) with a higher dose ceftriaxone 1g IM monotherapy as the recommended first-line treatment, appears to remain effective, as no treatment failures were reported in 2022.

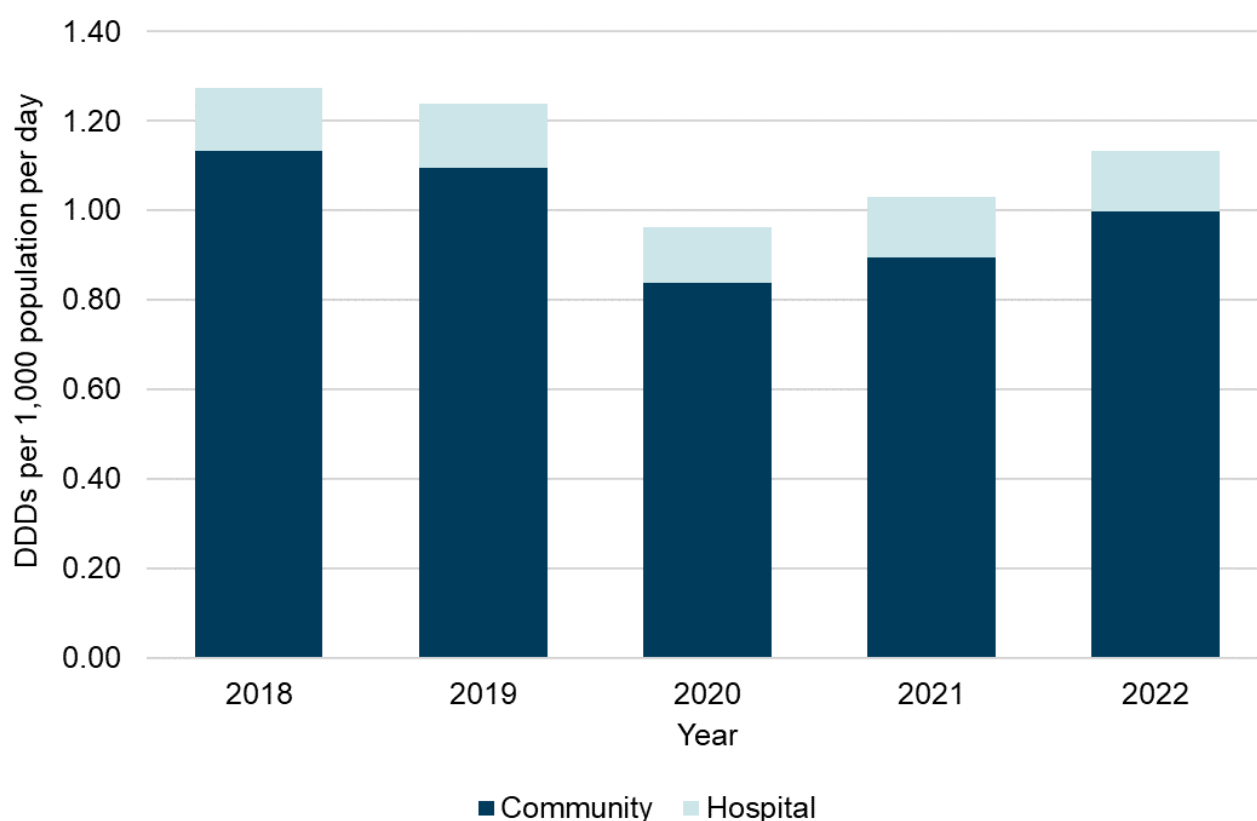
Antifungal consumption

Total antifungal consumption

Total consumption of systemic antifungals in England decreased by 11.0% from 1.27 DID in 2018 to 1.13 DID in 2022 (Figure 3.5). As presented in previous ESPAUR reports, antifungal usage in 2020 exhibited a large decrease as a result of the COVID-19 pandemic. Usage has since increased towards (but remains below) pre-pandemic levels, increasing by 17.7% from 2020 to 2022.

The decrease between 2018 and 2020 was predominantly driven by reduced use in the community (-12.1%, from 0.14 to 0.12 DID). In 2022, 88% of systemic antifungal prescribing took place in the community setting. It is difficult to know if this is a true representation of community use as several antifungal agents can be supplied as over the counter (OTC) medicines, which are not captured in this data set.

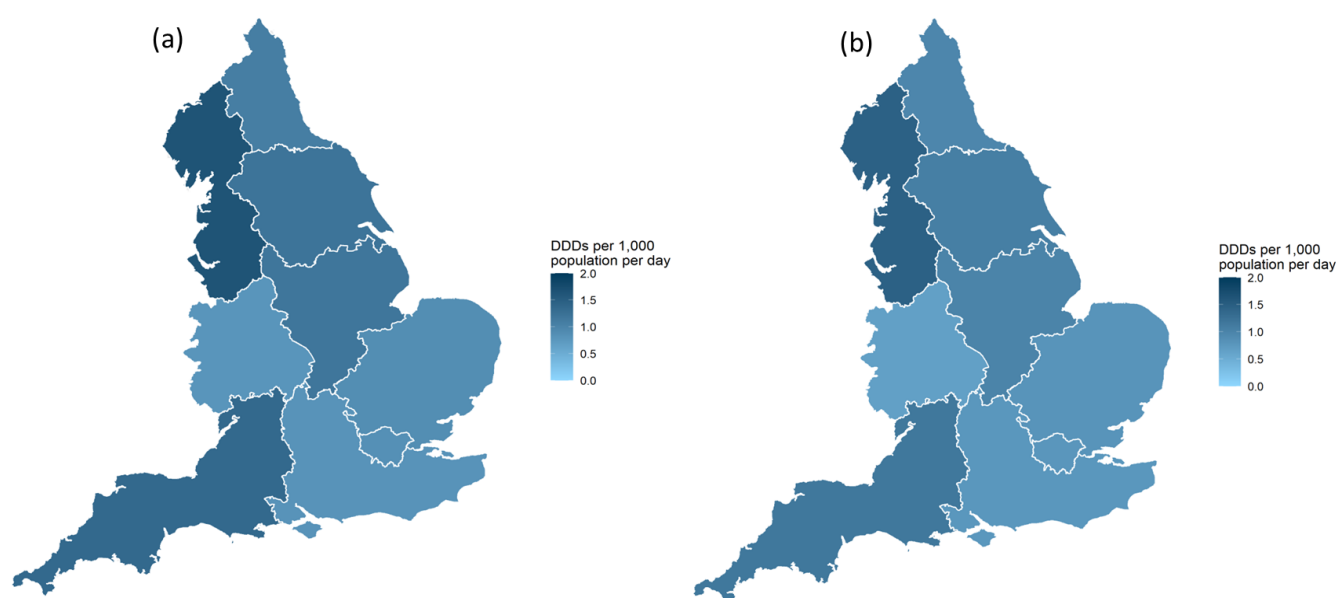
Figure 3.5. Total consumption of systemic antifungals in the community and acute hospitals in England, expressed as DDDs per 1,000 population per day, 2018 to 2022



3.3. Regional variation in antifungal consumption in England

There was marked regional variation in prescribing of antifungals in England (Figure 3.3.1). In 2022, and for the previous 4 years, the North West had the highest prescribing rate (1.46 DID). West Midlands the lowest (0.80 DID).

Figure 3.3.1. Total consumption (primary and secondary care) of systemic antifungals for UKHSA centres, expressed as DDDs per 1,000 inhabitants per day, (a) 2018, and (b) 2022



Across all regions, prescribing decreased between 2018 and 2022, most markedly in the East and West Midlands, by 15.3% (1.19 to 1.01 DID) and 17.5% (0.80 to 0.66 DID), respectively. The decrease in prescribing was most pronounced from 2019 to 2020; percentage decrease from 2018 to 2019 ranged 0.1% to 4.6%, whilst from 2019 to 2020 it ranged from 19.3% to 25.1% in the separate centres. This larger decrease was likely a result of the COVID-19 pandemic. All regions then showed increased prescribing from 2020 to 2022, ranging from a 10.6% increase in the South West, to 23.1% in Yorkshire and Humber.

Differences in the resident population characteristics and distribution of specialist care trusts may account for the variations seen between regions.

Antifungal prescribing in primary care

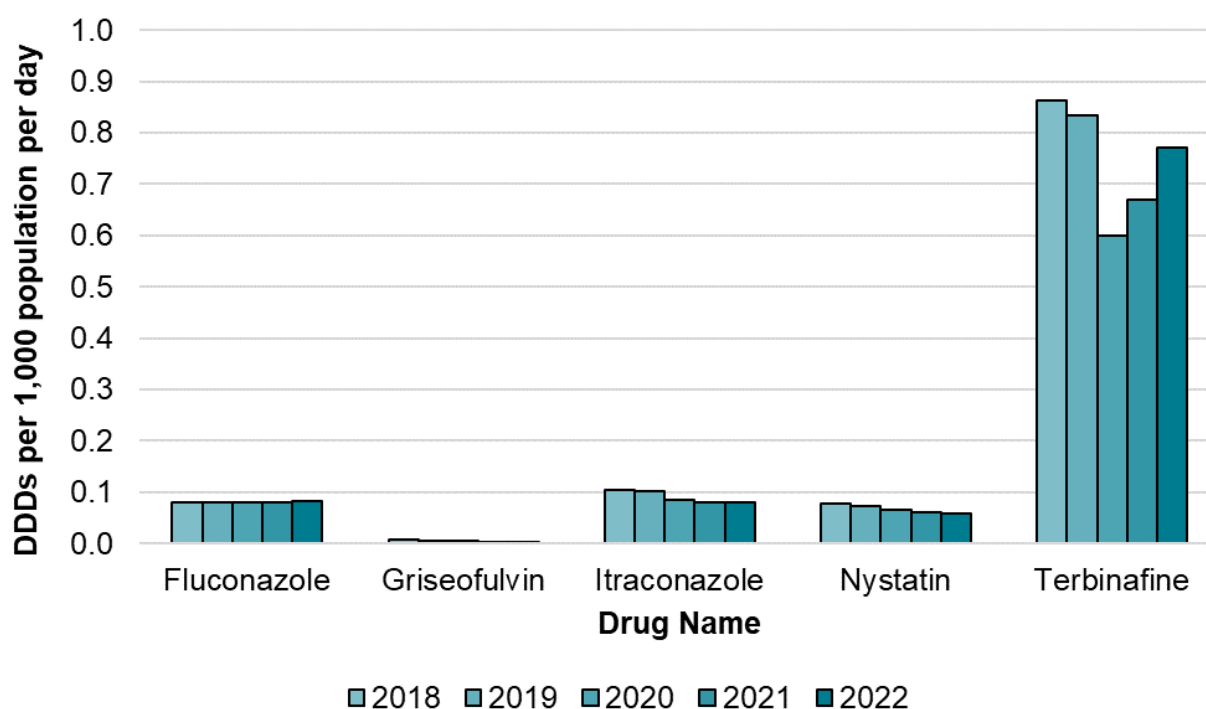
The total prescribing of systemic antifungals in the community decreased by 11.9%, from 1.1 to 1.0 DID, between 2018 and 2022. Figure 3.5 shows that the greatest decrease in total systemic antifungals prescribed in the community was between 2019 and 2020 (23.5%, 1.1 to 0.8 DID), the reduction seen from 2018 to 2019 was 3.2% (1.13 to 1.1 DID). There have been year on year increases from 2020 to 2021 (6.9%, 0.84 to 0.90 DID) and from 2021 to 2022 (11.4%, 0.90 to 1.00 DID).

[Figure 3.6](#) shows, the most frequently prescribed antifungal in the community was terbinafine (0.77 DID in 2022), an oral agent active against common dermatophyte infections of the skin, hair and nails. Usage of terbinafine decreased by 10.6% from 2018 to 2022, with a large decrease in 2020 related to the COVID-19 pandemic 'lockdowns' where transmission of dermatophyte infections were likely reduced.

Terbinafine was the only drug to show an increase between 2020 and 2021 (+11.6%, 0.6 to 0.67 DID), with the return of greater social interaction in 2021. Fluconazole usage has increased slightly over the last 5 years (+2.8%, 0.080 to 0.082 DID). Oral fluconazole, most often used for cutaneous and mucosal yeast infections, is available over the counter (OTC) hence numbers presented may not reflect true use. Itraconazole, nystatin and griseofulvin usage have decreased each year since 2018 (between 2018 and 2022, -23.4%, from 0.10 to 0.08 DID; -22.7%, from 0.08 to 0.06 DID; and -47.0%, from 0.007 to 0.004 DID, respectively).

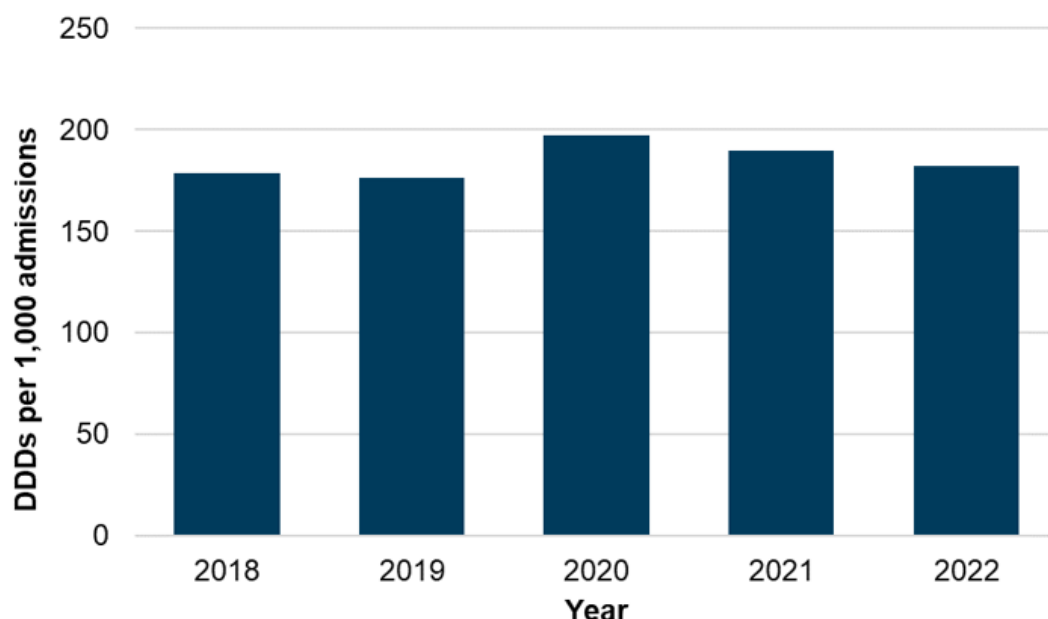
There are a limited number of drugs shown in [Figure 3.6](#), as there are limited types of antifungal prescribed for systemic use in the community setting; more variety can be seen in the hospital setting.

Figure 3.6. Total consumption of systemic antifungals by drug in the community in England, expressed as DDDs per 1,000 population per day, 2018 to 2022



Antifungal prescribing in secondary care

As can be seen in [Figure 3.7](#), total consumption of systemic antifungals in NHS acute trusts in 2022 was 182 DDDs per 1,000 admissions. This represents a 2.0% increase in the rate of prescribing from 2018 (179 DDDs per 1,000 admissions) but a 7.7% decrease from 2020 (197 DDDs per 1,000 admissions). The decrease in prescribing rate from 2020 to 2022 suggests that in 2022 antifungal prescribing and admissions were returning to pre-pandemic levels.

Figure 3.7. Total consumption of systemic antifungals in NHS acute hospital trusts in England, expressed as DDDs per 1,000 admissions, 2018 to 2022

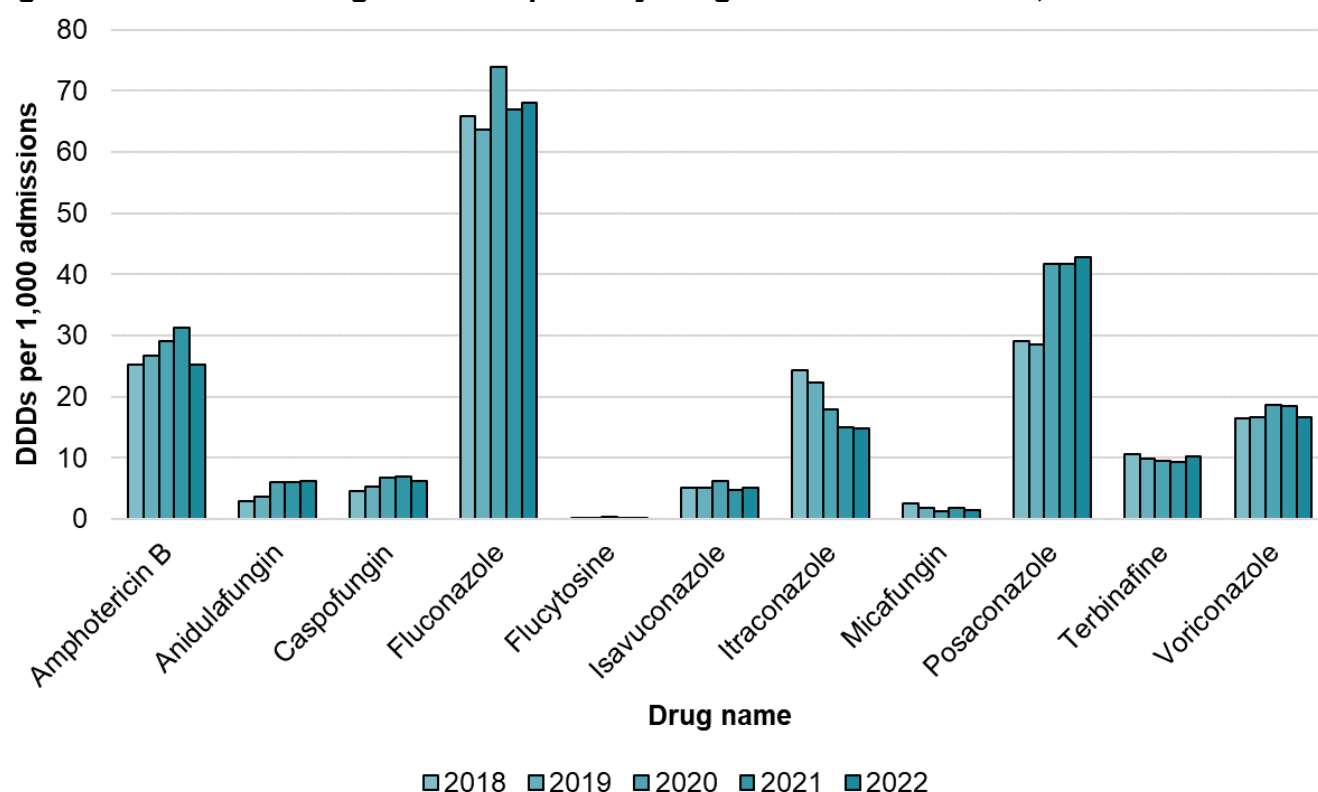
[Figure 3.8](#) shows the prescribing of individual systemic antifungals in secondary care. Fluconazole was the most frequently prescribed antifungal (2022: 68 DDDs per 1,000 admissions). From 2018 to 2022 prescribing of fluconazole increased (3.2%) however it has decreased from a peak of 74 DDDs per 1,000 admissions in 2020 (-7.9%). The next highest antifungal prescribed was posaconazole (2022: 43 DDDs per 1,000 admissions). Posaconazole prescribing increased markedly in 2020 (+46% in comparison to 2019) and remains at the increased rate in 2022, most likely due to the reduced cost of this drug following coming off patent from 2020. Voriconazole usage also increased in 2020 (to 18.6 DDDs per 1,000 admissions) but has reduced by 10.5% to 16.6 DDDs per 1,000 admissions in 2022. Itraconazole usage has decreased year-on-year between 2018 and 2022, with a 39.3% reduction overall during this time period.

Amphotericin B is a broad-spectrum agent suitable for most invasive yeast and mould infections. Usage of it increased year on year from 2018 to 2021, increasing by 24.1% from in 2018 to 2021 (from 25.2 to 31.2 DDDs per 1,000 admissions). Usage has since decreased by 19.2% from 2021 to 2022 (31.2 to 25.3 DDDs per 1,000 admissions).

In 2022, rate of echinocandin antifungals were 6.1, 6.2 and 1.4 DDDs per 1,000 admissions for anidulafungin, caspofungin and micafungin, respectively. Since 2018 both anidulafungin and caspofungin usage have increased (2018 to 2022: +115% and +33.8%, respectively, although rates are still small). Micafungin usage, however, has decreased by 44.5%, from 2.6 to 1.4 DDDs per 1,000 admissions between 2018 and 2022.

Flucytosine, which is not prescribed as a sole agent but as a combination, has the lowest levels of prescribing at 0.2 DDDs per 1,000 admissions. Terbinafine usage decreased between 2018 and 2021 (10.7 to 9.3 DDDs per 1,000 admissions), but has since increased to 10.3 DDDs per 1,000 admissions.

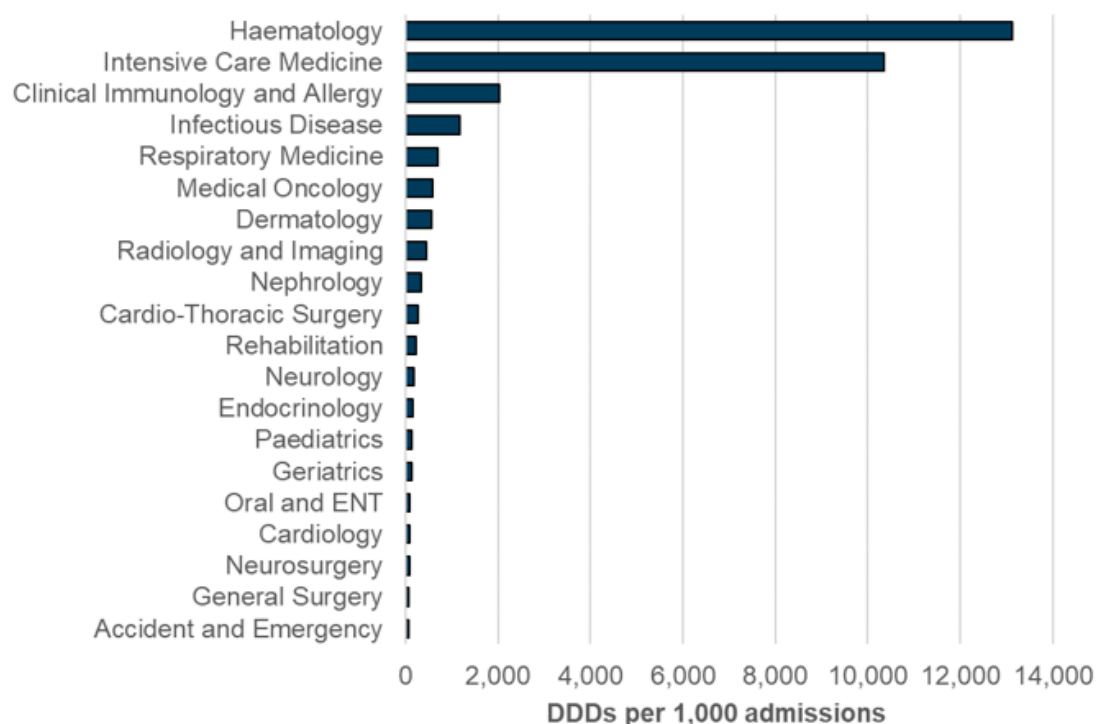
Figure 3.8. Total antifungal consumption by drug in NHS acute trusts, 2018 to 2022



By specialty

In 2022 the specialty with the highest systemic antifungal prescribing rate was 'Haematology' (13,123 DDDs per 1,000 admissions) followed by 'Intensive Care Medicine' (10,354 DDDs per 1,000 admissions) ([Figure 3.9](#)).

Figure 3.9. Antifungal consumption in NHS acute hospital trusts' top 20 specialties in 2022



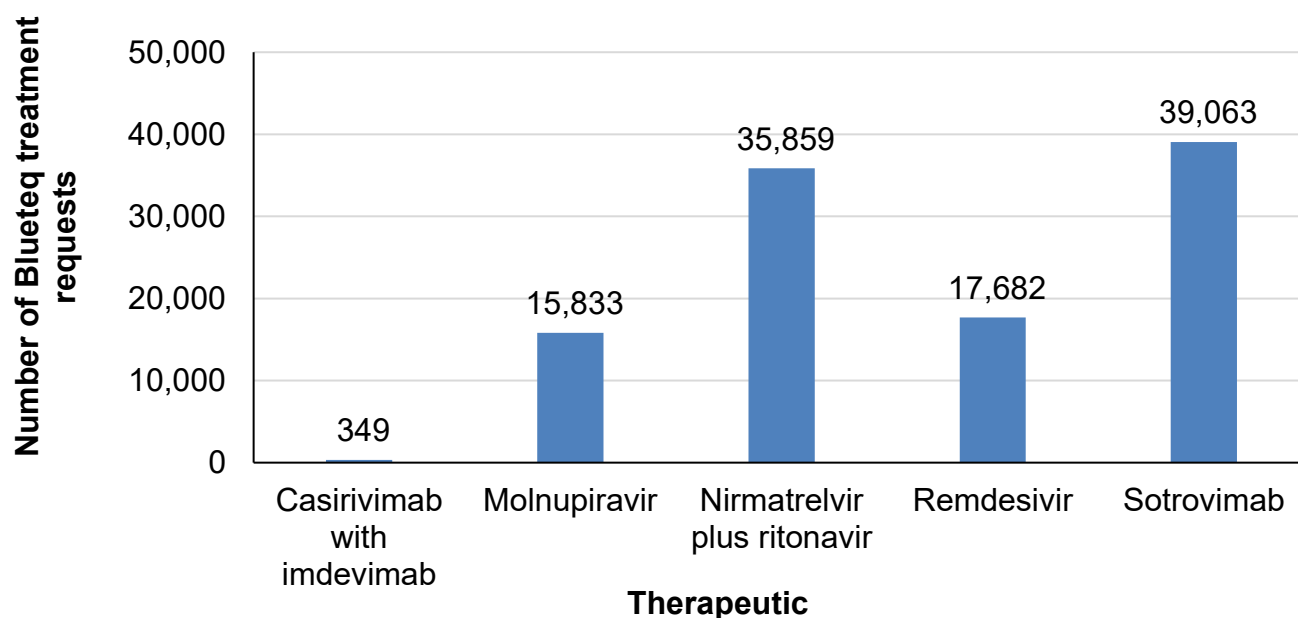
Antiviral consumption

SARS-CoV-2: COVID-19 therapeutics

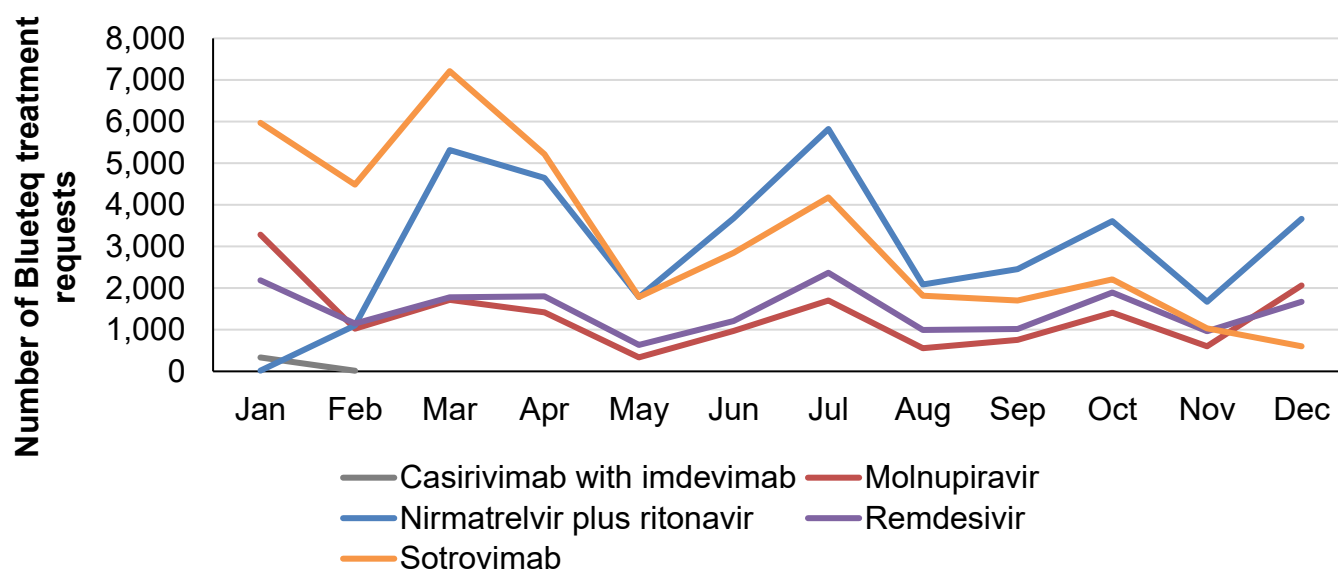
This section reports epidemiological surveillance data of 5 directly-acting antiviral COVID-19 therapeutics in use in England in 2022. These being 3 antivirals: nirmatrelvir plus ritonavir (Paxlovid), remdesivir (Veklury), molnupiravir (Lagevrio) and 2 neutralising monoclonal antibody therapies (nMAbs): sotrovimab (Xevudy) and casirivimab with imdevimab (Ronapreve). Usage data has been obtained from Blueteq treatment requests sourced from NHS England and Improvement (see the [Annexe](#) for details on data sources, analyses, and clinical commissioning policy).

In 2022 there was a total of 108,786 Blueteq treatment requests for COVID-19 therapeutics in England. By therapeutic, [Figure 3.10](#) shows that sotrovimab had the highest number of treatment requests (39,063, 36%), followed by nirmatrelvir plus ritonavir (35,859, 33%). Note that not all agents were available for the entire year of 2022: nirmatrelvir plus ritonavir was included in the clinical commissioning policy since February 2022; casirivimab with imdevimab requests were low as treatment with this monoclonal antibody was removed from the interim clinical commissioning policy in February 2022, after the onset of the Omicron variant which casirivimab with imdevimab had low efficacy against ([37](#)).

Figure 3.10. Total number of Blueteq treatment requests in England in 2022, by therapeutic

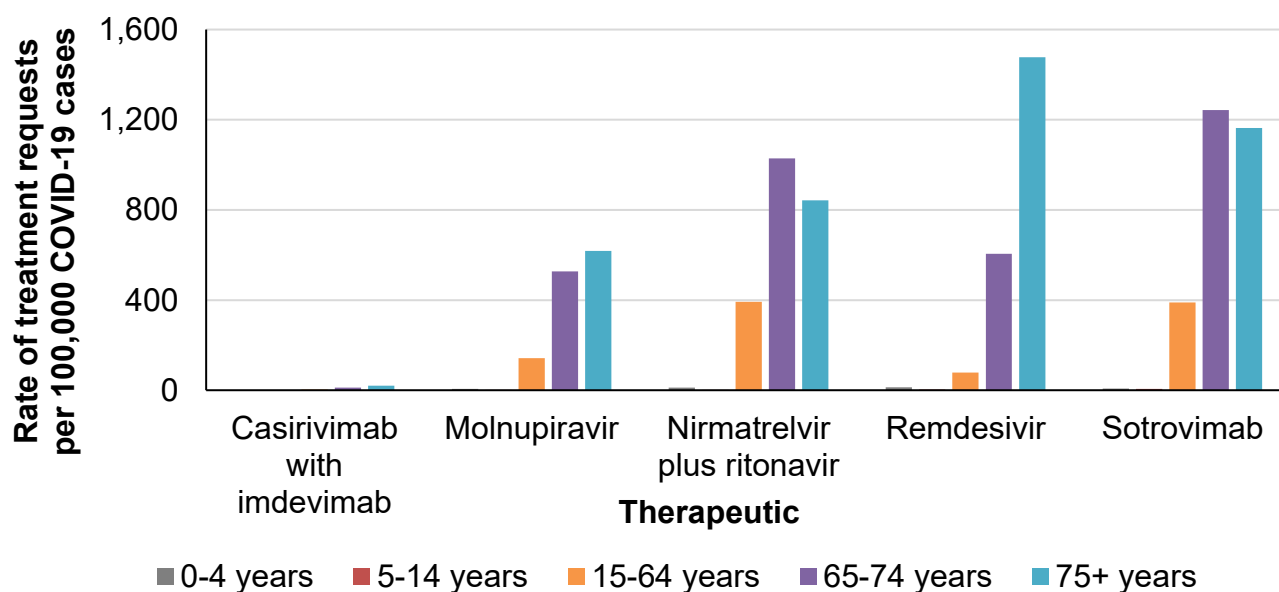


[Figure 3.11](#) shows treatment requests by therapeutic and month in 2022. Sotrovimab use was highest in March (7,213 requests) and, aside from a smaller peak in July (4,175 requests), gradually decreased over the year, dropping to its lowest point in December (602 requests). Use of nirmatrelvir plus ritonavir was higher than sotrovimab from June (5,823 requests) onwards. Molnupiravir and remdesivir use were lower and fairly stable over the course of the year. Peaks in usage generally followed peaks in COVID-19 cases ([38](#)).

Figure 3.11. Number of Blueteq treatment requests in England by therapeutic and month from January to December 2022

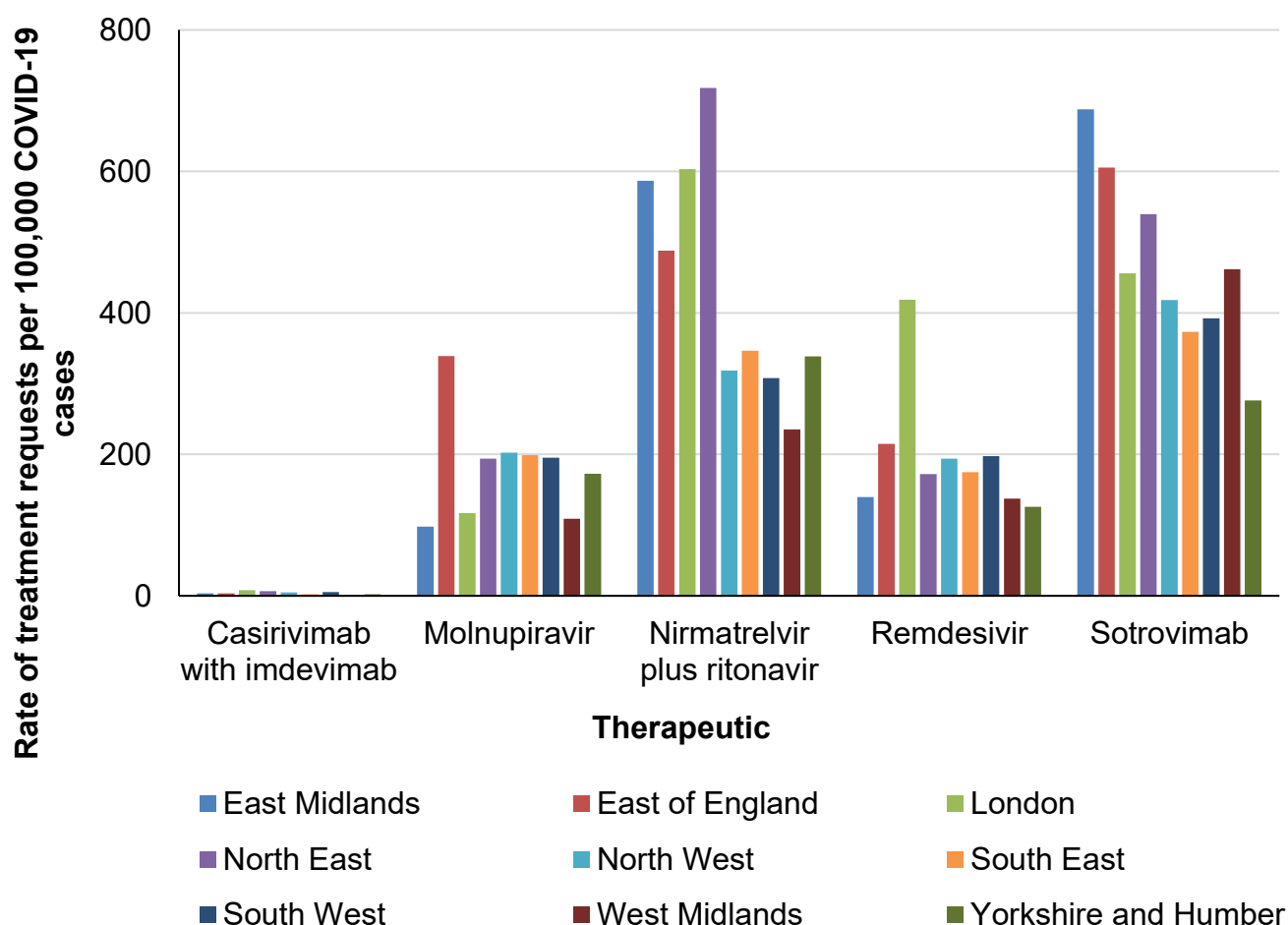
The following 3 figures report the rate of treatment requests per 100,000 COVID-19 cases by age, region and Indices of Multiple Deprivation (IMD). Note that without data on individuals who were eligible, offered and accepted each treatment, this is considered an exploratory analysis and may not directly reflect variations or inequities in access to treatment.

[Figure 3.12](#) shows that the rate of use of all COVID-19 therapeutics was highest in older age groups. The rate of use of remdesivir, which is used in patients hospitalised with COVID-19, was highest in the oldest age group, 75 years and over (1,477 treatment requests per 100,000 COVID-19 cases). Rates for molnupiravir, nirmatrelvir plus ritonavir and sotrovimab were highest in the 65 to 74 years and 75 years and over, with rates considerably lower in younger age groups (64 years and under).

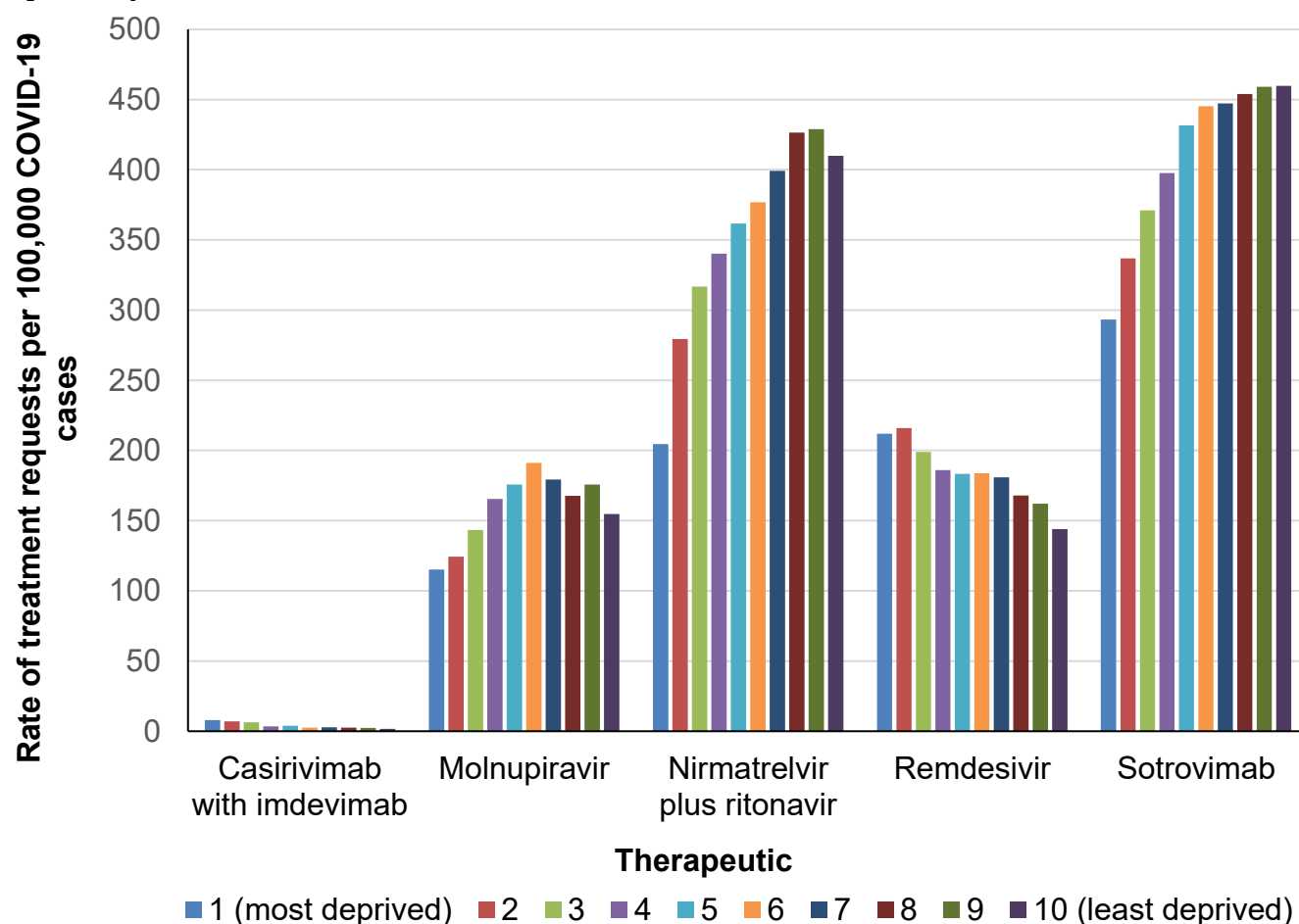
Figure 3.12. Rate of Blueteq treatment requests per 100,000 COVID-19 cases in England by therapeutic and age group in 2022

The use of each therapeutic in 2022 varied by UKHSA region ([Figure 3.13](#)). London had the highest use of remdesivir (419 treatment requests per 100,000 COVID-19 cases) compared to other regions (ranging from 106 to 215 treatment requests per 100,000 COVID-19 cases). Sotrovimab highest use was seen in the South West, whilst nirmatrelvir plus ritonavir in the North East.

Figure 3.13. Rate of Blueteq treatment requests per 100,000 COVID-19 cases in England by therapeutic and UKHSA region in 2022



The use of each therapeutic in 2022 varied by IMD, a statistic used to measure relative deprivation ([Figure 3.14](#)). Rates of use of sotrovimab and nirmatrelvir plus ritonavir, which are prescribed for non-hospitalised COVID-19 patients, were much lower in more deprived areas than less deprived areas. The reverse pattern was seen in rates of use of remdesivir where higher rates of use were seen in more deprived areas compared to less deprived areas. Different exposures as well differences in access to healthcare may be part of the reasons behind the variation seen. Further research is planned to explore on variation seen across different settings.

Figure 3.14. Rate of Blueteq treatment requests per 100,000 COVID-19 cases in England by therapeutic and IMD in 2022

Hepatitis C virus

3.4. Antiviral prescribing for the treatment of hepatitis C virus (HCV)

In May 2022, the UK Government adopted the World Health Assembly's updated global strategies that support the World Health Organization's (WHO) ambition to eliminate viral hepatitis by 2030 ([39](#)). In 2021, England estimates suggest that approximately 92,900 people are living with chronic Hepatitis C virus (HCV; a bloodborne virus that infects and damages the liver) infection, this being a reduction of 47% from 2015 ([39](#)). Efforts to reduce HCV have been related to improved testing and access to treatment with direct-acting antiviral (DAA) drugs.

Where first-line DAA therapy is unsuccessful, re-treatment regimens are available, with high cure rates. However, unsuccessful therapy provides the opportunistic development of mutations in viral genes which encode the protein targeted by the drugs, causing subsequent antiviral drug resistance. Hence, monitoring of access to HCV treatment not only forms an important part of the response to the WHO HCV elimination targets, but can inform and be used to monitor use and efficacy of DAAs.

The UKHSA Hepatitis C annual report presents data on the number of individuals initiating HCV treatment in the UK (39). For the period between 2015 to 2019, there was an increased number of individuals initiating HCV treatment in the UK, reflecting improved access to DAA drugs. Between April 2019 to March 2021, numbers of individuals accessing treatment in the UK decreased by 40.2%. This is thought to be related to the impact of the COVID-19 pandemic on reduced transmission, testing, service provision and restrictions. With re-engagement of services between 2020 and 2022 there was an increase of 24.6% in treatment initiations.

(Please refer to the Hepatitis C annual report for further information (39)).

Antimalarial consumption

Each year approximately 1,500 cases of malaria are imported into the UK. The treatment of choice for *P. falciparum* is oral therapy with artemisinin combination therapy (ACT), usually artemether-lumefantrine. Severe and complicated cases are treated with intravenous artesunate, followed by oral ACT. Atovaquone-proguanil is sometimes used as alternative to ACTs but is slower acting. Quinine plus clindamycin or quinine plus doxycycline can also be used, but patient tolerance of oral quinine is poor and ACTs should be the default treatment regimen. To assess drug usage, ACTs are used only for malaria treatment, whereas the alternatives listed above are also used either for other conditions (quinine, doxycycline, clindamycin) or for malaria prevention (atovaquone-proguanil).

In contrast to the overuse or inappropriate use of antibiotics, the situation with malaria prevention is reversed, in that there is significant underutilisation of antimalarial prophylactic drugs by travellers from the UK visiting malarious areas. In 2021, 89% of those suffering from malaria imported into 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 preventive advice.

The consumption data below is reported for the treatment and prophylaxis against malaria. Consumption of total antimalarials, in primary and secondary care combined, can be seen in [Table 3.5](#). The most frequently prescribed antimalarial was quinine (0.56 DID in 2021), although as mentioned above this is sometimes used for indications other than malaria. There was a decreasing trend (-29.5%) in DID between 2018 and 2022 in the use of quinine, with no substantial change in decline coinciding with COVID-19 pandemic.

To note, atovaquone is used as one of 2 components (along with proguanil) in the drug Malarone for malarial treatment, but may also, less commonly, be used as standalone drug for treatment of *Pneumocystis* pneumonia; we are unable to distinguish use of this drug for non-antiparasitic purposes, due to lack of data on prescribing indication. Assuming a large proportion of atovaquone is prescribed as an antimalarial as part of the atovaquone with proguanil combination, there does seem to be a steady level in atovaquone with proguanil use from 2018, followed by an increase in prescribing between 2019 and 2022 (+34.1% in DID), with sustained higher prescribing since the COVID-19 pandemic. The lack of prescription indication

data makes it difficult to comment on these trends in antiparasitic agents and makes a strong argument for the need of improved data granularity, patient-level data and prescription rationale.

Table 3.5. Total antimalarial consumption in England, expressed as DDDs per 1,000 inhabitants per day, 2018 to 2022

Antimalarials	2018	2019	2020	2021	2022
Quinine*	0.7578	0.6851	0.6093	0.5596	0.5338
Atovaquone/proguanil**	0.0041	0.0047	0.0063	0.0064	0.0073
Chloroquine***	0.0013	0.0011	0.0010	0.0007	0.0007
Primaquine	0.0010	0.0009	0.0009	0.0008	0.0008
Mefloquine	0.0002	0.0001	0.0000	0.0001	0.0001
Artemisinin compounds^	0.0002	0.0002	0.0001	0.0002	0.0002
Piperaquine phosphate/artenimol	0.0000	0.0000	0.0000	0.0000	0.0000

Notes to Table 3.5

* Quinine includes: quinine bisulfate, quinine dihydrochloride, quinine sulfate.

** Atovaquone/proguanil includes: proguanil, proguanil/atovaquone, atovaquone. (Atovaquone alongside use as antimalarial may also be used for treatment of pneumocystis pneumonia).

*** Chloroquine includes: chloroquine and chloroquine phosphate.

^ Artemisinin compounds includes: artemether/lumefantrine, artesunate.



Progress against the National Action Plan

The NAP has set ambitions to be reached and reviewed by 2024, with the main consumption ambition being: to reduce UK antimicrobial total use in humans by 15% from a 2014 baseline ([2](#)). The maximal use of antibiotics in the UK in the last 20 years occurred in 2014, hence it is utilised as the baseline.

The NAP ambitions apply to the UK as a whole, to note this report presents data for England only. The UK ambition is to reduce total consumption levels to/below 16.92 DDDs per 1,000 inhabitants per day (DID), by 2024. The England decreasing trend in 2021, seen in the chapter analyses, highlighted the impact that the COVID-19 pandemic had on total antibiotic consumption (2021 England total consumption reached lowest level of 16.01 DID). The increase in total antibiotic use seen in 2022 (17.35 DID), although remains below 2019 antibiotic consumption levels (18.03 DID), highlights the continued improvements needed in AMS to progress towards reaching the NAP ambitions.

In 2017, the WHO classified the Essential Medicine List antibiotics into 3 AWaRe categories ('Access', 'Watch' and 'Reserve'). Adapted WHO AWaRe categories were then created for the UK context and used since ([31](#)). There are several national- and trust-level antibiotic consumption targets based on these adapted AWaRe categories ([2](#), [32](#)). The WHO updated their AWaRe categorisations in 2021 and UKHSA are involved with revising antibiotics and their

respective categories for a subsequent revised UK-wide AWaRe groupings. Until the current NAP period has been completed (2024), updates in the categorisation will not be implemented, and progress towards current ambition will not be affected (Ambition 2B: a 10% reduction in use of 'reserve' and 'watch' antibiotics in hospital from 2017 baseline).

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 [\(2\)](#).

Participation in the European Centre for Disease Prevention and Control (ECDC) via the European Surveillance of Antimicrobial Consumption Network (ESAC-Net) ceased following UK's exit from the European Union. The last submission was for 2019 data. England, alongside the UK devolved administrations, have become focal members, submitting and validating data (for England and Scotland, for the years covering 2016 to 2021) to the WHO Global Antimicrobial Resistance and Use Surveillance System (GLASS) antimicrobial consumption module, referred to as GLASS-AMC.

Future actions

Analysis of patient-level primary care prescribing data, to inform on the appropriateness of antibiotic prescribing is underway. Similar efforts will be explored for secondary care.

Access to independent sector antibiotic prescribing data is being investigated. This would assist in fully understanding the role of private sector prescribing in current trends and provide a more accurate picture of total antimicrobial consumption across the country and by setting.

Secondary care antibiotics categorised into the WHO AWaRE index has been embedded within NAP ambitions as well as quality improvement schemes. The AWaRe categorisations were adapted to create a specific index for the UK and are currently under review.

Work on assessing potential unintended consequences following changes in antibiotic use in England will continue. This will build on previous collaborative work between UKHSA and the Health Protection Research Unit in Healthcare-Associated Infections and Antimicrobial Resistance (HPRU HCAI and AMR) at Imperial College London, as well as projects with the University of Oxford HCAI & AMR HPRU and London School of Hygiene and Tropical Medicine (LSHTM).

Assessment into the impacts of COVID-19 on dental consumption has been completed and published. It would be beneficial for qualitative research to inform on the sustained/longevity of the COVID-19 pandemic (changes in service delivery during this period) on antibiotic prescribing trends, and reasons behind the persistently higher consumption since normal services were resumed.

UKHSA have engaged and reestablished the ESPAUR antifungal sub-group, future antifungal collaboration should inform antifungal prescribing and resistance surveillance.

Certain newer antibiotics are still not widely used (for example, meropenem and vaborbactam; imipenem, cilastatin and relebactam; and delafloxacin) however, ongoing surveillance is important to assess changes in consumption alongside subsequent implications on resistance to these drugs. This will inform roll-out, guidance and stewardship.

Future work will expand on the variations seen in antibiotic consumption across the country, with assessment planned on correlating antibiotic use and resistance with deprivation or health inequalities, ethnicity and demographics (age and sex). The literature describes higher prescribing, as well as healthcare seeking behaviour, in more deprived areas ([40](#), [41](#), [42](#)).

Chapter 4. Antimicrobial stewardship

Main messages

TARGET antibiotics toolkit

Resources for community pharmacy section and tools to help prescribers reflect on their practices have been added to the TARGET antibiotics toolkit. Two posters for clinicians were developed in collaboration with the National Institute for Health and Care Research (NIHR)-funded, STEP-UP group, and include useful evidence-based approaches, discussing antibiotics with patients and discussing back-up or delayed antibiotic prescriptions.

TARGET 'How to...' guides

Implementation of the acne 'How to...' resources significantly improved 5-point Likert scale responses on capability, opportunity and motivation, with increases of 0.29, 0.23 and 0.16 respectively. The acne 'How to...' resources improve confidence in capability of managing acne and are recommended for use in general practice frameworks to improve AMS in relation to acne management.

Start Smart then Focus updates

Two thematic recommendations were co-produced following feedback from 29 healthcare professionals for the update of the Start Smart then Focus AMS toolkit, namely fostering a culture of stewardship, and further integrating AMS into clinical practice. Theme 1 recommendations included defining AMS, reiterating principles of enhancing patient care and preserving the effectiveness of antimicrobials, emphasising the importance of AMS, outlining healthcare professionals' specific responsibilities regarding AMS, and explicitly stating the benefits of AMS programmes. Theme 2 recommendations encompassed providing evidence-based guidance for antimicrobial prescribing decisions, promoting best practices, incorporating criteria for intravenous to oral switch, and encouraging prompt source control interventions. These recommendations were supported by a peer-reviewed research evidence base and have been integrated into the updated SSTF AMS toolkit. These changes have involved the redesign of the 'Start Smart then Focus' AMS clinical management algorithm.

Introduction to Chapter 4

Tackling antimicrobial resistance (AMR) requires action on multiple fronts to optimise antimicrobial use 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 on tackling AMR](#) which includes a target to reduce UK antimicrobial use in humans by 15% by 2024 (2).

In this chapter we provide a summary of national primary and secondary care AMS interventions led by UKHSA. In addition, we outline ongoing work to tackle health inequalities associated with antibiotic resistance and prescribing.

Professional and public education and training is an important strand of AMS. Further information, including World Antimicrobial 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.

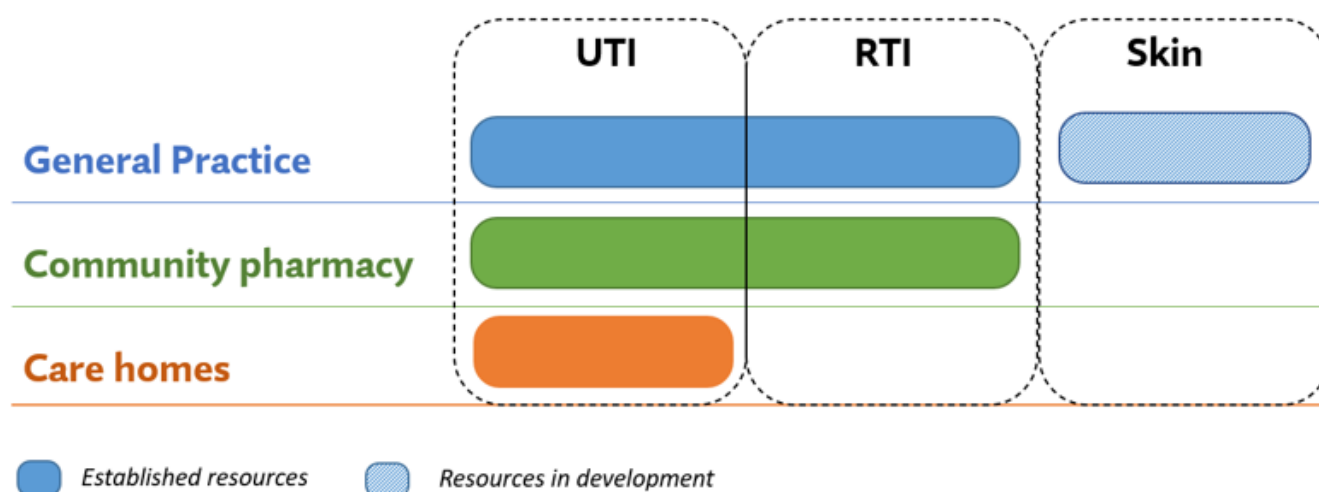
Primary care AMS

The TARGET antibiotics toolkit, programme objectives and introduction

The [TARGET \(Treat Antibiotics Responsibly, Guidance, Education and Tools\) antibiotics toolkit](#) is a suite of AMS resources to support primary care clinicians to champion, and implement, AMS activities (43).

TARGET was commissioned by the Advisory Committee on Antimicrobial Prescribing, Resistance and Healthcare Associated Infections (APRHA) and first published in 2012 with the aim of improving antibiotic prescribing by general practitioners (44). The toolkit was designed, developed and maintained by Public Health England (now UKHSA) and is hosted on the [Royal College of General Practitioners \(RCGP\) website](#). TARGET was the fourth most accessed resource in the RCGP e-Learning hub in 2022 to 2023. Since 2012 the toolkit has been expanded to cover multiple stakeholders across 3 main areas of primary care, focussing on the common infections that account for approximately 85% of primary care antibiotic prescribing, namely respiratory tract infection (RTI), urinary tract infection (UTI), and skin infection ([Figure 4.1](#)) (29).

Figure 4.1. TARGET antibiotics toolkit pillars of work, linked to the 3 main groups of common infections and primary healthcare settings



Text version of Figure 4.1

This infographic shows TARGET Antibiotics Toolkit pillars of work, linked to the 3 main groups of common infections and primary healthcare settings. It shows that there are established resources for UTI and RTI for use in general practice and community pharmacy. There are also established UTI resources for use in care homes. Resources for skin infections are in development for general practice.

End of text version of Figure 4.1

TARGET takes a user-centred approach, collaborating with a wide range of stakeholders to develop evidence-based resources thereby supporting infection prevention and control initiatives, improving how antimicrobials are used in primary care, providing information and tools to empower patients and clinicians, and promote shared decision making.

The TARGET antibiotics toolkit resources are underpinned by evidence and developed using behaviour change frameworks, for example, the behaviour change wheel which shows how interventions and policies influence ability (capability), opportunity, and motivation to make decisions, impacting behaviour (COM-B) ([45](#), [46](#)).

Throughout 2022 to 2023 a number of toolkit resources have been reviewed and updated to provide an informed evidence base and to reach a broad range of primary care providers thereby influencing as many opportunities for behaviour change as possible.

1. Tools and resources to support AMS in the Community Pharmacy setting

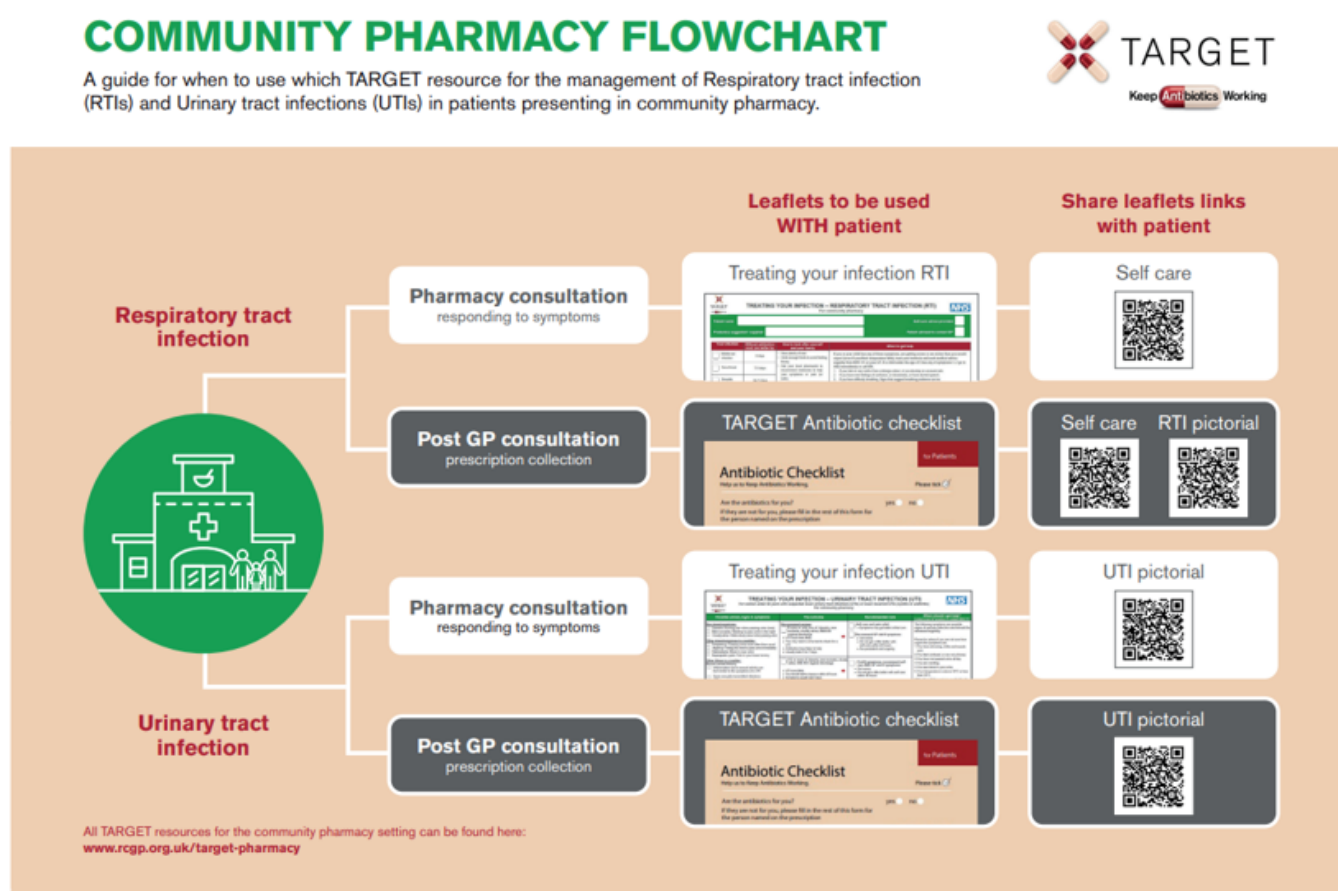
Community pharmacy staff have a critical role in AMS with their expertise in medicines and accessibility to patients. In September 2022 a section on ‘resources for the community

pharmacy setting' was published on the TARGET toolkit website (43), to support the AMS Criteria of the Pharmacy Quality Scheme (PQS) ([Chapter 5 section: NHS Pharmacy Quality Scheme 2022 to 2023](#)) comprising:

- the TARGET Antibiotic Checklist to be completed by patients and pharmacists on collection of antibiotics to facilitate individualised advice to the patient
- the TARGET Respiratory Tract Infection (RTI) patient information leaflet adapted for community pharmacy
- the TARGET Urinary Tract Infection (UTI) patient information leaflet for women under 65 with uncomplicated UTIs, adapted for community pharmacy
- the Community Pharmacy Flowchart ([Figure 4.2](#)) highlighting which TARGET resources can be used depending on where the patient is in the consultation pathway

Although tailored to suit community pharmacy needs, the pharmacy patient information leaflets contain the same consistent evidence-based messaging about antibiotic use, infection prevention, safety-netting and self-care advice as the leaflets for general practice, to ensure patients receive consistent advice wherever they enter the primary care pathway.

Figure 4.2. TARGET Community Pharmacy Resource Flowchart, which demonstrates where TARGET resources can be used in the patient pathway



TARGET is operated by the UK Health Security Agency. Developed in collaboration with professional medical bodies. Published November 2022, Review: November 2025. Version 1. KAW18-07 © Crown copyright 2018.

Text version of Figure 4.2

This infographic shows the TARGET Community Pharmacy Resource Flowchart, which demonstrates where TARGET resources can be used in the patient pathway.

The flow chart indicates leaflets to be used with patients and leaflet links to be shared with patients for pharmacy consultation responding to symptoms and post-GP consultation prescription collection for RTI and UTI.

End of text version of Figure 4.2

2. Tools to help prescribers reflect on their practices

The TARGET toolkit aims to encourage primary care prescribers to reflect on their antibiotic prescribing by developing an action plan to elicit positive behaviour change. In 2022 to 2023, audits specific to the management of RTIs in alignment with national guidelines were reviewed and updated, and a new antibiotic audit was published to help assess prescribing of the '4Cs' broad-spectrum antibiotics (cephalosporins, co-amoxiclav, ciprofloxacin and clindamycin). The audits were promoted during a live webinar focussed on audits in May 2023 and will continue to be promoted through existing communication channels.

The new TARGET 'How to..?' series, developed in collaboration with NHS England, aims to support primary care teams to review the appropriateness of antimicrobials in the evidence-based treatment and prevention of acne vulgaris and chronic obstructive pulmonary disease (COPD). [Evaluation of these resources is presented later in this chapter.](#)

3. Learning and reference resources for primary care providers

Two posters for clinicians were developed in collaboration with the National Institute for Health and Care Research (NIHR)-funded, STEP-UP group, including useful evidence-based approaches, 'discussing antibiotics with patients' and 'discussing back-up or delayed antibiotic prescriptions'. [They are hosted on the RCGP website.](#)

The clinical scenario training materials for acute sore throat, UTIs, acute rhinosinusitis, acute otitis media, acute cough, and slides on prescribing and AMS were reviewed and updated. These materials will be used during the TARGET Train-the-Trainer cascade across England ([see Chapter 6: Healthcare professional education and training](#) for more information).

TARGET antibiotics toolkit website visits and resource downloads

[Figure 4.3](#) shows website views of the TARGET antibiotics toolkit between April 2022 and March 2023; a total of 263,276 views for the year. November 2022 had the highest number of views of the year (40,434), almost double that of the previous month (21,070) which coincided with the TARGET promotional campaign and WAAW.

The most viewed section of the toolkit was the 'Leaflets to discuss with patients' section, which tends to be the most popular page year on year. Despite being published in September 2022, the new section on resources for the community pharmacy setting was the second most visited page (39,249 views) and was the most visited section in the first 3 months of 2023, likely due to the Pharmacy Quality Scheme (PQS) for 2022 to 2023 ([Chapter 5 section: NHS Pharmacy Quality Scheme 2022 to 2023](#)) resources over the year.

A total of 30,210 patient information leaflets were accessed over the year; 22,564 downloaded hard copy PDF or word version, and 7,846 views of the HTML leaflets (accessible web version), see [Figure 4.4](#). This included the leaflets for the community pharmacy setting published in September 2022 to support the PQS; 8,014 accessed the UTI pharmacy leaflet and 5,941 accessed the RTI pharmacy leaflet.

Outside of the pharmacy setting, the most accessed leaflets designed for the GP setting were the RTI leaflet (accessed 4882 times) and the UTI leaflet for women under 65 (accessed 4,049 times). In most cases the hard copy versions were used more than the HTML versions, with the exception of the UTI leaflet for women under 65.

Figure 4.3. TARGET antibiotics toolkit monthly views between April 2022 and March 2023. The data points represent the total monthly visits to the website. The dotted line in September 2022 indicates the addition of new section on resources for the community pharmacy setting, and the dashed line in November 2022 indicates the WAAW campaign

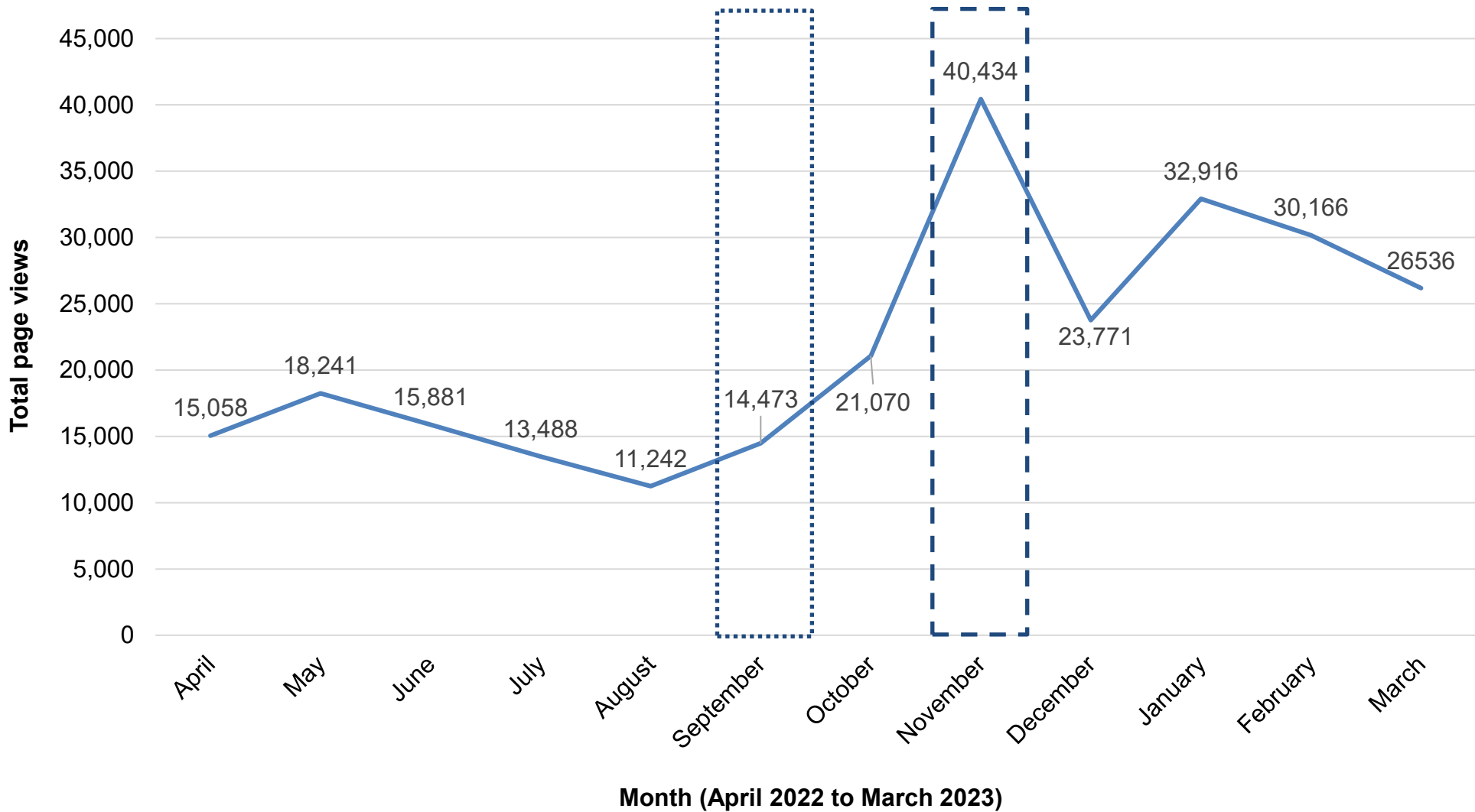
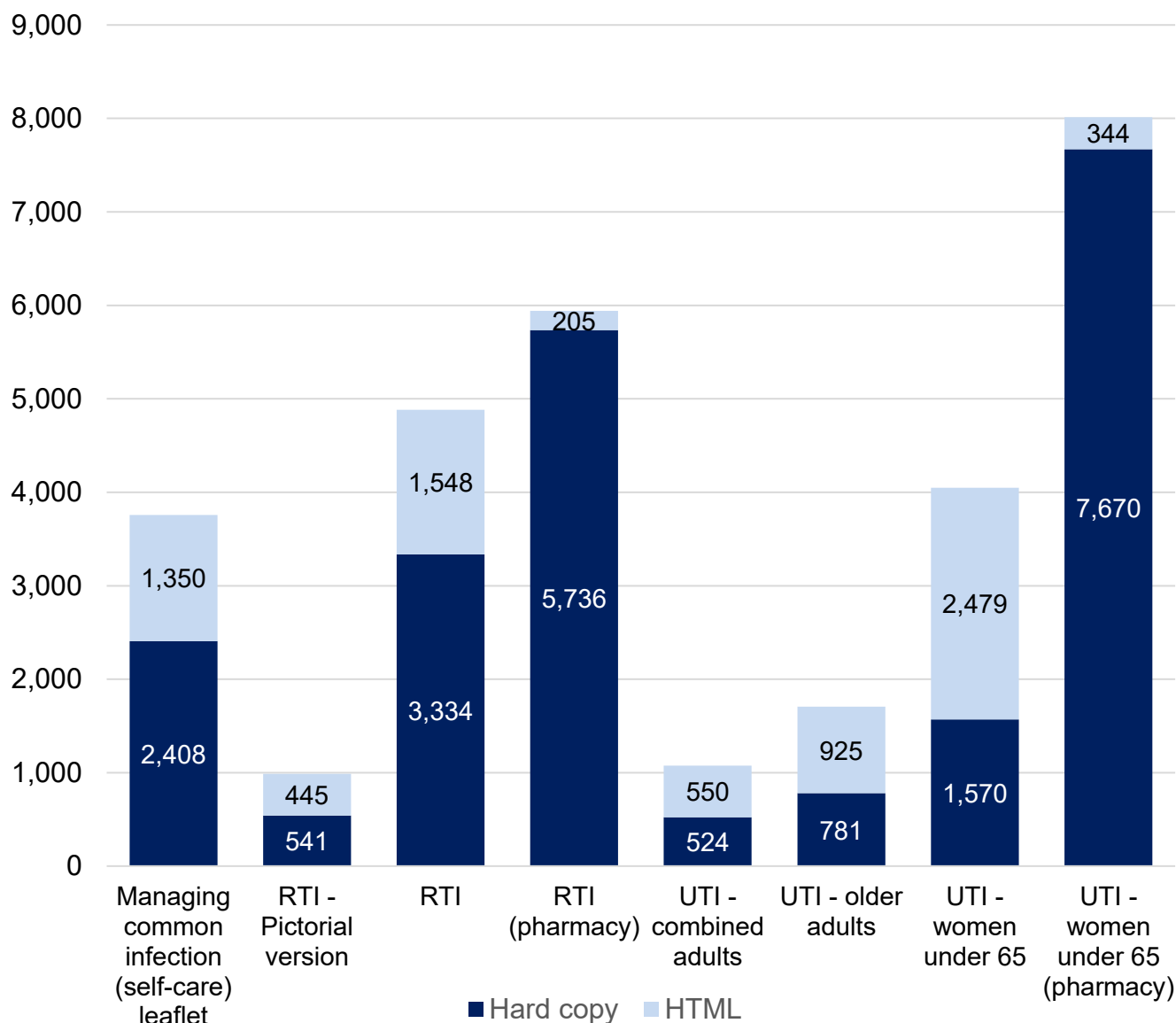


Figure 4.4. Hard copy downloads and HTML views of the TARGET Patient information leaflets, between April 2022 and March 2023

(Hard copy includes downloaded PDF or Word versions of the main version of the leaflets, not including translated documents. HTML refers to the accessible web page version. Note, the Pharmacy versions of the RTI and UTI leaflet were published in September 2022.)



Use of healthcare communication services to implement TARGET resources

TARGET has collaborated with the company Accurx who developed software that allows GPs to communicate digitally with patients and is used by 98% of general practices in England. Accurx provides SMS messaging service for GPs to send text templates to patients before, during or after a consultation. The TARGET HTML patient leaflets have been integrated into 6 SMS text templates. From January to March 2023 a total of 2,630 leaflets have been shared nationally through the SMS messaging templates. The UTI leaflet for women under 65 years of age is the

most commonly shared, accounting for 38% of all leaflets sent, and this is reflected in increased use of the HTML leaflet in TARGET website analytics.

TARGET collaborated with Accurx to develop a UTI questionnaire to help GPs assess a patient's urinary symptoms before consultation ([47](#)). Questions were created and prioritised through a focus group with primary care prescribers and medicines managers. From April 2022 to 31 March 2023, a total of 83,170 TARGET UTI questionnaires have been sent to patients, with a completion rate by patients of 89%. Of the 31 questionnaires available through Accurx, the UTI questionnaire is consistently within the top 3 most used. GPs are increasingly using e-consult software to support screening and management of common infections to support consultations.

National implementation of the TARGET RTI and UTI leaflets in community pharmacies through the 2022 to 2023 Pharmacy Quality Scheme

The TARGET UTI and RTI leaflets for the community pharmacy setting (available via the TARGET Antibiotics Toolkit) were co-developed with pharmacy staff and other stakeholders. The leaflets can support staff to assess patients presenting to community pharmacies with suspected UTI or upper RTI without a prescription and to provide tailored information to patients on self-care, safety netting and the need (or otherwise) for antibiotics. The leaflets were included as a criterion of the 2022 to 2023 Pharmacy Quality Scheme (PQS) (see [Chapter 5](#) section: NHS Pharmacy Quality Scheme 2022 to 2023 for full information). To support the implementation of the leaflets as part of the PQS, a hard copy version of the 2 TARGET pharmacy leaflets and the community pharmacy resource flowchart were sent to all community pharmacies in England in September 2022 (n=11,202).

Evaluation of the 'How to...' acne treatment resources in primary care and feasibility of implementation in community pharmacy

The 'How to...' guides were developed last year in line with the National Action Plan ambition to: "enhance the role of pharmacists in primary care to review the dose and duration of antimicrobial prescriptions (especially long-term or repeat ones) and work with prescribers to review those that are inappropriate through evidence-based, system-wide interventions". In collaboration with the University of Nottingham and NHS England, this project aimed to improve AMS within general practice through the clinical pharmacy workforce and by focusing on patients with high burden antimicrobial use – specifically, those on long-term and repeat antimicrobials for acne. The use of ['How to...'](#) acne management resources, previously developed in collaboration with partners, were piloted by pharmacy professionals working in general practice to review patients with acne to determine the feasibility of implementing them in community pharmacy ([48](#)).

The pharmacy professionals in general practice were sent and pre- and post-surveys based on the COM-B model used to assess knowledge and behaviour change after the implementation of

the acne resources. Two further surveys were distributed to community pharmacy professionals and stakeholders including (licensed professional counsellors, licensed practical nurses, commissioners and GPs) to understand how the acne resources could be used to develop acne management in community pharmacy. This included potential for review of patients on repeated treatments for acne and upskilling needed to enable community pharmacists to supply acne treatments. Questions in all surveys also included considerations and recommendations for wider use and development of the resources.

Summary of findings

General Practice pilot

A total of 141 pharmacy professionals working in GP practices completed the initial survey and 19 completed the follow-up. Of those that completed both surveys, implementation of the acne 'How to...' resources significantly improved 5-point Likert scale responses on capability, opportunity and motivation (see [Annexe](#) Table 4.1). Capability improved the most: 3.68 (SD 0.40) to 4.11 (SD 0.29); $p < 0.001$. From the initial survey 2 areas of low capability were identified: pharmacy technicians reported their capability as 2.70 (SD 0.94) and all respondents reported low capability in managing acne (2.79, SD 1.23), including long-term antibiotic review. The 'How to...' resources were rated as being useful and supportive to help pharmacy professionals in all areas of managing acne ([Table 4.1](#)). Specific areas of usefulness were in supporting pharmacy technicians and the clinical scenario case studies provided. Areas for improvement identified were in the look and feel of the resources and potential additional information to be added.

Feasibility of implementation in community pharmacy

A total of 44 community pharmacy professionals took this survey and of these, 25% responded that they had not received training on AMS. In addition, 10 stakeholders responded to the survey. Reviewing of long-term medications prescribed by another healthcare professional was only thought of as being a current role by 32% of all respondents, and the confidence of pharmacy professionals in managing acne was rated as moderate (mean response on a 5-point Likert scale: 3.75, SD 1.08). The opportunity and motivational needs to undertake roles such as reviewing and/or prescribing antimicrobial treatments were training, availability of patient group directions for treatment and appropriate remuneration. The acne resources were thought of as being very useful for these roles in acne management (5-point Likert scale mean response 4.32; SD 0.16), however some further development is needed to tailor these resources to community pharmacy as some sections were not seen as being very useful.

Conclusion

There is an unmet training need for pharmacy professionals in general practice, specifically around management of acne and review of antimicrobials. The acne 'How to...' resources are demonstrated as being able to improve the confidence in capability of managing acne and

should therefore be embedded in general practice frameworks to improve AMS in relation to acne management. Community pharmacy professionals do not currently see review of long-term medications for acne as part of their current role. The acne 'How to...' resources are thought to be a useful framework to community pharmacy professionals and could upskill pharmacy professionals in the management and review of antimicrobial treatment for acne. However, the acne resources may need some minor amendments before wider use by pharmacy professionals working in general practice and community pharmacy.

If these resources are further embedded into general practice and taken up by community pharmacy, there is an opportunity to further assess the capability, opportunity, motivation and subsequent and behaviour changes of these professionals in the long-term management of acne.

Table 4.1. Mean 5-point Likert responses from the question: 'the 'How to...' resources support me.....in my current or future role', from the pharmacy professionals working in general practice and community pharmacy

The 'How to...' resource supports me to do the following in my current or future role:	Mean (S.D.)	
	General practice (n=16)	Community pharmacy (n=17)
Diagnose acne vulgaris	3.94 (0.75)	4.29 (0.82)
Provide self-care advice	4.38 (0.70)	4.59 (0.49)
Initiate topical treatment for mild or moderate acne	3.94 (0.83)	4.35 (0.68)
Initiate topical and oral treatment for moderate/severe acne	3.94 (0.83)	4.41 (0.77)
Make referrals to a general practice as required	-	4.41 (0.77)
Make referrals to a dermatologist as required	4.06 (0.75)	4.35 (0.90)
Make referrals to mental health services as required	3.81 (0.88)	4.12 (1.13)
Review current treatment and swap topical treatments for acne	4.25 (0.75)	4.24 (0.94)
Review current treatment of acne and trial off antibiotics	4.31 (0.68)	4.24 (0.94)
Review current treatment and add in oral antibiotics	4.13 (0.86)	4.18 (0.93)
Mean	4.08 (0.18)	4.32 (0.16)

n = sample size; S.D, standard deviation.

Improving healthcare professionals' interactions with patients to tackle antimicrobial resistance: a systematic review of interventions, barriers and facilitators

It is important for healthcare professionals (HCPs) who prescribe, dispense, administer and/or monitor antimicrobials to mitigate inappropriate antimicrobial use. A rapid systematic review was conducted in collaboration with the University of Warwick to identify existing interventions which aim to improve how HCPs' interact with patients and examine factors that enable or hinder appropriate prescribing behaviours. The review also looked to determine how findings differed across factors associated with health inequalities.

A search of MEDLINE, EMBASE, Science Citation Index, Social Sciences Citation Index, Google Scholar, the internet and forward and backward citation searching from eligible studies was conducted. Studies of any design, published in English language from year 2010 to 2023 were included. The methodological quality of the included studies was assessed using the mixed methods appraisal tool. A narrative synthesis was applied and the COM-B (Capability, Opportunity, Motivation – Behaviour) was used as a theoretical framework for barriers and facilitators at HCP and patient levels.

A total of 4,979 citations were screened, of which 59 studies of diverse design examining a range of interventions from 16 countries were included (see [Annexe](#) Figure 4.1 for PRISMA diagram). Many interventions were established strategies such as TARGET and involved multiple components beyond HCPs' interaction with patients. The patient interaction components mostly involved the use of posters, leaflets, videos, interactive decision support tools and C reactive protein point-of-care testing. We identified barriers and facilitators relating to capability (for example, knowledge or understanding about AMR, diagnostic uncertainties, awareness of interventions, forgetfulness); opportunity (for example, time constraint, intervention accessibility) and motivation (for example, patient's desire for antibiotics, fear of litigation). Although 49 of the studies included participants from disadvantaged groups, only 3 examined how outcomes differed between groups. In these studies, antimicrobial prescribing was not associated with age, gender, or level of learning disability. Studies reported issues with language barriers and digital exclusion, especially for older people.

In conclusion, there are many useful interventions to improve HCPs and patients' interactions for appropriate behaviours in antibiotic use. The barriers and facilitators identified in this review should be considered by intervention designers/adopters and policy makers to improve implementation and effectiveness.

Secondary care AMS

Start SMART then Focus

AMS programmes play a crucial role in combatting AMR by reducing healthcare-associated infections, minimising costs, and improving patient safety and outcomes ([49 to 51](#)). On such

AMS programme is the [Start Smart then Focus](#) (SSTF) AMS toolkit which was first published in November 2011 and has since gained widespread adoption across the UK.

A project was undertaken to review and update the SSTF AMS toolkit to ensure its continued relevance to healthcare services. This involved incorporating the latest evidence and best clinical practices while reiterating the significance of AMS, particularly considering that the last update occurred in March 2015. The project outlined several objectives:

- a) establishing a core project team consisting of multiple agencies
- b) conducting focused literature searches on SSTF principles
- c) identifying a multidisciplinary group of expert stakeholders from all UK nations
- d) sharing the findings of the literature searches with stakeholders to gain consensus on necessary updates to the SSTF toolkit

The SSTF update group initially comprised 25 healthcare professionals from national stakeholders, with diverse expertise. The core project team selected and invited these individuals via email. [Table 4.2](#) summarises their initial contributions to the update of the toolkit.

Table 4.2. Summary of initial contributions from SSTF update group members

Initial SSTF update group members	Number of members	Method of participation	Output
25 healthcare professionals	20	Group discussion	Transcripts were thematically analysed to develop themes for update
	9	Questionnaire	More than half of respondents agreed or strongly agreed with proposed additional guidance, which included antimicrobial prescribing practice and implementation of AMS programmes

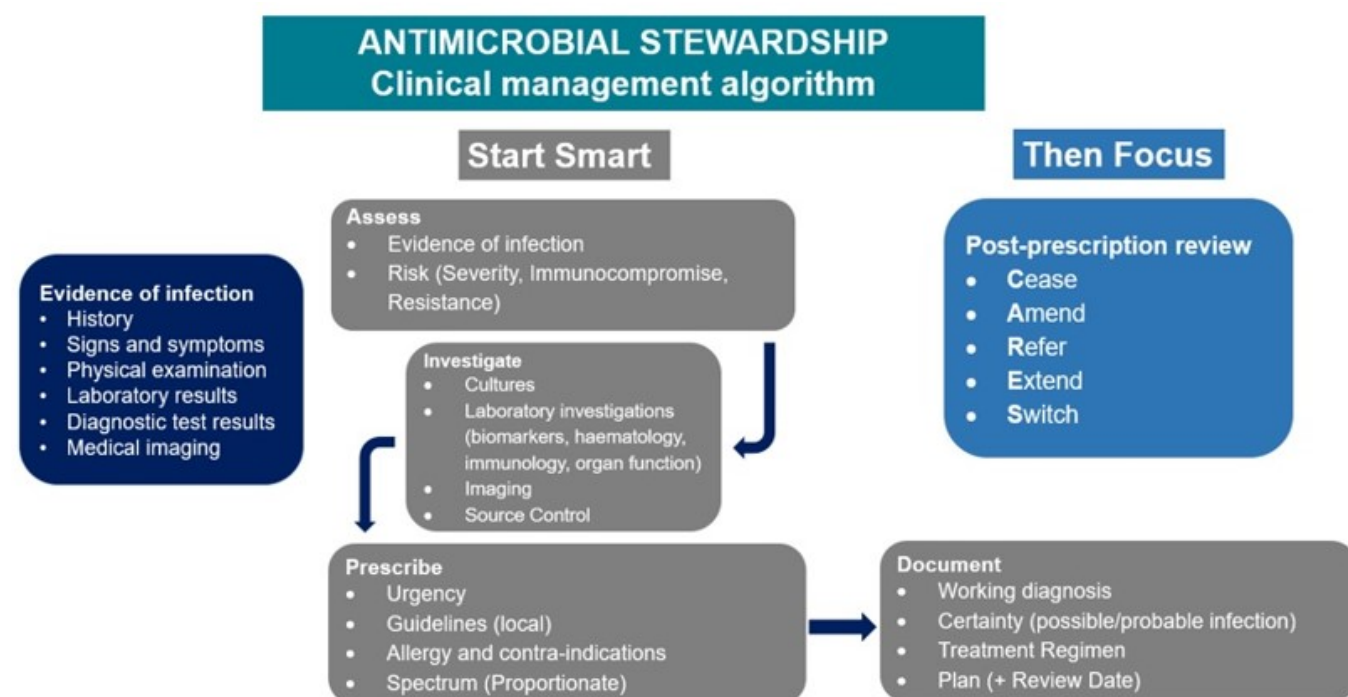
Data collection to support the update process also involved rapid literature searches based on research questions to identify new research evidence.

The analysis of the collected data revealed 2 themes for the updated SSTF AMS toolkit: (a) fostering a culture of AMS, and (b) further integrating AMS into clinical practice. These themes played a significant role in shaping the vision for the updated toolkit are detailed in [Table 4.3](#).

Table 4.3. Generation of themes and recommendations for update of SSTF AMS toolkit

Consensus for updating the SSTF toolkit	
Theme	Recommendations
Fostering a culture of antimicrobial stewardship	<ul style="list-style-type: none"> defining AMS and reaffirming the key principles of improving patient care and protecting the effectiveness of antimicrobials emphasising the importance of AMS within a local, national, and global context clarifying healthcare professional specific AMS responsibilities where possible stating the benefits of structures and processes of AMS programmes
Embedding antimicrobial stewardship within clinical practice	<ul style="list-style-type: none"> providing evidence-based advice for making antimicrobial prescribing decisions revising the timings of clinical reviews to reflect best practice incorporating national antimicrobial IV to oral switch criteria encouraging prompt source control

These recommendations were supported by a peer-reviewed research evidence base and have been integrated into the updated SSTF AMS toolkit with the the redesign of the 'Start Smart then Focus' AMS clinical management algorithm as outlined in [Figure 4.5](#).

Figure 4.5. AMS clinical management algorithm

Text version of Figure 4.5

This diagram shows the Antimicrobial Stewardship: Start Smart then Focus Clinical management algorithm. It shows a flowchart of the 7 steps taken during clinical management of an infection. The first box has the title evidence of infection and 6 bullet points. These points are: history, signs and symptoms, physical examination, laboratory results, diagnostic test results and medical imaging.

A box in the top middle of the figure contains the text 'Start Smart'.

The box below is marked 'Assess' and contains 2 2 bullet points: evidence or suspicion of infection, and patient risk (severity, immunocompromise, resistance).

An arrow links to a box below with the title 'Investigate' which contains 4 bullet points: cultures, laboratory investigations (biomarkers, haematology, immunology, organ function), imaging and source control.

An arrow links from the 'Investigate' box to a box with the title 'Prescribe' which contains 4 bullet points: urgency, guidelines (local), allergy and contra-indications and spectrum (proportionate).

Another arrow links the 'Prescribe' box to a box with the title 'Document', which contains 4 bullet points: working diagnosis, certainty (possible or probable infection), treatment regime and plan plus review date.

A box in the top right contains the text 'Then focus'. A box underneath this has the title 'Post-prescription review outcome options'. This box contains 5 bullet points: cease, amend, refer, extend and switch.

End of text version of Figure 4.5

The toolkit has undergone further review by an additional 25 multi-professional colleagues across the UK prior to publication. This process involved distributing the toolkit throughout UK AMS networks and the ESPAUR oversight group, and an expression of interest process, to ensure its broad dissemination and effective implementation.

Information for Action: reporting on health inequalities

UKHSA has made progress over recent years to report on factors associated with health inequalities within routine reporting on antimicrobial use and AMR. Data on protected characteristics, such as age and sex, socio-economic status, such as index of multiple deprivation, ethnicity, geographical differences and people in adult social care are currently included within routine reporting (see [Table 4.4](#)). However, there remain large gaps in our knowledge of how infection incidence, AMR and antibiotic use differ between populations, for example within high network settings such as prisons.

Table 4.4. Data on the domains of health inequalities which is currently being collected and/or reported

Domains of Health Inequalities	Data currently collected	Where reported
Index of Multiple Deprivation (IMD)	Yes	Annual Epidemiology Commentary ESPAUR report CPE report
Ethnic minority communities	Yes	Annual Epidemiology Commentary ESPAUR report
People with a learning disability and autistic people	No	-
People with multiple long-term health conditions	No	-
Coastal communities with pockets of deprivation hidden amongst relative affluence	No	-
Young carers	No	-
Looked after children or care leavers	No	-
Protected characteristic groups as defined by the Equality Act 2010	Yes	Prescribing data for primary care can be reviewed by age and sex. Annual Epidemiology Commentary reports data for age, sex and race. Quarterly report acquired carbapenemase-producing GNBSI reported by geography, age and sex Annual Epidemiological commentary also includes age and sex break down of organisms causing BSI in ICU patients
Inclusion health groups: including individuals experiencing 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	No	-

Domains of Health Inequalities	Data currently collected	Where reported
Socioeconomic status and deprivation groups	Yes	Annual Epidemiology Commentary reports data on deprivation categories
Differences in geographies	Yes	CPE reporting for population composition and urban, rural or coastal dwelling
People in Adult Social Care	Yes	Through NOIDs and notification of outbreaks to Health Protection Teams

Links to reports

Annual [Epidemiology Commentary](#)

Quarterly report acquired carbapenemase-producing [GNBSI](#)

[NOIDS, Notifications of Infectious Diseases](#)

Future actions

UKHSA will continue working alongside NHS England to implement TARGET and other AMS resources through the pharmacy quality scheme. Data collected from the 2022 to 2023 criteria of use of the pharmacy UTI and RTI leaflets will be analysed, and findings published. All previous AMS resources for the pharmacy setting have been renewed as criteria for the 2023 to 2024 PQS, including use of the TARGET UTI and RTI leaflets, the TARGET Antibiotic Checklist, Antibiotic Guardian pledge, and AMS e-learning. The AMR resources will also be used to create an AMS action plan.

The TARGET patient information leaflets will be reviewed against evidence in 2023 to 2024. over the next several years a suite of resources for skin infections will be developed, which will be informed by analysis of UK antibiotic prescribing data and an antibiotic prescribing survey of UK GPs. A diagnostic picture guide on cellulitis will be developed which includes diverse images to assist with diagnosis on different skin tones to drive improved antibiotic prescribing and a reduction in AMR.

The review and update of the UTI diagnostic decision tools will continue and focus groups with care home staff and healthcare professionals will inform the development of a TARGET UTI decision support tool for care homes; a feasibility pilot of the tool in care homes is planned in 2023 to 2024.

An action plan for promotion and continued implementation of the SMTF toolkit will be developed in collaboration with NHS England.

A needs assessment will be undertaken in collaboration with NHS England to develop relevant AMS interventions required for social care settings including care homes and prisons.

There remain significant gaps in routine reporting especially for inclusion health groups. Therefore, future work is needed to outline data flows which would allow this information to be captured and included within routine reporting.

Develop AMS activities to support high prescribing in risk settings such as prisons.

Promote awareness of factors associated with health inequalities and other clinical factors which are associated with an increased risk of developing sepsis (covered in more detail in the Research chapter).

Chapter 5. NHS England: improvement and assurance schemes

Main messages

NHS England designs and administers improvement and assurance schemes including elements to incentivise prudent use of antimicrobials, to optimise patient outcomes, minimise avoidable exposure to antimicrobials and reduce selection pressure for antimicrobial resistance (AMR).

During 2022 to 2023, NHS England improvement and assurance schemes have included the NHS Oversight Framework for Integrated Care Boards (ICBs), the Pharmacy Quality Scheme for community pharmacy, the NHS Standard Contract for acute hospital trusts and the Commissioning for Quality and Innovation (CQUIN) framework for acute hospital trusts.

NHS Oversight Framework

For the 12 months to 31 March 2023, the number of ICBs meeting the national target for total primary care prescribing of antibiotics 'at or less than 0.871 items per STAR-PU' was 7 out of 42 (17%) and the number of ICBs meeting the national target for primary care broad-spectrum antibiotic prescribing 'at or less than 10%' was 41 out of 42 (98%). The number of ICBs meeting both targets was 7 out of 42 (17%). This reflects a reduction in ICB performance compared to the previous year (12 months to March 2022) and coincided with a period of increased incidence of group A *Streptococcus* infection associated with increased demand for antibiotics. For England as a whole, total primary care antibiotic prescribing for the 12 months to 31 March 2023 exceeded the national target, increasing to 0.984 items per STAR-PU (15% below the 2013 to 2014 baseline).

Pharmacy Quality Scheme (PQS)

The PQS ran from 10 October 2022 to 31 March 2023, and in that time 8,363 community pharmacies submitted data for 104,142 patients with symptoms of urinary tract infections and 8,221 community pharmacies submitted data for 115,094 patients with symptoms of respiratory tract infections.

NHS Standard Contract

40 out of 137 (29.2%) of trusts achieved the standard contract target to reduce 'Watch' and 'Reserve' prescribing by 4.5% from the 2018 baseline. The antibiotic consumption for antibiotics from the 'Watch' and 'Reserve' categories across all participating trusts at financial year end was 2,397 DDD per 1,000 admissions, which was 1.1% higher than the 2018 baseline of 2,371 DDD per 1,000 admissions.

Commissioning for Quality and Innovation (CQUIN) framework

Commissioning for Quality and Innovation (CQUIN) framework. 65 out of 137 (47%) NHS trusts adopted this Urinary Tract Infection CQUIN scheme and submitted data for one or more quarters to UKHSA. A total of 19,283 cases were submitted during all 4 quarters of the scheme life, with 10,902 (57%) cases reported as case compliant. 41 out of 45 (91%) NHS trusts who submitted data for each of the 4 quarters achieved $\geq 40\%$ case compliance while 22 out of 45 (49%) NHS trusts achieved $\geq 60\%$ case compliance.

Reducing antibiotic prescribing in primary care

The [NHS Oversight Framework](#) is aligned with the ambitions set out in the NHS Long Term Plan and the 2022 to 2023 NHS operational planning and contracting guidance. It also reflects the significant changes enabled by the Health and Care Act 2022 including the formal establishment of integrated care boards and the merging of NHS Improvement (comprising of Monitor and the NHS Trust Development Authority) into NHS England. The NHS Oversight Framework contains 2 AMR-related indicators with set targets for integrated care boards (ICBs) that have been used in NHS improvement and assurance schemes since 2015.

NHS oversight framework metrics

The NHS Oversight Framework 2022 to 2023 includes 2 AMR-related metrics for ICBs – ‘Antimicrobial resistance: appropriate prescribing of antibiotics and broad-spectrum antibiotics in primary care.’ The metrics and associated national targets are set out in [Table 5.1](#). The national target for total prescribing of antibiotics is aligned with the UK AMR National Action Plan (NAP) (2019 to 2024) ambition to reduce community antibiotic prescribing by 2024 by 25% from a 2013 baseline [\(2\)](#).

Table 5.1. NHS System Oversight metrics and targets (March 2024) for antibiotic prescribing

Code	AMR Metric Description	Target
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
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	At or less than 10%

Code	AMR Metric Description	Target
	fluoroquinolone class drugs as a percentage of the total number of antibacterial items prescribed in primary care.	

NHS England in collaboration with the NHS Business Services Authority report ICB performance for both AMR indicators to monitor antibiotic prescribing in primary care and report ICB progress towards the NHS Oversight Framework targets. The NHS Business Services Authority report ICB performance monthly within the NHS England AMR NHS Oversight Framework 2022 to 2023 dashboard which is published in the [Antimicrobial Resistance \(AMR\) Programme FutureNHS workspace](#).

Integrated Care Board (ICB) performance 2022 to 2023

For the 12 months to 31 March 2023, 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 7 out of 42 (17%) and the number of ICBs meeting the national target for primary care broad-spectrum antibiotic prescribing 'at or less than 10%' was 41 out of 42 (98%). The number of ICBs meeting both targets was 7 out of 42 (17%). This reflects a reduction in ICB performance compared to the previous year (12 months to March 2022).

For England as a whole, total primary care antibiotic prescribing for the 12 months to 31 March 2023 exceeded the national target, increasing to 0.984 items per STAR-PU. This is 15% below the 2013 to 2014 baseline of 1.161 on which the UK AMR NAP ambition to reduce community use of antibiotics by 25% by 2024 is based and reflects an actual increase of 5 million primary care antibiotic prescriptions in the 12 months to 31 March 2023 compared to the previous 12 months to 31 March 2022. Meanwhile primary care prescribing of broad-spectrum antibiotics met the target of 'at or less than 10%' with a proportion of 7.7% of prescriptions being for broad-spectrum agents, despite an actual increase of 100,000 prescriptions compared to the previous 12 months to March 2022.

Primary care antibiotic prescribing remains impacted by the consequences of the COVID-19 pandemic, and the unusual high prevalence of group A streptococcal infection in December 2022 resulted in a relatively high volume of antibiotic prescribing in primary care, exceeding levels of prescribing previously reported for the same months both during and prior to the pandemic.

NHS Pharmacy Quality Scheme 2022 to 2023

The Pharmacy Quality Scheme (PQS) forms part of the Community Pharmacy Contractual Framework (CPCF). It supports delivery of the NHS Long Term Plan and rewards community pharmacy contractors that deliver quality criteria in 3 quality dimensions: clinical effectiveness, patient safety and patient experience. (See the [NHS England Pharmacy quality scheme](#)).

The AMS criteria of the Pharmacy Quality Scheme included a rollout of the TARGET (Treat Antibiotics Responsibly, Guidance, Education, and Tools) Treating Your Infection (TYI) [leaflets](#) for Respiratory Tract Infections (RTIs) and Urinary Tract Infections (UTIs) to community pharmacies in England. Pharmacy teams were required to submit evidence that they had reviewed their current AMS practice using the TARGET TYI leaflets over 4 weeks with a minimum of 15 patients for each condition, or up to 4 weeks if the minimum number of patients was not achieved within 8 weeks.

Urinary tract infections

Data was submitted by 8,363 community pharmacies, for 104,142 patients presenting with UTI symptoms.

Most (non-pregnant) women (77%; 75,071) presented with none or only one of the 3 strongly predictive symptoms of dysuria, new nocturia, cloudy urine; and/or vaginal discharge and therefore were less likely to have an UTI, as outlined in UTI diagnostic guidance.

Conversely, 22,381 (23%) of women presented with 2 or more symptoms of dysuria, new nocturia, cloudy urine and with no vaginal discharge and therefore they were more likely to have a UTI.

The TARGET UTI leaflets were designed to support community pharmacy teams to differentiate between symptoms more likely to be associated with UTIs and those that could be managed with self-care. The findings suggest that most women presenting to community pharmacy with urinary symptoms were less likely to have an UTI, and could be suitably managed with self-care, pain relief and appropriate safety netting.

Around a third of patients were managed by community pharmacy team members without the need for escalation to a pharmacist and 78% (80,791) patients were managed within the pharmacy, by the pharmacist and pharmacy team without the need to escalate to another healthcare setting. Most women (94%; 97,452) received self-care advice, of whom 37,565 (36%) were also provided with patient information leaflets.

Respiratory tract infections

Data was submitted by 8,221 community pharmacies for 115,094 RTI leaflets. Of patients with suspected RTIs, 43% (49,813) were managed by the pharmacy team without the need to escalate to the pharmacist.

Most (88%; 101,846) patients were managed within the pharmacy, by the pharmacist and pharmacy team without the need to escalate to another healthcare setting.

The other 12% of patients (13,248) presented with symptoms suggesting that urgent medical advice was required. Of these, 6,859 (6% of all patients) were signposted to other healthcare

services, with most (5,507 – 5% of all patients) referred to their GP. Of these patients, 6,011 were advised to seek medical advice if symptoms did not improve within 48 hours or got worse.

Most patients (95%; 109,474) were provided with self-care advice, of whom 31% (35,624) were also provided with patient information leaflets to support the verbal advice provided.

The use of the TARGET TYI leaflets has supported community pharmacy teams to respond to RTI symptoms in a structured way. The leaflets help to reassure patients when symptoms are mild, providing safety netting advice to these patients as well as promoting self-care while supporting the identification of patients who require escalation and signposting to other healthcare settings.

Reducing antibiotic consumption by NHS trust providers of acute care

NHS standard contract 2022 to 2023

The scope of the antibiotic reduction requirement within the [NHS standard contract 2022 to 2023](#) (33) has been narrowed to antibiotics from the World Health Organisation (WHO) ‘Watch’ and ‘Reserve’ categories (adapted for use in England) (31). This change brings the performance measure into alignment with the ambition set out in the UK AMR NAP for 2019 to 2024. In order to maintain trajectory towards the NAP 10% reduction target, the NHS Standard Contract 2022 to 2023 required each NHS trust that provides acute services to reduce consumption of antibiotics from the ‘Watch’ and ‘Reserve’ categories by 4.5% from the 2018 baseline.

[Table 5.2](#) shows that for 2022 to 2023, 40 out of 137 (29.2%) trusts achieved the standard contract target to reduce ‘Watch’ and ‘Reserve’ prescribing by 4.5% from the 2018 baseline. The antibiotic consumption for antibiotics from the ‘Watch’ and ‘Reserve’ categories across all participating trusts at financial year end was 2,397 DDD per 1,000 admissions, which was 1.1% higher than the 2018 baseline of 2,371 DDD per 1,000 admissions.

Table 5.2 Summary of changes to antibiotic consumption targets and achievement 2019 to 2023

NHS Standard Contract	Target reduction in antibiotic consumption from calendar year 2018 baseline	Number of trusts that met requirement	Antibiotic consumption value at year end
2019 to 2020	1% reduction in total DDD per 1,000 admissions (cf. 2018)	43/145 (30%)	4,612 DDD per 1,000 admissions
2020 to 2021	Suspended due to COVID-19 pandemic	N/A	N/A
2021 to 2022	2% reduction in total DDD per 1,000 admissions (cf. 2018)	69/138 (50%)	4,465 DDD per 1,000 admissions

NHS Standard Contract	Target reduction in antibiotic consumption from calendar year 2018 baseline	Number of trusts that met requirement	Antibiotic consumption value at year end
2022 to 2023	4.5% reduction in DDD per 1,000 admissions for antibiotics from the WHO 'Watch' and 'Reserve' categories (cf. 2018)	40/137 (29.2%)	2,397 'Watch' and 'Reserve' categories DDD per 1,000 admissions

NHS Standard Contract final performance data by trust for the antibiotic consumption targets for 2022 to 2023 are available within the NHS England AMR Programme Workspace in [FutureNHS](#).

NHS Commissioning for Quality and Innovation (CQUIN) scheme 2022 to 2023: Improving appropriate antibiotic prescribing for UTI (Urinary Tract Infection)

During the financial year 2022 to 2023 NHS hospital trusts providing acute care services participated in the NHS Commissioning for Quality and Innovation (CQUIN) scheme: CCG2: Appropriate antibiotic prescribing for UTI in adults aged 16+ in NHS trust providers of acute care. This scheme was intended to improve the diagnosis and appropriate use of antibiotics to treat acute UTI in adults aged 16+ years in line with National Institute for Health and Care Excellence (NICE) guidance for UTI (lower): antimicrobial prescribing ([NG109](#)), pyelonephritis (acute); antimicrobial prescribing ([NG111](#)), UTI (catheter-associated); antimicrobial prescribing ([NG113](#)) and PHE guidance on diagnosis of UTIs.

This CQUIN scheme required submission of a minimum sample of 100 patient cases meeting the inclusion criteria of acute UTI in adults aged 16+ years each quarter. Quarterly reporting was submitted to UKHSA using a standard data capture tool, and quarterly performance was published on the Office for Health Improvement and Disparities Fingertips [AMR portal](#), and on the [NHS England AMR FutureNHS workspace](#). CQUIN scheme achievement required case compliance, with 5 pre-defined UTI care processes, of 40% of cases or greater to receive partial payment and 60% or greater to receive full payment. [CQUIN scheme details](#) are published by NHS England. Resources to support implementation of the CQUIN scheme were published on the [NHS England AMR FutureNHS workspace](#).

CQUIN scheme case compliance required the antibiotic prescription for adults aged 16+ years for the treatment of an acute UTI to meet 5 care processes:

- documented diagnosis of specific UTI based on clinical signs and symptoms
- diagnosis excludes use of urine dip stick in people aged 65+ years and in all urinary catheter-associated UTI (CAUTI)
- empirical antibiotic regimen prescribed following NICE guidance or local guidelines
- urine sample sent to microbiology as per NICE requirement

- for diagnosis of CAUTI, documented review of urinary catheter use is made in the clinical record

NHS England expect commissioners and providers to include all relevant quality indicators within their CQUIN schemes but where more than 5 indicators are relevant to a particular provider's services, the co-ordinating commissioner and the provider should agree the most relevant 5 indicators across the services in scope for each contract. In 2022 to 2023, for the first time, NHS England CQUIN guidance stipulated that in all instances, providers that are in scope for a CQUIN scheme, were required to report their performance against the complete set of CQUIN scheme indicators, even where these indicators are not among the 5 included within their CQUIN scheme.

For the CQUIN scheme CCG2: Appropriate antibiotic prescribing for UTI in adults aged 16+ in NHS trust providers of acute care 72 (53%) of the 137 NHS trusts in scope for the scheme did not adopt the CQUIN. Thirty-one (43%) of these 72 NHS trusts submitted performance data for one or more quarters – a total of 8,131 cases; 4,325 (53%) of these cases were reported as case compliant. 16 out of 72 (22%) of these NHS trusts submitted data for all 4 quarters and this accounted for 5,918 of the 8,131 cases. This data has been excluded from further analysis which is limited to the 65 NHS trusts who adopted this CQUIN scheme.

65 out of 137 (47%) NHS trusts adopted this CQUIN scheme and submitted data for one or more quarters to UKHSA. A total of 19,283 cases were submitted during all 4 quarters of the scheme life, with 10,902 (57%) cases reported as case compliant. The data is reported by quarter in Table 5.3 which demonstrates improvement in case compliance increased each quarter from 54% in Q1 to 59% in Q4.

56 out of 65 (86%) NHS trusts achieved a case compliance rate of 40% or greater with 32 out of 65 (49%) NHS Trusts achieving a case compliance of 60% or greater.

As shown in [Table 5.3](#), the number of NHS trusts submitting data varied for each quarter with 45 out of 65 (69%) NHS Trusts submitting data for each of the 4 quarters. This represented 86% of all cases submitted (16,635 out of 19,283 cases).

41 out of 45 (91%) NHS trusts who submitted data for each of the 4 quarters achieved $\geq 40\%$ case compliance while 22 out of 45 (49%) NHS trusts achieved $\geq 60\%$ case compliance. These 22 trusts reported 8,146 cases representing 42% (8,146 out of 19,283) of all cases audited during the scheme life. Eleven NHS trusts achieved $\geq 60\%$ case compliance in each of the 4 quarters.

Table 5.3 2022 to 2023 CQUIN scheme CCG2: Improving appropriate antibiotic prescribing for UTI (Urinary Tract Infection) England

	Q1	Q2	Q3	Q4	Q1 to Q4 total	All 4 quarters
Number of cases audited by Quarter	4,813	4,972	4,799	4,699	19,283	16,635
Number of cases CQUIN compliant	2,586	2,773	2,758	2,785	10,902	9,538
Proportion of cases CQUIN compliant	54%	56%	57%	59%	57%	57%
Number of acute trusts adopting the CQUIN scheme submitting data	55	55	55	55	65	45
Number of acute trusts adopting the CQUIN scheme	65	65	65	65	65	65
Proportion of acute trusts adopting the CQUIN scheme submitting data	85%	85%	85%	85%	100%	69%
Number of NHS trusts achieving < 40% case compliance					9	
Number of NHS trusts achieving ≥ 40% case compliance					56	
Number of NHS trusts achieving ≥ 60% case compliance					32	
Number of NHS trusts submitting data for each of the 4 quarters achieving ≥ 40% case compliance						41
Number of NHS trusts submitting data for each of the 4 quarters achieving ≥ 60% case compliance						22

FutureNHS AMR Programme Workspace

Update on commitment 2022 to 2023

The NHS England AMR Programme workspace was launched on the [FutureNHS](#) collaboration platform in March 2022. The workspace is designed to support local, regional and national stakeholders to access guidance, resources (including frequently asked questions) and performance data for national improvement and assurance schemes.

The FutureNHS platform, upon registration, is open to all staff working within the NHS, and those providing or supporting NHS funded services, at the discretion of the workspace manager. During 2022 to 2023, over 1,000 new users registered to access the workspace.

In addition to content to support AMS, the platform provides registered users with the opportunity to network, collaborate, and share learning via a dedicated discussion forum.

Plans for 2023 to 2024

NHS Oversight Framework 2023 to 2024

The NHS Oversight Framework 2023 to 2024 retains the 2 AMR-related metrics for Integrated Care Boards (ICB) – ‘Antimicrobial resistance: appropriate prescribing of antibiotics and broad-spectrum antibiotics in primary care.’ The metrics and associated national targets are unchanged as set out above in [Table 5.1](#). The national target for total prescribing of antibiotics continues to align with the UK AMR NAP (2019 to 2024) ambition to reduce community antibiotic prescribing by 2024 by 25% from a 2013 baseline.

NHS Standard Contract 2023 to 2024

For 2023 to 2024 the NHS Standard Contract continues to require acute providers to make year-on-year reductions in their per-patient usage of antibiotics from the WHO ‘Watch’ and ‘Reserve’ categories, in line with the ambition for a 10% cumulative reduction set out in the UK 5- year action plan for antimicrobial resistance 2019 to 2024. To date, the standard contract requirement for annual reductions in antibiotic prescribing has been expressed against the 2018 baseline of actual usage. For consistency with the UK 5-year AMR NAP target, the Contract target has been amended for 2023 to 2024 so that the requirement is for a 10% cumulative reduction by 31 March 2024 against the 2017 baseline.

A survey was carried out in February 2023 of trusts that had successfully reduced consumption of WHO ‘Watch’ and ‘Reserve’ antibiotics and the results were published within the [Summary of key changes in response to consultation feedback report \(Annexe A\)](#). It is anticipated that the intravenous-to-oral switch CQUIN indicator for 2023 to 2024 (see below) will also support trusts with achieving reductions in consumption of ‘Watch’ and ‘Reserve’ antibiotics.

NHS Commissioning for Quality and Innovation (CQUIN) Framework 2023 to 2024

There are 17 clinical priority indicators highlighted for adoption in the 2023 to 2024 CQUIN scheme. The NHS England AMR Programme is responsible for 2 CQUIN indicators:

- CQUIN03: Prompt switching of intravenous (IV) antimicrobial treatment to the oral route of administration as soon as patients meet switch criteria
- CQUIN07: Recording of and appropriate response to NEWS2 score for unplanned critical care admissions

CQUIN03 requires 100 patients with active prescriptions for IV antibiotics at the point of audit to be audited prospectively per quarter. The aim is to encourage timely appropriate IV-to-oral

switch (IVOS) and achieve 40% (or fewer) patients continuing to receive IV antibiotics past the point at which they meet national switching eligibility criteria (the national IVOS criteria are described [here](#)). Minimum payment will be available at a level of 60% of patients still receiving IVs (as a yearly average) past the point at which they meet the switch criteria, and a maximum payment will be available at a level of 40% (as a yearly average).

CQUIN07 requires achieving 30% of unplanned critical care unit admissions from non-critical care wards having a timely response to deterioration, with the NEWS2 score, escalation and response times recorded in clinical notes. A minimum payment will be available at 10% and a maximum at a level of 30%.

National support from the NHS England AMR programme is available to support the implementation of the CQUIN scheme via dedicated resources on the AMR programme [FutureNHS](#) workspace.

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

Main messages

TARGET professional education, training and promotional campaigns

The national TARGET (Treat Antibiotics Responsibly, Guidance, Education, and Tools) ‘Train-the-Trainer’ antimicrobial stewardship (AMS) training rollout was launched with an inaugural workshop in October 2022. It was attended by NHS England Regional AMS Leads, regional infection prevention and control (IPC) leads and UKHSA health protection team (HPT) leads. Between October 2022 and July 2023, TARGET training has been delivered to 337 primary healthcare professionals.

TARGET live ‘Skin infections’ webinar had 836 sign ups and 236 attended on the evening. From the webinar evaluation survey, 100% of participants rated the webinar “excellent” or “good” and would recommend it to a colleague.

UKHSA and the Royal College of General Practitioners (RCGP) ran a joint campaign, aimed at general practitioners (GPs), to promote awareness of the TARGET Toolkit and use of resources. Implemented as part of World Antimicrobial Awareness Week (WAAW) in November 2022, activities included emails to over 42,000 RCGP members and a social media campaign that achieved over 46,000 impressions.

Antibiotic Guardian

Eighty-nine organisations registered their AMS activities on the Antibiotic Guardian website in 2022, 83 were from the UK and 6 were international. Highest numbers were from hospitals, GP practices, NHS trusts and community pharmacy.

Update to Antibiotic Guardian pledges through feedback from a survey and a stakeholder workshop, led to 81 of the 132 pledges being updated, 16 pledges being removed and the addition of 12 new pledges to reflect changes in the field of antimicrobial resistance (AMR), medical practice and information dissemination.

Antibiotic Guardian Schools Ambassadors Programme: Since 2021, the programme has aimed to target the regions with the most deprived areas. A total of 189 colleagues registered to become an Antibiotic Guardian Schools Ambassador in 2022 (110 in 2021 and 79 in 2019). In 2022, registrations were received for the first time from international colleagues and an initiative was started for trainee pharmacists to actively participate in a national AMS public health campaign. A total of 197 trainee pharmacists registered to participate in the project. Early feedback from post-project questionnaires suggested that trainee pharmacists felt an increased

sense of confidence in delivering public health campaigns and providing health information to young people

World Antimicrobial Awareness Week (WAAW) and European Antimicrobial Awareness Day (EAAD) 2022

Digital resources were developed and shared through a toolkit for healthcare professionals in England to support the NHS and others to lead activities. The webpage hosting the toolkit was visited 3,454 times between publication in October 2022 to the end of 2022.

Digital notes remain one of the most shared resources during WAAW.

A feedback survey indicated that the top 3 resources in the toolkit when ranked by helpfulness were the digital notes, teleconference backgrounds and Keep Antibiotics Working (KAW) materials.

Reviews of AMR campaigns

A rapid review was undertaken of global AMR campaigns to alter public awareness and antimicrobial use behaviours. A total of 41 studies were included, after de-duplication and screening. The review provided evidence that both large and small-scale campaigns can significantly improve outcome measures relating to AMR and antibiotic usage. Despite a lack of homogeneity between studies some common themes emerged between effective campaigns, including use of mass media to disseminate messaging targeted towards a specific disease, healthcare professional education, and use of healthcare professional-patient interactions.

A review was undertaken of the cost effectiveness of AMR public awareness campaigns. Although only 2 studies were included, both reported a reduction in antibiotic prescribing. However, the sources of outcome data, methods used to calculate results and time horizon over which outcomes were captured, varied considerably.

Public education and engagement with e-Bug

The e-Bug public-facing website has been redeveloped to meet web content accessibility guidelines standards, ensuring that users with disabilities and/or using assistive technologies can access all content without barriers.

An evaluation survey for all maintained schools in England highlighted that of the 248 respondents, 56% were aware of e-Bug and 89% would recommend e-Bug to another educator.

In collaboration with North West UKHSA and NHS England regional infection prevention and control (IPC) and AMS leads, e-Bug educator training was delivered to 19 of the 23 local authorities in the North West (83% coverage) in January 2023. 97% of delegates rated the quality of the training as excellent or very good. 69% of local authorities have plans to begin implementing e-Bug in schools within 6 months of receiving the training.

Update to 'Antimicrobial Prescribing and Stewardship' Competency Framework

The 'Antimicrobial Prescribing and Stewardship' Competency Framework was reviewed and updated using a Delphi method with a diverse group of multidisciplinary professionals from a variety of healthcare settings.

Introduction to Chapter 6

Education and training reached a wide variety of professionals across the care pathway, both online and face-to-face. TARGET (Treat Antibiotics Responsibly, Guidance, Education, and Tools) continued its provision of learning through webinars, e-Learning and an updated cascaded national antimicrobial stewardship (AMS) training. There was an update of the Antimicrobial Prescribing and Stewardship (APS) Competency Framework for healthcare professionals to ensure that it aligned with current guidance and recommendations for best practice.

National campaigns aimed to educate and engage both the public and healthcare professionals, including the Antibiotic Guardian campaign, TARGET social media campaign aimed at general practitioners (GPs), digital resource toolkits to support World Antimicrobial Awareness Week (WAAW) and European Antimicrobial Awareness Day activities, e-Bug social media campaigns for WAAW and British Science Week. The Antibiotic Guardian Schools Ambassadors Programme continued to improve and expand its reach, connecting healthcare professionals with local schools and community groups to share information about antibiotics, AMR and infection prevention and control (IPC). It continued to focus on the most deprived UK regions and engaging trainee pharmacists, as well as receiving registrations from outside the UK for the first time. The Antibiotic Guardian Schools Ambassadors Programme rolled out a new initiative to allow trainee pharmacists to actively participate in a national AMS public health campaign. Findings from a rapid review of AMR campaigns provided some evidence that both large and small-scale campaigns can significantly improve outcome measures relating to AMR and antibiotic usage. The review highlighted avenues for future research, mainly including evaluation of campaign effectiveness and social media campaigns.

An evaluation of the national dissemination of e-Bug educational infection and AMR resources to all maintained schools across England found that interest for e-Bug teacher training was high. The feedback has been used to structure the e-Bug training programme and communication to suit educator preferences.

UKHSA has continued to examine the public's self-reported incidence of infections, health-seeking behaviours, knowledge and attitudes towards antibiotic use. This will help inform future resource development and engagement activities.

Healthcare professional education and training

Workshops: TARGET Antimicrobial Stewardship Training

The TARGET AMS workshop designed for primary care healthcare professionals was developed using the COM-B behavioural theory (46) to facilitate appropriate antibiotic prescribing. The training aims to influence attitudes and behaviours towards the use of antibiotics for common infections by focussing on:

1. Capability

The individual’s psychological (self-efficacy) and physical capacity (control, skills) to prescribe antibiotics appropriately.

2. Opportunity

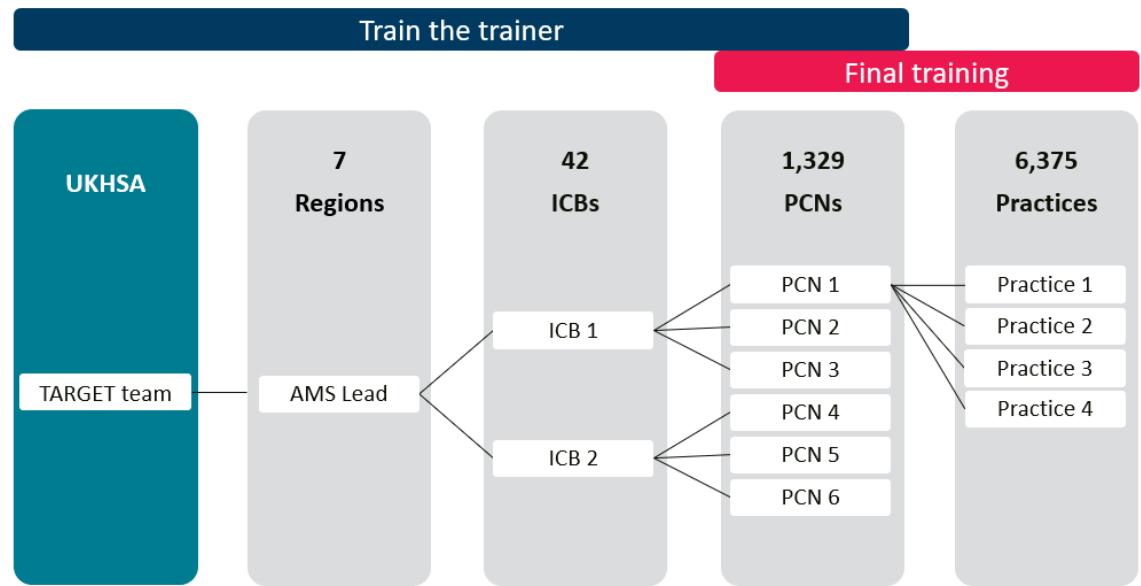
Factors that lie outside the individual that make appropriate antibiotic prescribing possible or prompt it (barriers, cues to action, social norms surrounding appropriate antibiotic prescribing).

3. Motivation

Brain processes that energise and direct behaviour, including habitual processes, emotional responding (fear, attitudes), as well as analytical decision-making (health motivation).

The national TARGET training roll out, launched with an inaugural workshop in October 2022, was attended by 22 AMR and IPC lead representatives from UKHSA and NHS England (NHSE) from 6 out of 7 of the NHSE regions; colleagues from the South West were provided information during a separate meeting. UKHSA, in collaboration with NHSE, aims to cascade the training workshops to primary care healthcare professionals regionally via a proposed tiered ‘Train-the-Trainer’ approach (Figure 6.1).

Figure 6.1. Proposed cascade for national TARGET Train-the-Trainer antimicrobial stewardship training



Text version of Figure 6.1

The flow diagram shows the proposed training cascade, in which the TARGET team cascade the training to regional AMS leads, who cascade to ICBs, who cascade to PCNs ('train-the-trainer'). The final training involves the PCNs cascading to practices. Abbreviations: AMS, antimicrobial stewardship; ICBs, Integrated Care Boards; PCNs, Primary Care Networks

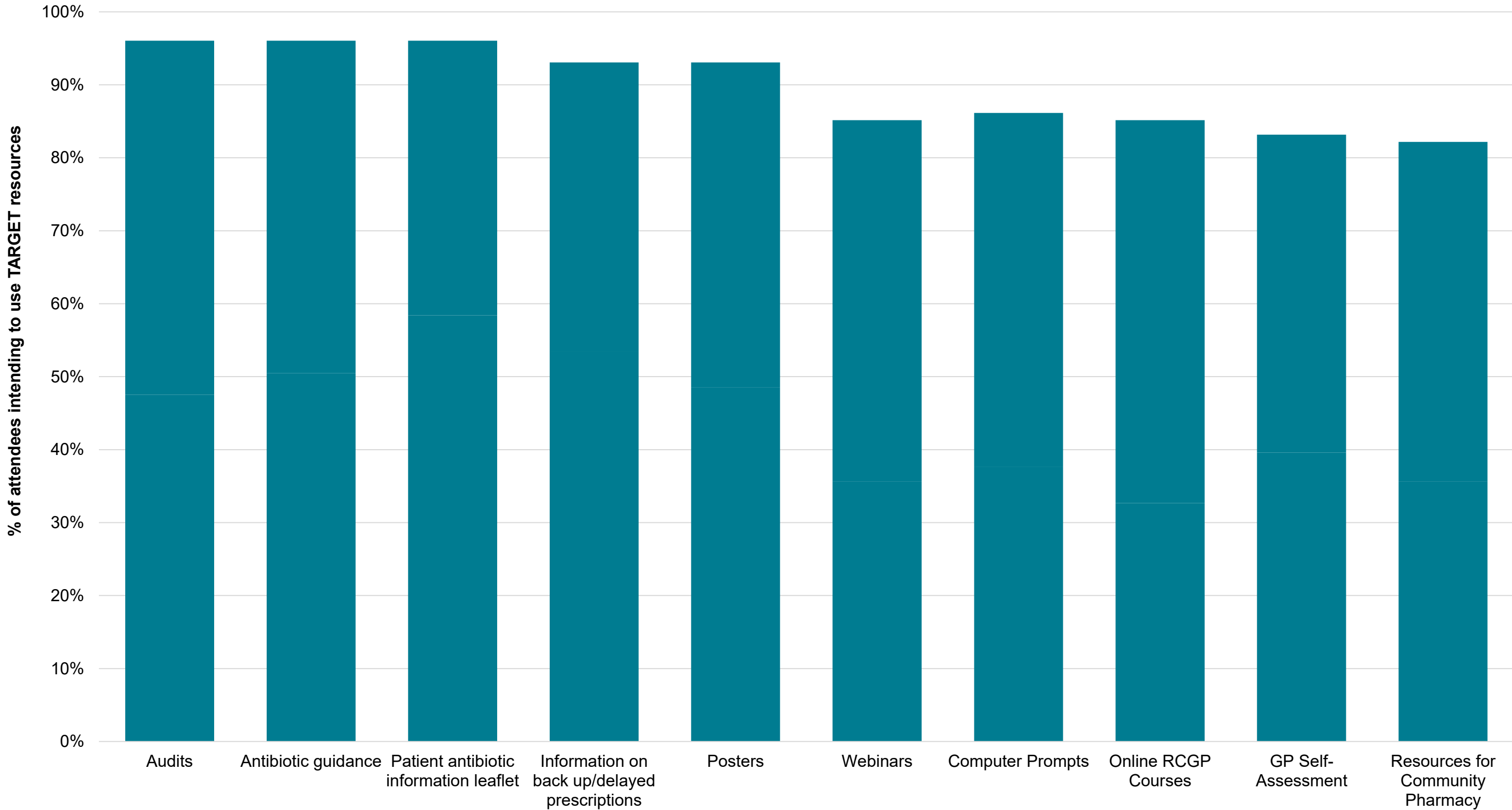
End of text version of Figure 6.1

Facilitated discussions, following the principles of the behaviour change wheel ([52](#)), were led by the UKHSA Behavioural Insights team where regions identified barriers and facilitators to the implementation of training. Facilitators identified included nominated TARGET training champions across different levels within the region; improved accessibility and usability of regional prescribing data; a training delivery audit; provision of a range of flexible training channels; definition of data-driven goals; and linking TARGET training to continuing professional development. Identified barriers included a lack of capacity (in terms of resourcing, turnover, time constraints and external pressures); competing priorities and demands on national and local levels; accessibility of regional AMR data allowing response to local prescribing challenge; a lack of awareness of current training delivery; and a lack of confidence in presenting training to others.

Additionally, attendees reported on wider AMS strategies that are being used, or planned, in their region against the Expert Recommendations for Implementing Change (ERIC) ([53](#)) framework. Over 50% of identified strategies fell across 5 domains; train and educate stakeholders, use evaluative and iterative strategies, develop stakeholder interrelationships, provide interactive assistance and support clinicians, with financial strategies being the least utilised.

Further workshops with this audience are planned to understand the realised barriers and facilitators to the training roll out and update the ERIC framework with regional AMS strategies. Between October 2022 and July 2023, TARGET training (TARGET Train-the-Trainer and TARGET Antibiotic Training) has been delivered to 337 primary healthcare professionals across the NHSE Regions. Following TARGET Antibiotic Training, attendees indicated that they intend to use a wide range of resources from the TARGET toolkit (see [Figure 6.2](#))

Figure 6.2. Intended use of the TARGET Toolkit resources post-TARGET Antibiotic Training
Each bar represents the percentage of attendees who intended on using TARGET Toolkit resources following TARGET Antibiotic Training.



TARGET Antimicrobial Stewardship Training: a case study of Black Country Integrated Care Board

In June 2023, the Black Country Integrated Care Board (ICB) took an alternative approach to the Train-the-Trainer cascade, inviting a representative from all practices in the ICB to an AMS training event, tying attendance and implementation of the TARGET toolkit into an incentive scheme. Data was collected via pre- and post-workshop surveys.

Of 157 attendees (12 advanced nurse practitioners, 94 GPs, 49 pharmacists, 2 others not specified) who completed the pre-session survey, 105 completed post-session survey (10 advanced nurse practitioners, 58 GPs, 37 pharmacists) with responses from representatives of all 33 Primary Care Networks (PCNs).

A total of 87% (91 out of 105) agreed that attending the session was a good use of their time. Some attendees used TARGET resources prior to training but intention to use the toolkit following the session was high for: audits (93%, 98 out of 105), antibiotic guidance (93%, 98 out of 105), patient antibiotic information leaflets (93%, 98 out of 105), information on back-up or delayed antibiotic prescriptions (90%, 95 out of 105) and posters (90%, 95 out of 105).

Attendees also plan to implement a range of AMS strategies such as discussing AMS at practice meetings (96%, 101 out of 105), keeping AMS on the agenda in their practice (94%, 99 out of 105), reflecting on their own prescribing (94%, 99 out of 105), monitoring, and assessing practice/PCN prescribing rates (94%, 99 out of 105), using appropriate coding (93%, 98 out of 105), taking a whole practice approach to AMS (92%, 97 out of 105), identifying an AMS lead (92%, 97 out of 105), using delayed or back-up antibiotic prescriptions (92%, 97 out of 105), taking time to explain prescribing decision with patients (92%, 97 out of 105) and carrying out an audit and developing an action plan (91%, 96 out of 105).

This case study indicates that the collaborative working model has been successful in extending training reach. Although it is too early to measure the impact on prescribing rates, high engagement, and intention to implement AMS strategies and use TARGET resources indicate that an ICB-wide training event is a feasible and acceptable approach to cascading training.

Webinars: skin infection

The TARGET webinar [Skin infections: Incorporating NICE antimicrobial prescribing guidelines](#), covering the treatment and management of impetigo, leg ulcers and cellulitis webinar for primary care prescribers, took place in April 2023. The webinar was developed using the COM-B behavioural model comprised of clinical scenarios, primary care antibiotic prescribing data and resistance trends.

A total of 836 people signed up to join the webinar, hosted by the Royal College of General Practitioners (RCGP), with 236 attending on the evening. From the webinar evaluation survey, all participants rated the webinar “excellent” or “good” and would recommend it to a colleague.

The webinar recording, slides and clinical scenarios can be accessed on the TARGET Toolkit to support healthcare professional learning and training ([43](#)).

e-Learning: TARGET and BSAC FutureLearn course

The [TARGET Antibiotics: Prescribing in Primary Care e-learning course](#), developed in collaboration with the British Society for Antimicrobial Chemotherapy (BSAC), is a free course hosted on FutureLearn ([54](#)). Comprising 6 weekly one-hour modules aimed at healthcare professionals (HCPs), the course covers AMS topics related to management of common infections. The course ran from 11 March 2022 to 23 March 2023, and just over half (53.5%, 265 out of 495) of registered learners actively participated during that run. Almost all survey respondents (96.7%, 29 out of 30) stated that the course either met or exceeded their expectations and the majority (79.3%, 23 out of 29) said they would apply the learning in practice. This course has been running for 4 years, with an update planned in autumn 2023 and a full review planned in the future.

Public and professional engagement activities

World Antimicrobial Awareness Week (WAAW) and European Antimicrobial Awareness Day (EAAD) 2022

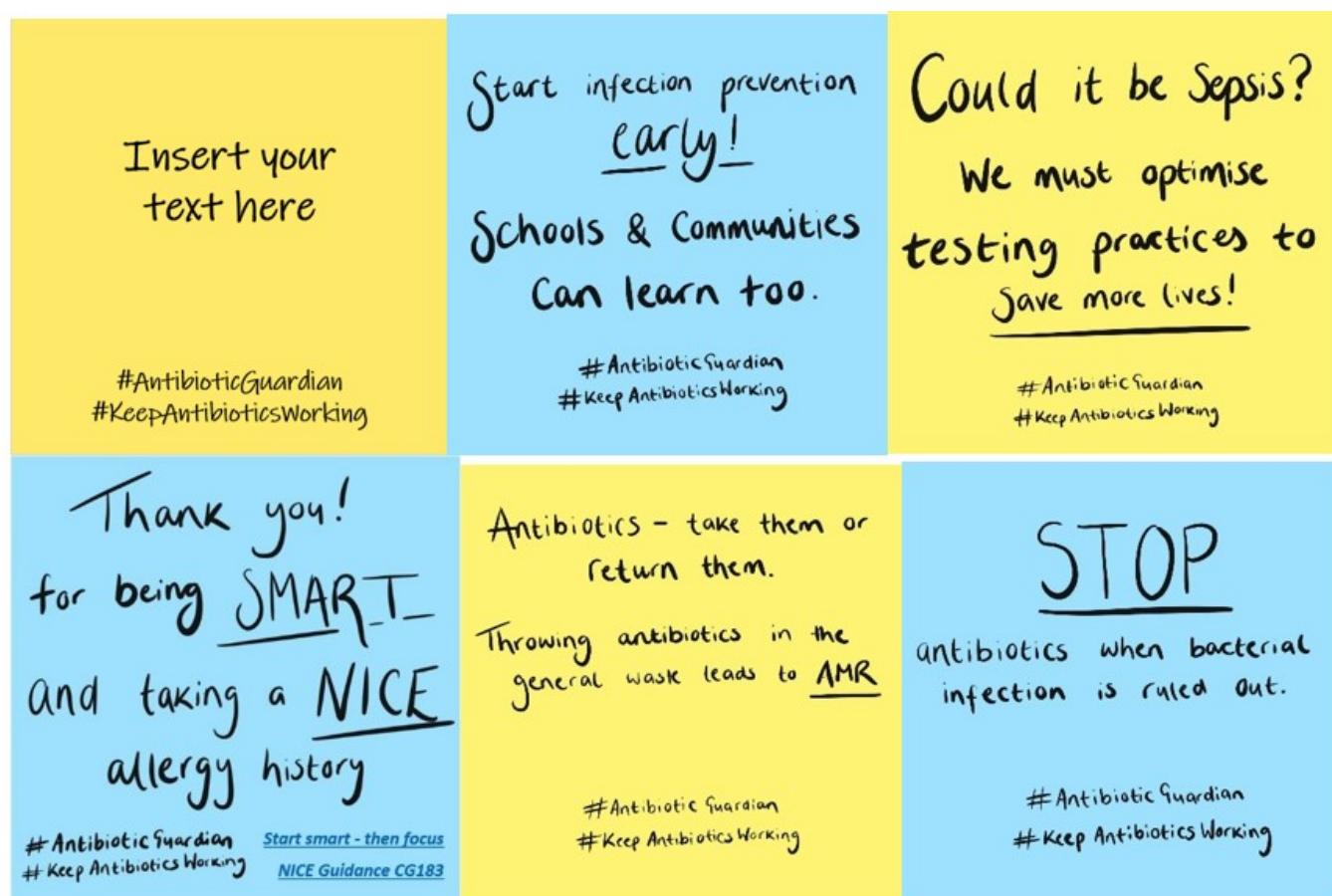
World Antimicrobial Awareness Week (WAAW) took place between 18 and 24 November 2022 and European Antimicrobial Awareness Day (EAAD) on 18 November. The COVID-19 pandemic necessitated a shift to digital resources and these resources were consolidated in 2022. Resources were developed to align with 5 daily themes:

- Day 1: 'Prevention' theme (including IPC measures and vaccination)
- Day 2: 'Antimicrobials in clinical practice' theme (antibiotic course length, promoting shorter course length, empiric prescribing, intravenous-oral switch, promotion of current clinical guidelines)
- Day 3: 'Optimising diagnostics' theme (increasing understanding of established and innovative methods of detection of infection, antibiotic-resistant or otherwise)
- Day 4: 'Antimicrobials and untrue or spurious allergy' theme (including issues such as untrue penicillin allergy labels and de-labelling spurious antibiotic allergy labels)
- Day 5: 'AMR and the environment/sustainability and research' theme (linking AMR with environmental considerations, such as disposal of antibiotics and environmental contamination; One Health approaches to tackling AMR through research were also highlighted on this day)

Resources were shared through a toolkit for healthcare professionals in England to support the NHS, local authorities and others to lead activities and encourage responsible use of antibiotics. The webpage hosting the toolkit was visited 3,454 times between its publication in October 2022 to the end of 2022. Digital notes were introduced in 2020 and new messages were

designed for 2022, with digital notes remaining one of the most shared resources during WAAW ([Figure 6.3](#)).

Figure 6.3. Selection of digital notes that were promoted for use during WAAW 2022



A range of custom teleconference backgrounds and screensavers were created in 2021 and re-designed in 2022, for colleagues to use during WAAW and the World Health Organisation (WHO) 'Go Blue for AMR' campaign was promoted and supported by designing blue versions of these resources. [Figure 6.4](#), below, shows examples of these backgrounds, which included messages aligned with the digital notes for each day and editable versions were created for colleagues to include their own wording or institutional logos. The design of these backgrounds was based around the two-tone pill motif used in both 'Keep Antibiotics Working' and 'Antibiotic Guardian' campaign materials.

A range of blogs aligned to each daily theme was published on the [Antibiotic Guardian website](#). These blogs covered topics such as reduced antibiotic course length from a primary and secondary care perspective and the potential of wastewater-based epidemiology for tackling antimicrobial resistance.

Figure 6.4. Teleconference backgrounds designed for use during World Antimicrobial Awareness Week 2022



World Antimicrobial Awareness Week (WAAW) 2022 feedback survey

In May 2023, a feedback survey was conducted to collect feedback on national WAAW resources provided in 2022 and to understand levels of engagement. This survey received 40 responses by 30 June 2023. The majority of respondents were from NHS or Health and Social Care trusts (19.4%, 7 out of 36) regional NHS organisations, hospitals or public health organisations (13.9% each, 5 out of 36) and over half identified as a pharmacist (55%, 22 out of 40).

The majority of respondents (47.2%, 17 out of 36) found out about registering organisational activity for WAAW through communications from UKHSA, with 13.9% (5 out of 36) finding out through professional organisation email or newsletter. 27.5% of respondents (11 out of 40) accessed the 2022 ESPAUR report and 20% (8 out of 40) used the ESPAUR 2022 data infographics.

42.5% of respondents (17 out of 40) downloaded and used the digital notes. Of those accessing Keep Antibiotics Working (KAW) resources (77.5%, 31 out of 40), all accessed them in English, 5 of these respondents also accessed the resources which had been translated into Polish, Hindi, Gujarati, Bengali and Arabic (3.2%, 1 out of 31 for each translated resource).

42.5% of respondents (17 out of 40) reported that they engaged with the WHO 'Go blue for AMR' campaign, with engagement cited as turning organisational buildings blue, wearing blue and using blue resources. 42.5% of respondents (17 out of 40) noticed others engaging with the 'go blue for AMR' theme.

The majority of respondents (75%, 30 out of 40) responded that they did not learn anything new from the toolkit, which likely results from its promotion to HCPs and consolidation or expansion of existing resource types. The average usefulness score was 7.6 out of 10 (n=40) and 75% of respondents (30 out of 40) found the use of 5 daily themes to guide activity throughout the week helpful, with the 'antimicrobials in clinical practice' theme being most popular and 'AMR and the environment' being the least popular.

The top 3 resources in the toolkit when ranked by helpfulness were the digital notes, teleconference backgrounds and KAW materials. Taken together, survey responses suggest that the WAAW national digital resources remained a useful tool for healthcare and public health professionals to draw upon during the campaign week. Work in 2023 will focus on updating resources where appropriate, giving colleagues more time to access and plan their local activities.

TARGET promotional campaign

UKHSA and the RCGP ran a joint campaign, aimed at GPs, to promote the awareness of the TARGET antibiotics toolkit and use of resources. Implemented as part of the WAAW activities in November 2022, promotional campaign activity included:

- emails to over 42,000 RCGP members
- featured content in several RCGP email communications:
 - Primary Care Development Newsletter, aimed at practices and decision makers
 - Learning Bulletin and RCGP Weekly Digest, a message from the RCGP Chair to all members
- paid digital search advertising via Google and Bing
- paid digital social media adverts on Facebook, Instagram and Twitter (targeting RCGP members and tailored audiences)
- social media posts on Facebook, Twitter and Instagram stories

A paid social media campaign ran across Facebook, Instagram and Twitter. This performed exceptionally well achieving more than 46,000 impressions (number of people who have seen a post, even if they didn't click, comment, or otherwise engage with that post) combined across platforms (in comparison there were 14,541 engagements in the 2021 campaign). Facebook consistently performs the strongest of the social media channels.

Instagram stories and quiz questions were developed with a focus on tips and resources to enhance discussions with patients around antibiotics and back-up or delayed antibiotic prescriptions. The Instagram campaign featured on a single day, which differed from last year's activity, where the stories featured over 3 days, in order to 'test and learn' which has the highest impact. Viewers dropped off through the story, with the link being clicked fewer times compared with the previous year. Although this is lower, looking across campaigns over the year, this is the seventh highest of those the RCGP have posted on Instagram stories.

The success of the campaigns can be seen through increased visits to the TARGET website (see Chapter 4 [for more information on the TARGET website](#)). During the campaign period, total views of the TARGET toolkit landing page reached almost 12,000, which is an uplift of 1,500 views compared to the previous year's campaign (10,402). Most of the marketing activity concentrated on the third week in November (beginning 21 November), corresponding with a rise in page views in this and the subsequent week.

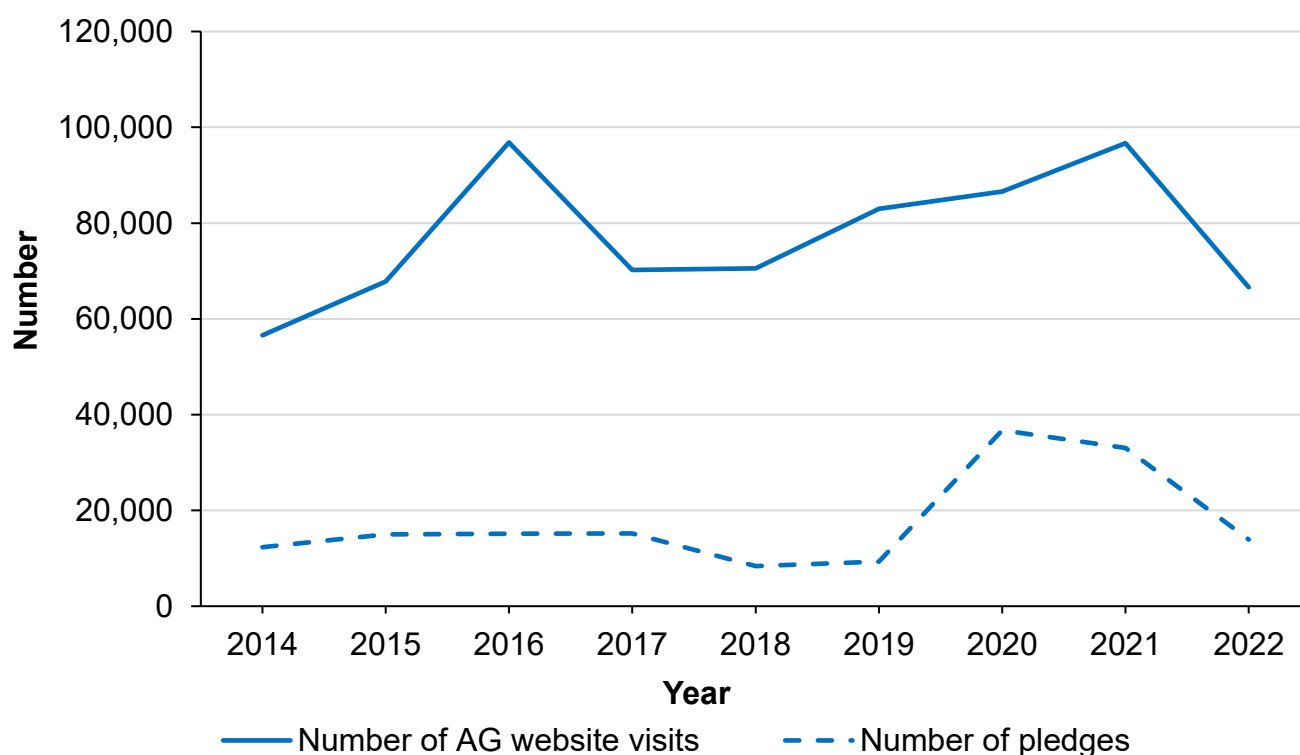
Antibiotic Guardian

Public Health England (PHE now UKHSA) launched the pledge-based [Antibiotic Guardian](#) (AG) campaign in 2014, with the aim of transitioning from raising awareness to increasing engagement. The campaign uses an online pledge-based approach among human and animal health professionals, scientists and educators and the public.

During 2022, the campaign website was visited 66,595 times, resulting in 13,915 pledges, 1,880 of which were made during WAAW (18 to 24 November 2021) ([Figure 6.5](#)). The majority of all pledges were made by those identifying as a health or social care professional or leader (105,867 pledges). Of these 77,713 were made by those belonging to 'pharmacy teams', including from primary and secondary care and community pharmacy. [Annexe](#) Table 6.1 has a breakdown of pharmacy team pledges from 2014 to the end of 2022. Between 2014 and the end of 2022, 42,861 users stated finding out about AG through community pharmacy. The majority of these (39,691) were healthcare or social care professionals, whilst 710 were members of the public and 423 were students, educators or scientists. The sharp decline this year in the number of pledges suggests a reduction in the effectiveness of initiatives implemented previously to promote AG.

A total of 89 organisations registered their AMS activities on the AG website in 2022, 83 were from the UK and 6 were international. Highest numbers were from Hospitals, GP practices, NHS trusts and community pharmacy. See [Annexe](#) Table 6.2 for full break down.

Figure 6.5. Graph showing the trend in Antibiotic Guardian pledges (including international pledges) each year, from 2014 to 2022 and annual number of visits to the Antibiotic Guardian main pledge page



Update to Antibiotic Guardian Pledges

An update to the Antibiotic Guardian was conducted between February and March 2023. A survey was developed to gather both quantitative and qualitative data on the appropriateness of the AG pledges and professional groups. A total of 74 responses were collected from stakeholders working across a range of organisations, including the British Dental Association (n = 1), clinical commissioning groups (n = 1), primary care services and GP practices (n = 2), NHSE (n = 2) and NHS trusts (n = 29), veterinary care (n = 2), Public Health Agency (Northern Ireland) (n = 1), universities (n = 7) and UKHSA (n = 19). The survey and subsequent stakeholder workshop led to 81 of the 132 pledges being updated, 16 pledges being removed and the addition of 12 new pledges to reflect changes in the field of AMR, medical practice and information dissemination in recent years.

Antibiotic Guardian Schools Ambassadors Programme

The Antibiotic Guardian Schools Ambassadors programme, first piloted in 2019, aims to connect healthcare professionals with local schools and community groups, in order to share information about antibiotic use, AMR and IPC. Since 2021, the programme has aimed to target the regions with the most deprived lower-layer super output areas (LSOAs) ([55](#)) through cascading information through regional AMS pharmacy leads and the regional AMS pharmacy network.

A total of 189 colleagues registered to become an Antibiotic Guardian Schools Ambassador in 2022 (compared to 110 in 2021 and 79 in 2019) and the targeted engagement activity led to high engagement in North West (24% of registrations, 45 out of 189), South East (15% of registrations, 28 out of 189) and Midlands (16% of registrations, 30 out of 189). In 2022, registrations were received for the first time from international colleagues, with 11 colleagues registering from outside of the UK. Those that provided information on country were based in India, Ghana, Kampala, Tanzania and East Africa.

As of 30 July 2023, 15 ambassadors have provided feedback on their involvement in the scheme in 2022. 86.7% (13 out of 15) of respondents were from the UK and 13.3% (2 out of 15) were from outside of the UK. Of these 15 ambassadors, 86.7% (13 out of 15) confirmed that they contacted schools to participate in the programme in 2022; 73.3% (11 out of 15) of those that contacted schools had their offer accepted by the school. Eight respondents promoted an article for distribution in school newsletters, 6 provided a toolkit (which includes e-Bug resources) for schools to plan a lesson and 5 provided a lesson in person. Of those that participated in the programme, 85.7% (11 out of 13) stated that taking part in this programme helped them personally and/or professionally.

The Antibiotic Guardian Schools Ambassadors programme demonstrates the dedication of HCPs to engage with schools around AMR including antibiotic use and infection prevention and control, even during the pandemic, and the utility of regional AMS lead networks in increasing engagement in areas of deprivation. The international reach of Antibiotic Guardian materials

was demonstrated in 2022, suggesting that use of translated e-Bug materials in future versions of the Antibiotic Guardian Schools Ambassadors lesson-planning toolkit may be helpful. Future work will focus on strengthening this focussed regional approach and designing robust indicators of impact.

Antibiotic Guardian Schools Ambassadors: engaging trainee pharmacists

In addition to the regular Antibiotic Guardian Schools Ambassadors activities undertaken annually, in 2022 UKHSA and Boots UK collaborated to integrate the 'Antibiotic Guardian Schools Ambassadors Project' into the Boots Trainee Pharmacist programme on a national scale. This initiative allowed trainee pharmacists to actively participate in a national AMS public health campaign. The project's main goals were for trainee pharmacists working with Boots UK to:

- a) deliver educational lessons and activities in local schools and community groups
- b) encourage the inclusion of AMR-related newsletter items in local schools and community groups
- c) raise awareness about the pharmacy profession among young people
- d) collect data for analysis and evaluation purposes

This engagement provided trainees with national public health experience and contributed to meeting several interim learning outcomes established by the General Pharmaceutical Council (GPHC), which are necessary for qualification to sit the registration assessment.

To support trainee pharmacists in managing their projects and planning educational lessons and activities, UKHSA provided a comprehensive toolkit comprising of written and video resources and Boots Learning and Development teams offered logistical support. Pre- and post-project feedback forms were employed to assess AMR knowledge, attitudes, behaviours, and confidence levels related to delivering educational lessons. Trainee pharmacists proactively reached out to schools and community groups within their localities to gauge interest and deliver the educational sessions and activities.

A total of 197 trainee pharmacists registered to participate in the project. Interim analysis of the data obtained from pre-project questionnaires indicates that over 95% of trainee pharmacists accurately answered 5 out of 8 AMR knowledge questions. Furthermore, more than half of them reported being 'quite' or 'very' confident in communicating with colleagues (70.5%, 129 out of 183), the general public (66.1%, 121 out of 183), and young people (58.5%, 107 out of 183) regarding antimicrobial use.

Early feedback from post-project questionnaires suggests that trainee pharmacists felt an increased sense of confidence in delivering public health campaigns and providing health information to young people, ultimately making a positive contribution to their communities. The majority (60%, 15 out of 25) of trainee pharmacists felt they were able to promote pharmacy as

a profession throughout their education lessons and activities, while 76% (19 out of 25) felt that their knowledge of antimicrobial resistance and appropriate use of antimicrobials increased through participation in the project. A total of 90.6% (29 out of 32) benefitted either professionally or personally, or a combination of both, by participating in the project ([Table 6.1](#)).

Table 6.1 Proportion of trainee pharmacists who felt they benefitted from their involvement in the AG schools ambassadors campaign

Response	Number of participating Boots trainee pharmacists (n=32)
Yes, both personally and professionally	20
Yes, personally	6
Yes, professionally	3
No	2
Unsure	1

Data continues to be analysed as responses from the trainee pharmacists are received – there is still a substantial amount of feedback to be captured.

Results from the post-project questionnaires suggested that, through their participation in a national public health awareness campaign, trainee pharmacists acquired valuable skills, boosted their confidence, and effectively educated young people about the significance of antimicrobial stewardship. Additionally, they embraced the role of ‘Antibiotic Guardians’ and showcased their commitment to preserving the future effectiveness of antimicrobials.

Based on feedback received, future efforts to enhance this project involve updating the UKHSA toolkit and making it accessible to all trainee pharmacists and pharmacy technicians and providing more resources to promote the pharmacy profession to young people.

Assessment of global AMR campaigns conducted to alter public awareness and antimicrobial use behaviours: a rapid review

Public health campaigns with a well-defined outcome behaviour have been shown to successfully alter behaviour ([56](#)). However, the complex nature of AMR creates challenges when evaluating campaigns aimed at raising awareness and changing behaviour related to antibiotic usage.

The review aimed to determine what campaigns have been conducted and which have been effective at improving awareness of AMR and changing behaviour around antimicrobial use in members of the public. A secondary aim was to determine what outcome measures studies have used to assess campaign effectiveness.

A systematic search of Ovid MEDLINE and Embase, was conducted in October 2022 using a predefined search strategy. Articles published between 2010 and 4 October 2022 were considered. Studies which outlined a campaign or intervention aimed at the public and focusing on AMR or antibiotic usage were considered. Systematic reviews and studies which solely targeted healthcare professionals were excluded to distinguish between healthcare professional and public interventions.

Literature and grey literature searches, as well as reference list searches produced 6,961 results. De-duplication and screening removed 6,535 articles giving a total of 41 studies (30 unique interventions) (see [Annexe](#) Figure 6.1). Most campaigns were conducted nationally, focused on the adult public and assessed changes in knowledge of and/or attitudes towards AMR. Successful campaigns tended to use mass media to disseminate information with messaging targeted towards a specific disease. Campaign duration did not seem to be predictive of campaign success. Inclusion of healthcare professional education and use of healthcare professional-patient interactions was also a recurring theme among successful campaigns.

This review provides some evidence that both large and small-scale campaigns can significantly improve outcome measures relating to AMR and antibiotic usage. Despite a lack of homogeneity between studies, some common themes emerged between effective campaigns.

Review of cost effectiveness of AMR campaigns

With the challenges posed by evaluation of outcomes relevant to behaviour change in the public, a rapid review was conducted with the aim of summarising data from economic evaluations of the value-for-money of AMR public awareness interventions. This review attempted to:

1. Synthesise findings from studies assessing the cost-effectiveness or return on investment of campaigns which focused on improving public awareness of AMR and changing antimicrobial use behaviours.
2. Make recommendations on optimum methods for the economic evaluation of future campaigns focusing on improving awareness of AMR and changing antimicrobial use behaviours.

The search strategy was based around the concepts of antimicrobial agents/AMR and public awareness campaigns, with a search filter for economic/cost-effectiveness studies in MEDLINE and Embase. The population for inclusion was the public and patients on which any campaigns to improve public awareness of AMR or change behaviour around antibiotic use were focussed. Outcomes of interest for this review were cost-effectiveness analyses or return on investment which reported a cost per unit-measure of effectiveness ratio (such as cost per quality adjusted life years) for public AMR awareness campaigns. Inclusion criteria included studies published in English since 2010.

The database search yielded 1,085 articles; after deduplication there were 781 articles for title and abstract screening. A further 9 articles were retrieved from a Google search and 24 from forward backward citation searching in reference lists of relevant articles. In total, 8 studies were identified for full-text screening which resulted in 2 studies that fulfilled the inclusion criteria for this review, the RAational Antibiotic use Kids (RAAK) campaign and the Do Bugs Need Drugs (DBND) programme (see [Annexe](#) Table 6.3 for summary of included studies).

A reduction in antibiotic prescribing was observed in both studies identified in this review. The RAAW campaign, which aimed to reduce antibiotic prescribing for children with respiratory tract infection (RTI) presenting to primary care, yielded incremental costs of €10.27 (€217.95 versus €207.68), with incremental effects of 12% (30% antibiotic prescription rate versus 42%) ([57](#)) in a cost-effectiveness analysis conducted from a societal perspective in the Netherlands. This produced an incremental cost-effectiveness ratio of €0.85 per percentage decrease in antibiotic prescribing. Subsequent analysis from a healthcare perspective showed the intervention was more effective in terms of prescribing reduction and less expensive compared with usual care.

The DBND programme aimed to reduce unnecessary antibiotic use in the community of British Columbia when implemented across the state. Average monthly outpatient and community prescription rates decreased by 14.5% (from 54.3 per 1,000 population in 2005 to 46.4 per 1,000 population in 2014). A 21% reduction in mean monthly total cost of antibiotics per 1,000 population (\$1,503 CAD) was estimated between August 2005 and December 2014, equating to a \$83.6 million CAD reduction in the total cost of antibiotic prescriptions in 2014 compared to 2005 for British Columbia, and a total cost reduction during the whole DBND program time period of \$449.7 million CAD. Authors reported that using the total DBND program cost (\$5.9 million CAD), and their conservative estimation of total cost reduction for antibiotics, every \$1 CAD spent on the program saved a total of \$76.20 CAD ([58](#)).

Whilst the two studies reviewed reported a reduction in antibiotic prescription rates, sources of outcome data, methods used to calculate results and time horizon over which outcomes were captured, varied considerably. Recommendations for optimum approaches to economic evaluations addressing AMR have been made extensively in the literature in recent times ([59](#) to [61](#)). These emphatically repeat the need to address the factors highlighted by Coast and colleagues over 20 years ago ([62](#)), suggesting little advance in adequate methodologies over this time, or at least limited implementation of such methodologies, to capture the true costs and outcomes of AMR interventions. These recommendations are relevant to the future cost-analysis of public AMR campaigns. Interventions of this nature face particular difficulties at the outcome measure stage.

Public education and engagement with e-Bug

The e-Bug programme, operated by UKHSA, seeks to reach and equip those who work with, or support children and young people (aged 3 to 16 years) in all communities with information and activities to build knowledge around microbes, disease, hygiene, vaccination and AMR. By promoting behaviour change amongst children and young people, UKHSA are supporting the

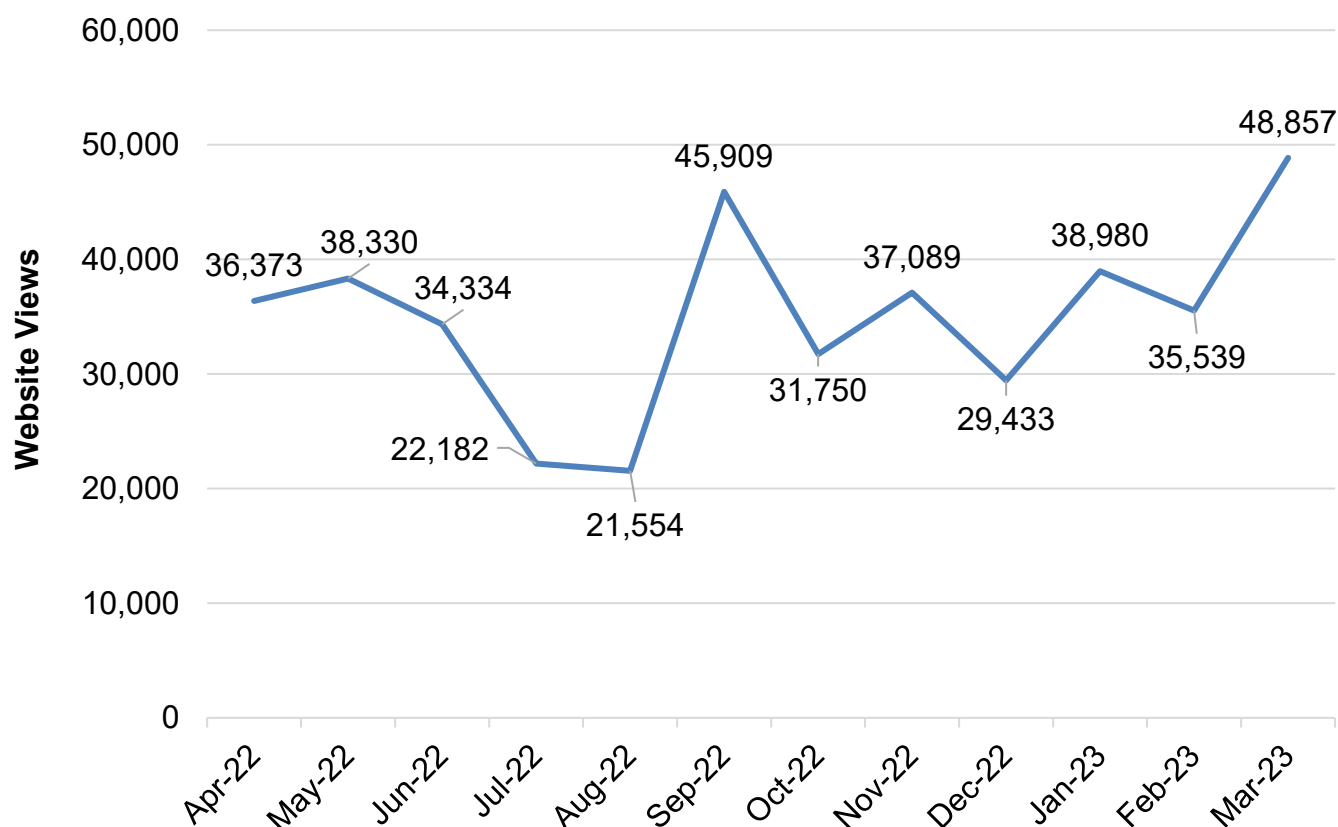
aims of the Department for Health and Social Care 2019 to 2024 National Action Plan for AMR by ensuring that the extensive work to address AMR is future proofed and supporting young people to be agents of change in their communities.

e-Bug have redeveloped the public-facing website to meet web content accessibility guidelines (WCAG) level AA standards. This ensures that users with disabilities and/or using assistive technologies can access all content without barriers. e-Bug resources both on and off the website, including video and media content hosted on social media and YouTube, have been made accessible to support improved access by all users. Further, the website has been developed to facilitate capacity to expand international partnerships.

In order to reach a wide and varied audience, e-Bug utilises various social media channels, running campaigns to support national educational initiatives such as WAAW (November) and British Science Week (March). Total impressions reached an excess of 104,000 for the months of November 2022 and March 2023 (107,700), with an engagement rate of between 1.7% (March 2023) and 2.5% (November 2022).

Between April 2022 and March 2023, 86,159 users have accessed the website viewing a total of 420,330 pages ([Figure 6.6](#)); on average each user viewed 4.87 pages. Website viewing trends follows the academic year with peaks during school term time and troughs during holidays.

Figure 6.6. e-Bug website monthly views between April 2022 and March 2023. The data points represent the total monthly visits to the website



Dissemination and evaluation of e-Bug resources

Following the national dissemination of e-Bug resources to all maintained schools and academies across England, in September 2022 and with support from NHSE, e-Bug resources were sent to special educational needs schools and alternative provision settings.

To gather feedback on the resources and investigate awareness of e-Bug, in April 2022, an evaluation survey was sent to all maintained schools in England. Of those responding, over half of the sample were aware of e-Bug (56%, 139 out of 248) and of those that had used the resources, 92% (228 out of 248) would use them again and 89% (221 out of 248) would recommend e-Bug to another educator. Educators recognised the high quality and usefulness of the resources. Interest was high for e-Bug teacher training, and the feedback was used to structure the training programme and communication to suit educator preferences.

e-Bug local authority and educator training

In collaboration with the North West UKHSA and NHSE regional IPC and AMR leads, in January 2023 e-Bug educator training was delivered to 19 of the 23 local authorities in the northwest (83% coverage). This included 20 delegates from 8 of the 9 upper-tier local authorities in Cheshire and Merseyside; 12 delegates from all 4 of the upper-tier local authorities in Cumbria and Lancashire; and 22 delegates from 7 of the 10 upper-tier local authorities in Greater Manchester. This served as a pilot of a national training cascade that will be disseminated across all 7 NHSE regions throughout 2023.

The training included demonstrations of e-Bug activities and discussions on each topic, and knowledge sharing on how to cascade training and increase implementation of e-Bug resources in schools. 97% of delegates rated the quality of the training as excellent or very good, while 69% of local authorities have plans to begin implementing e-Bug in schools within 6 months of receiving the training.

Public health-seeking behaviours, knowledge, and attitudes towards antibiotic use beyond the COVID-19 pandemic: the new baseline

UKHSA and its predecessors have carried out public surveys for almost 20 years examining the public's self-reported incidence of RTIs, health-seeking behaviours, knowledge and attitudes towards antibiotic use. To explore how this has changed since all pandemic restrictions were lifted in May 2022, an online survey was carried out with 5,454 adults across England to provide a new post pandemic baseline. Data was weighted to be nationally representative and the sample was boosted to ensure good representation across 7 main ethnicity groups.

Overall, nearly three-quarters of respondents (74%, n=4,059 out of 5,454) reported having had an RTI in the last 12 months; this was higher in younger people compared to the older population (18 to 24 years: 84%, n=442 out of 524 versus 65 to 74 years: 65%, n=580 out of 894; $p<0.05$).

Self-reported RTIs have increased slightly since pre-pandemic levels (70%, n=1,445 out of 2,052 in 2020). During 2023, a cough was reported as the most recent infection (41%, n=1,447 out of 3,496), consistent with previous years. In 2023, 40% (n=1,382 out of 3,474) of respondents contacted a healthcare professional for their most recent RTI; a lower proportion (21%, n=716 out of 3,474) contacted their GP compared to before the pandemic (23%, n=249 out of 1,104 in 2020) whereas a higher proportion reported they asked for advice at the pharmacy (12%, n=428 out of 3,474 compared to 8%, n=87 out of 1,104 in 2020). In 2023, 85% (n=573 out of 675) of respondents reported they were satisfied with their GP consultation and 69% (n=3,751 out of 5,454) of respondents would be unlikely to ask their GP to prescribe antibiotics if the GP had said they did not need them.

Reassuringly, 87% (n= 4,759 out of 5,454) of respondents stated you should only take antibiotics when you absolutely have to; however, this was significantly lower in the younger population compared to the older population (18 to 24 years: 72%, n=380 out of 524 versus 65 to 74 years: 96%, n=857 out of 894; p<0.05). Moreover, 65% (n=3,571 out of 5,454) of the population were worried about antibiotic resistance, higher in those who had experienced an RTI in the previous 12 months (68% n=2,744 out of 4,059; P<0.05).

Updating the Antimicrobial Prescribing and Stewardship (APS) Competency Framework

The Antimicrobial Prescribing and Stewardship (APS) competency framework was initially developed in 2013 by the Advisory Committee on Antimicrobial Prescribing, Resistance and Healthcare Associated Infection (APRHAI) ([63](#)) and UKHSA (known then as Public Health England) through the collaborative efforts of an independent, multi-professional development group. Its primary objective was to enhance the quality of antimicrobial treatment and stewardship while mitigating the risks associated with inadequate, inappropriate, and adverse effects of such treatments. Therefore, enhancing patient care safety and quality while making a substantial contribution to the reduction of AMR emergence and transmission. It is crucial to review and update the competencies outlined in the APS competency framework to ensure it aligns with current guidance and encompasses best practice recommendations, including newly developed frameworks, thereby providing appropriate guidance to healthcare professionals.

To facilitate the revision of the APS competency framework, an extensive list of potential domains, statements, and descriptors for consideration was compiled. This involved a comprehensive review of the original APS framework, as well as other recognised alternative frameworks. Several resources were consulted, including draft curricula for AMS and prescribing in pharmacy undergraduate programmes, a consensus-based framework for undergraduate medical education on AMR and stewardship, and the WHO's 'Competency Framework for Health Workers' Education and Training on Antimicrobial Resistance.' [Table 6.2](#) demonstrates the quantity of content within each framework reviewed for addition to the APS competency framework. The RPS Competency Framework for all Prescribers was also utilised to inform the structure of the framework,

Table 6.2. Quantity of content reviewed from frameworks

Framework reviewed	Number of domains and statements	Number of descriptors
Antimicrobial prescribing and stewardship competencies (Public Health England, 2013)	5	31
Draft curricula for antimicrobial stewardship and prescribing in pharmacy undergraduate programmes	6	74
Consensus-based framework for undergraduate medical education on antimicrobial resistance and stewardship	6	58
World Health Organisation's 'Competency Framework for Health Workers' Education and Training on Antimicrobial Resistance'	4	40

A consensus gathering (Delphi) method was employed for the revision process with a diverse group of 59 multidisciplinary professionals representing various disciplines and from a variety of healthcare settings evaluating the contents of the APS competency framework (see [Annexe Figure 6.2](#)).

Based on the responses received, over 75% of the participants considered the existing domains to be valid without requiring further editing. Consequently, it was decided to retain the format of the domains.

Descriptors that achieved full consensus (defined as receiving an 'essential' or 'absolutely essential' score from over 50% of respondents) were included in the updated APS competency framework. The vast majority of descriptors met this criterion, although some were revised based on valuable feedback. In the process of updating the APS framework, the descriptors were reorganised according to the level of agreement (that is, 'essential' or 'absolutely essential') to accurately reflect the degree of consensus reached among the participants.

The framework has undergone further review by an additional 33 multi-professional colleagues across the UK prior to publication which involved circulation throughout UK AMS networks and the ESPAUR oversight group, and an expression of interest process, to ensure broad and constructive feedback.

Future actions

TARGET Antibiotics programme

Cascading of the TARGET AMS workshops will continue across England throughout 2023 with an impact assessment conducted by Imperial College London and process evaluation carried out by UKHSA.

TARGET will continue to build on its online learning resources during 2023 through review and update of the 'Prescribing in Primary Care' course hosted on FutureLearn, and the continued delivery of the TARGET live webinar series hosted by the RCGP. TARGET webinar attendees have voted clinical scenario training webinars as a topic they would like to see in future TARGET webinar series.

e-Bug will continue to review and update their community resources to align with the findings of the independent evaluation. It will also seek to foster existing and build new international partnerships.

The Antibiotic Guardian Schools Ambassadors programme will run for a fifth year and maintain focus on areas of deprivation, as well as evaluating impact and engagement from ambassadors and schools. UKHSA will continue collaborative projects with external organisations, such as Boots, to incorporate the Antibiotic Guardian Schools Ambassadors programme within learning and development programmes where possible. The aim is to recruit more early career healthcare professionals and allow them to participate within the campaign. A clear plan should be made to boost feedback and data collection as this has been an issue during the 2022 campaign.

WAAW national planning will continue for 2023, with a focus on wider themes of 'sustainability' and 'children', there will be a strengthened one health component also.

The rapid review of AMR campaigns highlighted a number of avenues for future research, primary among them is the need for an increased number of experimental studies evaluating campaign effectiveness. The evaluation process needs to be considered and embedded within the initial design and development of the campaign; therefore, development of a campaign evaluation framework may be beneficial.

The AMR campaigns rapid review found that there have been a limited number of campaigns conducted in recent years ([64 to 68](#)). Methods of communication have changed substantially with social media now cited as a preferred source of healthcare information for many ([69](#)). However, this review highlighted only one study which piloted a social media focused campaign ([70](#)). Furthermore, most research on AMR messaging on social media has focused on Twitter ([71](#), [72](#)) despite this platform no longer being used extensively, especially by populations who tend to have poorer knowledge of AMR and appropriate antibiotic usage ([73](#)). Future research may wish to explore the use of social media to disseminate AMR-related information. During the COVID-19 pandemic, schools and healthcare settings adopted a range of preventative safety behaviours to keep staff and the public safe. UKHSA will run surveys with teachers and primary care HCPs (GPs, pharmacists and nurses), to understand if behaviours adopted during the pandemic have been retained or have reverted back to pre-pandemic behaviours (or a mix). Other themes covered for both professional settings (schools and general practice) will include knowledge and concerns around infection prevention and control (IPC), knowledge and changes to practice since the COVID-19 pandemic, participant professional roles during public health outbreaks, public response to outbreaks, needs around IPC, AMR and AMS.

Chapter 7. Research

Main messages

A wide range of new and ongoing research projects have been undertaken in the field of healthcare-associated infection (HCAI) and antimicrobial resistance (AMR) in the last year, with publication of at least 50 peer-reviewed papers from across the UKHSA.

The work covers many of the major themes of the UK National Action Plan (NAP) for AMR, including 'Stronger laboratory capacity and surveillance in AMR' (7 projects), 'Human infection prevention and control' (5 projects), 'Optimal use of antimicrobials' (5 projects) and the development and distribution of diagnostics, therapeutics and vaccines (9 projects).

This chapter summarises AMR and HCAI research projects undertaken by UKHSA between April 2022 and March 2023, highlighting projects looking at the impact and influence of health inequalities.

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) continue to produce a wealth of translational research aiming to impact public health practice and policy. Research highlights from both HPRUs are given, many of which are adapting and enhancing COVID-19 research to address AMR.

There has been an increase in the amount of data being reported by the domains of health inequalities over the previous 2 years. Factors associated with health inequalities, such as deprivation and clinical factors, such as frailty, learning disabilities, and chronic conditions including diabetes, chronic obstructive pulmonary disease and heart disease need to be considered in the management of infections. We present some initial findings from a project assessing sepsis incidence and mortality in the research chapter.

Introduction to Chapter 7

Within and in collaboration with UKHSA, there are a wide range of new and ongoing research projects in the field of healthcare-associated infections (HCAIs) and antimicrobial resistance (AMR) undertaken in the last financial year.

These projects cover many research and development priorities, including improvements in surveillance and data collection to enhance the insights drawn from them and studies to improve our understanding of behaviours around antimicrobial usage, as well as contribute to evidence on new and existing control strategies, including infection prevention and control

(IPC), and antimicrobial stewardship (AMS). There is work into the development of novel therapeutics and vaccines, as well as efforts to ensure wider access to therapeutics. We have projects investigating the mechanisms of disease transmission, the burden and risk factors for carriage, infection and serious clinical outcomes.

This work is focussed around many of the major themes and goals of the UK National Action Plan (NAP) for AMR. This is demonstrated in [Figure 7.1](#) which illustrates the wide distribution of publications resulting from research undertaken by UKHSA. A complete list of these AMR-related publications from April 2022 to March 2023 is provided in the [Annexe](#) (Chapter 7) accompanying this report.

Work is underway to determine research priorities going into the next UK AMR National Action plan (NAP) for 2024 to 2029. Initial prioritisation exercises within UKHSA have identified 7 priority areas covering:

- burden, drivers and epidemiology
- pathogen characterisation
- infection prevention and control (IPC)
- optimisation of antimicrobial use
- diagnostics
- vaccines
- development of antimicrobials and therapeutics

The importance of cross-disciplinary working has been highlighted, including for example, pharmacological, epidemiological, clinical, behavioural, health economic and microbiological disciplines. Furthermore, the importance of optimising use of data is at the forefront, ensuring appropriate data sharing and access, development of methods (AI, bioinformatics) alongside tools for, for example, clinical decision-making, intervention evaluation and outbreak detection. Finally, relevant populations and areas of focus were recognised as important in future research, including particular consideration of: children and neonates; community settings including long-term care facilities; the care pathway as an integrated whole; the built environment and health inequalities.

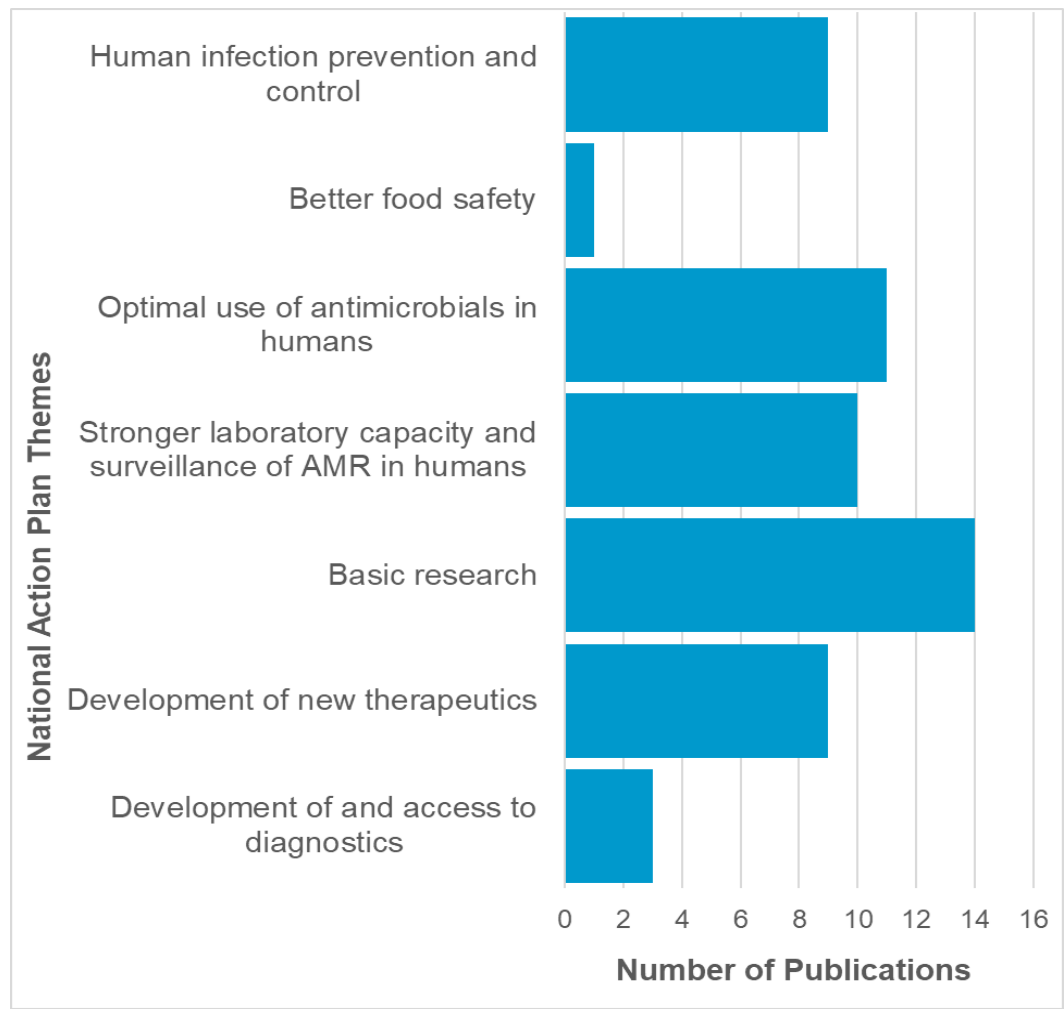
This chapter outlines examples of AMR and HCAI research projects undertaken with UKHSA from April 2022 to March 2023. Again, the projects here showcase research across many of the NAP's major themes, including:

- human infection prevention and control
- environmental contamination
- optimal use of antimicrobials
- stronger laboratory capacity and surveillance in AMR
- basic research
- development of new therapeutics
- wider access to therapeutics for those who need them
- development and access to diagnostics

In this chapter, we also highlight some of the research projects that are examining the impacts and influence of health inequalities on the risks, the epidemiology, the health seeking behaviours and the infection management and outcome of infections.

Research is presented 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 in partnership with UKHSA.

Figure 7.1. AMR publications from April 2022 to March 2023, by National Action Plan theme



Research projects

1. Human infection prevention and control

The influence of factors commonly known to be associated with health inequalities on risks and outcomes of sepsis: rapid literature review and large-scale data analyses

Authors

Tjeerd Pieter van Staa¹, Tim Felton^{3,4}, Alexander Pate¹, Glen P Martin¹, Anita Sharma², Xiaomin Zhong¹, Sian Bladon¹, Neil Cunningham⁵, Ellie Gilham⁵, Colin Brown^{5,6}, Mariyam Mirfenderesky⁵, Victoria Palin^{1,7}, Paul Dark³, Diane Ashiru-Oredope^{5,8}

¹ Centre for Health Informatics and Health Data Research UK North, Division of Informatics, Imaging and Data Science, School of Health Sciences, Faculty of Biology, Medicine and Health, The University of Manchester, Manchester Academic Health Science Centre, Manchester

² Chadderton South Health Centre, Eaves Lane, Chadderton, Oldham

³ Division of Infection, Immunity and Respiratory Medicine, Faculty of Biology, Medicine and Health, The University of Manchester, Manchester Academic Health Science Centre, Manchester

⁴ Intensive Care Unit. Manchester University NHS Foundation Trust, Wythenshawe Hospital, Manchester

⁵ Healthcare-Associated Infection (HCAI), Fungal, Antimicrobial Resistance (AMR), Antimicrobial Use (AMU) and Sepsis Division, United Kingdom Health Security Agency (UKHSA), London

⁶ NIHR Health Protection Unit in Healthcare-Associated Infection and Antimicrobial Resistance, Imperial College London, London

⁷ Maternal and Foetal Health Research Centre, Division of Developmental Biology and Medicine, the University of Manchester

⁸ School of Pharmacy, University of Nottingham, Nottingham

Background

There is substantive interest in the National Health Service (NHS) in England to reduce health inequalities. There is the NHS Core20PLUS5 approach which aims to prioritise initiatives to reducing health inequalities and has defined the population groups experiencing poorer than average health access and worse health. These include those with largest socioeconomic deprivation, ethnic minority communities and people with multi-morbidities, and clinical areas such as severe mental illness and chronic respiratory disease.

Aim

To better understand the interplay between health inequalities and sepsis morbidity, mortality, and management and to provide an evidence base for public health advice, to support decision making to reduce the impact of health inequalities in the treatment and management of sepsis.

This project involved 3 parts, including rapid review of literature, data analyses in England of several large primary care research datasets that had been linked to hospital data.

Results

The literature review identified 53 sepsis studies. Most of the studies were conducted in the USA (31 out of 50), with only 4 studies using UK data (all pregnancy related). Socioeconomic factors associated with increased incidence of sepsis included lower socioeconomic status, unemployment and lower education level. However the findings were not consistent across studies. For ethnicity, sepsis rates reported mixed results. Living in a medically underserved area or being resident in a nursing home was also shown to increase risk of sepsis. Risk of mortality or other outcomes from sepsis was also mixed, particularly in those considering ethnicity as a risk factor for mortality.

The data analyses included over 300,000 sepsis cases; 80% to 90% were community-acquired. Cases were matched to population-based controls without sepsis. Increased incidence rates were found in patients with largest socioeconomic deprivation, frailty and chronic conditions, while patients with non-white ethnicity did not show any increases in sepsis risk as a group overall. However, patient groups with Core20PLUS5 characteristics were found not to be homogeneous. In an analysis of 60 different clinical characteristics, it was found that patients with largest socioeconomic deprivation suffered more frequently, compared to non-deprived patients, from alcohol problems, chronic obstructive pulmonary disease (COPD), learning disabilities of severe mental illness, which were observed to be all strong risk factors for the development of community-acquired sepsis. Non-white people had higher prevalence of anaemia, diabetes mellitus, chronic liver disease, severe mental health illness and visual impairment, which were all found to be strong risk factors for sepsis. In severely frail patients, the prevalence of anaemia, chronic heart diseases and Parkinson disease was substantially higher compared to non-frail patients, that are all strong risk factors for sepsis. Risk prediction models differentiating community-acquired sepsis cases from controls achieved good discrimination (c-statistics between 0.75-0.80) using information on age, sex, chronic diseases, deprivation status, distant history of antibiotic prescribing and learning disabilities, despite not including indicators of the infection severity. Distant history of more frequent antibiotic prescribing was associated with increased risks of developing sepsis.

Conclusion

There is a need for studies based in high-income countries other than the USA, such as the UK, to understand the interplay between health inequalities and sepsis risk; such studies can help inform guidance for recognising and treating sepsis effectively.

The following policy priorities in the prevention of sepsis in primary care taking into account health inequalities are proposed:

1. Focus on risk-based prescribing of antibiotics for self-limiting bacterial infections with implementation of risk prediction models combining infection severity with age, sex, chronic diseases and indicators of poorer healthcare access and worse health.

2. Inclusion of common infection management into the Quality Outcome Framework (financial incentives scheme) for practices with practice populations with higher prevalence of indicators of poorer healthcare access and worse health.
3. Remote monitoring of worsening of common infections in patients at higher risk of infection-related complications.
4. Digitalisation of NICE treatment guidelines for common infections and strengthening these by including guidance on commonly encountered clinical challenges.
5. Implementation of the Learning Healthcare System for common infections.

Preventing and managing urinary tract infections: Using thematic analysis to explore interventions and strategies implemented by NHS commissioning organisations in English primary care, 2017 to 2022

Authors

Eirwen Sides¹, Donna Lecky¹, Esther Taborn², Luke O'Neill¹, Emily Cooper¹

¹ Primary Care and Interventions Unit, UKHSA, Gloucester

² National Infection Prevention Control Team, NHSEI

Aim

To identify and explore strategies, interventions and activities used by English Clinical Commissioning Groups (CCGs) to improve prevention and management of urinary tract infections (UTIs) 2017 to 2022.

Methods

Online questionnaires sent to primary care chief nurses and medicines optimisation leads via regional infection prevention control (IPC) and antimicrobial stewardship (AMS) leads August–September 2022. Qualitative data was mapped to the Theoretical Domains Framework. Results: Response rate was 14.1% (56 out of 397 participants approached), representing 29.2% (31 out of 106) of CCGs. Respondents provided 201 examples of UTI interventions. Education and training were the most used intervention type, while changing the environment interventions were least used. Most interventions targeted GP staff and patients accessing primary care, followed by care home staff, residents and their families.

Most used success measures included reduction in antibiotic prescribing (54.5%, 97 out of 178 intervention examples); positive feedback from stakeholders (42.1%, 75 out of 178); and increased adherence to national guidelines (32.6%, 58 out of 178). However, 48.8% (20 out of 41) stated their team's UTI activities had not been evaluated, indicating that success was determined using informal data or perceived outcomes. Barriers to implementation of UTI interventions included: lack of resources and time; low staff engagement, inaccurate data due to lack of clinical coding; inconsistent systems and processes; lack of dedicated roles. Facilitators:

availability of tools; financial incentives; multidisciplinary collaboration; sharing information; staff motivation; embedding resources into systems; digitalisation; dedicated roles.

Conclusions

Multidisciplinary teams and collaboration are key facilitators for implementation of UTI interventions. Although some teams are already using robust success measures, there is a need to improve how interventions are evaluated to inform resource allocation and planning. Education and training interventions should address or leverage the barriers and facilitators identified, including clinical coding skills, embedding resources and tools into existing systems and auditing adherence to diagnostic and antibiotic prescribing guidance. There may be missed opportunities for less widely used intervention types, for example, changing environmental factors.

Strategies for older people living in care homes to prevent urinary tract infection: the 'StOP UTI' realist synthesis of evidence

Authors

Jacqui Prieto¹, Jennie Wilson², Alison Tingle², Emily Cooper³, Melanie Handley⁴, Jo Rycroft-Malone⁵, Jennifer Bostock⁶, Lynne Williams⁷, Heather Loveday⁸

¹ School of Health Sciences, University of Southampton, University Road, Southampton

² University of West London, St Mary's Road, London

³ Primary Care and Interventions Unit, HCAI, Fungal, AMR, AMU and Sepsis Division, UK Health Security Agency (UKHSA), London

⁴ Centre for Public Health and Community Care, University of Hertfordshire, De Havilland Campus, Mosquito Way, Hatfield

⁵ Faculty of Health and Medicine, Lancaster University, Bailrigg, Lancaster

⁶ Patient and Public Involvement, based in England

⁷ School of Medical and Health Sciences, Bangor University, Bangor

⁸ Richard Wells Research Centre, University of West London, St Mary's Road, London

Objectives

To identify interventions that could be effective for preventing and recognising UTI in older people living in care homes in the UK and explore the mechanisms by which they work, for whom and under what circumstances.

Methods

A synthesis of evidence using a realist approach was undertaken to develop, test and refine programme theories, which are the units of analysis within the realist approach. These were expressed as context + mechanism = outcome configurations (CMOc). Their practical relevance and potential for implementation was established through consultation with stakeholders and teacher-learner interviews.

Results

Nine CMOc were identified, which describe what needs to happen in care homes to facilitate improvement in practice for the prevention and recognition of UTI. These were arranged under 3 theory areas: 1) supporting accurate recognition of UTI, 2) preventing UTI and catheter-associated UTI (CAUTI) and 3) the infrastructure and systems required to make best practice happen. The programme theories draw on evidence from a range of areas including infection prevention and control, antimicrobial stewardship, leadership and safety culture in care homes and person-centred care. The findings suggest a whole care team approach, involving residents, their family carers, care home staff and visiting health professionals is needed to develop and implement strategies to improve UTI prevention and recognition. Support at system level, with regulatory and inspection frameworks aligned to evidence on prevention and recognition of UTI, is imperative to ensure the resources and infrastructure are available to enable care home managers and their staff to prioritise this as part of person-centred care.

Conclusions

The findings have identified the active components of strategies that are effective in preventing and recognising UTI in older people living in care homes and will help guide delivery of future improvement programmes and research.

Comparing public knowledge around value of hand and respiratory hygiene, vaccination, and pre- and post-national COVID-19 lockdown in England

Authors

Brieze Read¹, Cliodna McNulty¹, Neville Verlander², Nicola Moss³, Donna Lecky¹

¹ Primary Care and Intervention Unit, UKHSA, Gloucester

² Statistics, Modelling and Economics Department, UK Health Security Agency (UKHSA), London

³ Ipsos MORI, UK

Aim

The COVID-19 pandemic spotlighted the importance of infection prevention and control (IPC) measures. Existing literature focuses on healthcare professionals, whereas this work explored changes in public knowledge of IPC, where knowledge is comparably sparse.

Methods

National surveys were conducted before (March 2020) and after (March 2021) the COVID-19 pandemic lockdown across England. A telephone survey of 1676 adults (2021) and a face-to-face survey of 2202 adults (2020) across England were conducted. Key demographics were representative of the population. Weighted logistic regression with composite Wald P-values was used to investigate knowledge change from 2020 to 2021.

Results

Compared with 2020, significantly more respondents correctly stated that infections can spread by shaking hands (86% post vs 79% pre; $P < 0.001$) and that microbes are transferred through touching surfaces (90% vs 80%; $P < 0.001$). More knew that hand gel is effective at removing microbes if water and soap are unavailable (94% vs 92%; $P = 0.015$); that when you cough, you may infect other people near you in a room (90% vs 80%; $P < 0.001$). Knowledge that vaccination protects others from infection also increased (63% post vs 50% pre; $P < 0.001$). There was also significant increase in those confident in their answers.

Conclusion

Knowledge of IPC measures was higher in 2021 than before the pandemic. Future public health hygiene campaigns should capitalise on this and emphasise that continuing hygiene behaviours and vaccination can help prevent acquisition and illnesses with other non-COVID-19 infections, thus reducing the strain on the national health service.

Ongoing project: reducing Gram-negative bloodstream infections (GNBSIs)

Lead author

Emily Agnew (UKHSA, London)

Work is ongoing to quantify the most effective strategies and interventions for reducing GNBSIs, by investigating patient pathways that lead to GNBSIs, with a focus on urinary tract infection (UTI) (catheter and non-catheter related) pathways, including hospital, community and long-term care facility (LTCF)-acquired infections. An individual based mathematical model of patients and their pathways to GNBSIs has been developed to examine the potential benefits of different intervention strategies in reducing incidence of GNBSI and AMR, as well as a cost-effectiveness analysis of these strategies.

2. Environmental contamination

Ongoing project: Intervention and healthcare environment models

Lead author

Ginny Moore (UKHSA)

A full-scale, fully-functional model ward has been built at UKHSA Porton site to facilitate applied microbiology research. It allows transmission dynamics of antimicrobial-resistant bacteria and other emerging pathogens to be investigated and a range of infection prevention strategies to be evaluated – importantly without impacting patients or disrupting clinical practice. This bespoke facility allows us to study the survival of microorganisms on surfaces, in water and in the air with the aim of providing evidence-based recommendations to prevent infection.

3. Optimal use of antimicrobials in humans

Investigating the influence of the social determinants of health on health seeking behaviours and healthcare provision for marginalized and deprived populations at risk of and affected by antibiotic resistant infections: a systematic review

Authors

Alison Shutt¹, Ela Carter¹, Amrita Ghataure¹, Diane Ashiru-Oredope², James Price³, Alison Holmes¹, Esmita Charani^{1,4}

¹ Imperial College London

² UKHSA

³ University Hospitals Sussex, Brighton

⁴ Faculty of Health and Life Sciences, University of Liverpool

Background

Social determinants of health influence the emergence and spread of AMR. The populations at greatest risk of AMR are often those with least access to public interventions. This systematic review examines the existing global evidence on the intersection of the social determinants of health and health-seeking behaviours related to AMR, and the potential health inequalities which may be driving AMR. Secondary objectives for the review include analysis of interventions specifically focused for vulnerable populations and the inclusion of public patient participation in research. The systematic review is designed to link with the NHS policy document to reduce health inequalities Core20PLUS5.

Methods

The protocol was registered with PROSPERO and outlines inclusion and exclusion criteria. The methodology followed the Cochrane guidelines for Systematic reviews. Search strategies were developed using key words and MeSH terms for anti-microbial resistance, antibiotic resistance, specific infections, vulnerable populations, the social determinants of health, health seeking behaviour and health inequalities. Ovid MEDLINE, Ovid EMBASE, the Cochrane Library, PsycINFO and Scopus, were searched. Scopus was also used for Grey literature searches and this was supplemented by hand searches. Title and Abstract, Full text review and Data extraction were undertaken by using Covidence software. Qualitative and quantitative studies were assessed using quality assessment and risk of bias tools. Published material from 2000 and in the English language were eligible for inclusion.

Results

The final search strategies revealed 17252 papers of which 616 papers were duplicates. After the title and abstract review 16138 papers were excluded. A full text review resulted in 180 studies for full data extraction. The majority of the included studies are from the last 10 years and predominantly from low and lower middle income countries.

Discussion

The full stage review is currently ongoing. The social determinants of health and health seeking behaviour are broad, diverse research areas. It can be argued that an examination of individual determinants would provide a more focused approach. However, this perpetuates a silo approach to the management of AMR. It detracts from the importance of examining all the determinants via a holistic lens to examine the interrelationship of different factors. A holistic public, patient approach is required to assist in addressing AMR. This systematic review will map the research in this field, highlight the related research gaps and identify a more responsive policy and healthcare pathway approach to the management of AMR in the UK with opportunities for scale to different settings.

What the public in England know about antibiotic use and resistance in 2020: a face-to-face questionnaire survey

Authors

Clodna McNulty¹, Brieze Read¹, Anna Quigley², Neville Verlander³, Donna Lecky¹

¹ Primary Care and Interventions Unit, UKHSA, Gloucester

² Social Research Institute, Ipsos MORI UK Ltd, London

³ Statistics, Modelling and Economics Department, UKHSA, London

Objectives

To describe public attitudes and knowledge around antibiotic activity, resistance and use and expectations for antibiotics and trust in healthcare professionals.

Methods

Face-to-face household 18 question surveys using computer-assisted data collection were undertaken by Ipsos Market and Opinion Research International (Ipsos MORI). Households were randomly selected across England, between January to February 2020.

Results

A total of 2,022 adults (aged 15+) responded. Analyses were weighted to obtain estimates representative of the population with multivariable analysis undertaken for questions with 5 or more significant univariate variables. 84% stated they would be pleased if their general practitioner (GP) said they did not need antibiotics. Trust in GPs to make antibiotic decisions remains high (89%) and has increased for nurses (76%) and pharmacists (71%). Only 21% would challenge an antibiotic decision; this was significantly greater in participants from ethnic minority backgrounds (OR 2.5, 95% CI: 1.89-3.35). 70% reported receiving advice when prescribed antibiotics. Belief in benefits of antibiotics for ear infections was very high (68%). 81% answered that antibiotics work for bacterial, 28% cold and influenza viruses. 84% said antibiotic resistant bacteria (ARB) are increasing, only 50% answered healthy people can carry ARB and 39% felt there was nothing they personally could do about ARB. Social grade DE and

ethnic minority participants and those with lower educational attainment had significantly less knowledge of antibiotics and resistance.

Conclusions

As trust in healthcare practitioners is high, we need to continue antibiotic education and other interventions at GP surgeries and community pharmacies but highlight that most ear infections are not benefitted by antibiotics. Targeted interventions are needed for socioeconomic DE, ethnic minorities and previous antibiotic users. Further exploration is needed into if increasing perceived personal responsibility for preventing ARB reduces antibiotic use.

Determining the impact of professional body recommendations on the screening of acquired carbapenemase-producing Enterobacterales in England

Authors

Kirsty Bennet¹, Rebecca Guy¹, Sarah Gerver¹, Katie Hopkins¹, Richard Puleston², Colin Brown¹, Katherine Henderson¹

¹ Healthcare-Associated Infections, Fungal, Antimicrobial Resistance, Antimicrobial Usage and Sepsis Division, UKHSA, London

² Field Services Midlands Regions Directorate, UKHSA, Nottingham

Acquired carbapenemase-producing Gram-negative bacteria are an increasing public health concern globally and have been mandatory to report in England since October 2020. However, in light of the COVID-19 (SARS-CoV-2) pandemic, new guidance was released to assess the impact of the Royal College of Pathologists (RCPATH) recommendations on screening of carbapenemase-producing Enterobacterales (CPE) calling for reducing the need for screening of CRE (carbapenem-resistant Enterobacterales) in low-risk areas, without defining 'low risk'. An online Select Survey was sent to all NHS acute hospitals in England. The initial survey distribution was between March and April 2021 and the survey was relaunched between November 2021 and March 2022. In total, 54 hospitals completed the survey, representing 39.1% of 138 eligible trusts. All hospitals had a CPE screening policy in place, and the majority of these reflect UKHSA's Framework of actions to contain CPE. Of the 23 hospitals who reported a reduction in CPE screening, only 3 (13.0%) indicated that this was due to the RCPATH recommendations, with 21 (91.3%) indicating that there had been a natural reduction in the number of patients admitted to the trust who would have previously been screened due to the COVID-19 pandemic. For most surveyed hospitals, CPE screening was not reduced due to the RCPATH recommendations. However, the results highlighted that there is a large amount of individual variation in CPE screening practices and diagnostic testing between hospitals.

Mapping of laboratory practices to promote antimicrobial stewardship in the East of England

Authors

Helen Benson¹, Ashley Popay², Ella Casale¹, Jackie Gilbey¹, Smita Kapadia¹, Nicholas Brown³

¹ Health Protection Team, UKHSA, East of England

² Field Services East of England, UKHSA, East of England

³ Cambridge University Hospitals NHS Foundation Trust, Cambridge

Introduction

Clinical and public health laboratories play a significant role in antimicrobial stewardship (AMS), including the functions of testing and reporting antimicrobial susceptibilities to clinical submitters, reporting of patient-specific information to facilitate appropriate prescribing, and adhering to guidance for specimen processing and reporting. While the UK has national standards for microbiology investigations of urine samples, laboratory reporting practices for antimicrobial susceptibilities vary. Studies have shown laboratory practice for reporting antimicrobial susceptibility results can impact on prescribing behaviour in General Practice (GP). Selective reporting of susceptibility results has been suggested as an important mechanism for laboratories to encourage appropriate prescribing. Selective reporting describes the practice of performing antibiotic susceptibility testing (AST) according to standard practice, but reporting a limited set of results, such as inclusion of only first line agents, or not reporting results when colonisation is likely.

It is recognised that approaches to reporting antimicrobial susceptibilities vary by country, often reflecting the relationship between the laboratory and the clinical service. While susceptibility reports provided by hospital microbiology laboratories to clinicians in some countries will generally include a complete list of antimicrobial agents tested, with little to no interpretation of results, in others, including the UK, hospital microbiologists will assist clinicians to interpret results. The nature of information systems and working practices within UK hospitals supports communication and coordination between microbiologists and treating clinicians so that laboratory testing, reporting and interpretation of results to inform treatment can best support patients' needs. As a substantial proportion of antimicrobial prescribing takes place in primary care however, there is a need to better understand the mechanisms through which GPs request laboratory testing for patient samples, and the interface between laboratories and primary care for the reporting of results.

Regional context

The East of England (EoE) region includes a total of 11 hospital microbiology laboratories working across 14 NHS trusts and a regional public health laboratory. While a degree of variation in reporting practices is to be expected, the extent of variation was largely unknown. At the regional EoE Healthcare Associated Infection (HCAI) and Antimicrobial Resistance (AMR) forum a service mapping was proposed.

Aim

A service evaluation to understand how and why laboratory reporting practices differ, and barriers and enablers to influencing AMS was undertaken. The focus was on antimicrobial susceptibility reporting for urine samples, due to the large number of antimicrobials prescribed for urinary tract infections (UTIs), the wide range of antimicrobials that are prescribed and because this aligns with an NHS area of focus for quality improvement.

The desired outcomes for this study were to:

- gain an understanding of the differences in laboratory practice for antimicrobial susceptibility reporting across the EoE
- identify any barriers and enablers
- identify key actions and recommendations to support laboratories to promote prudent antimicrobial prescribing

Methods

Structured interviews via videocall with consultant microbiologists from each EoE NHS hospital laboratory, using a bespoke proforma developed by members of the research team following a pilot with one hospital microbiologist.

All interviews were conducted over Microsoft Teams and where necessary, interviewees were asked to clarify information provided over email following the initial interview. Interviews lasted from between 30 to 45 minutes, with 2 to 4 members of the research team attending each interview. Interviews were conducted over the period December 2021 to July 2022.

Through the interviews and bespoke proforma information was captured on availability and adherence to local and national policies on reporting susceptibilities, number and types of antimicrobials tested for susceptibility, the characteristics of laboratory reporting systems, validation and audit processes, quality improvement activities the hospitals were involved in, and barriers and enablers to promoting AMS. Interviewees were invited to share their experience on how the system could be improved to promote AMS. Thematic analysis was undertaken to identify differences and common themes.

IV to oral switch – A collaborative initiative in the East of England (NHS led with UKHSA contributing)

Authors

Naomi Fleming¹, Alishah Lakha², Ella Casale³, Jackie Gilbey³, Smita Kapadia³, Rachel Cullum³, Jon White⁴, Sabina Khanom⁵, Fiona Marshall⁶, Conor Jamieson², Laura Whitney², Kieran Hand²

¹ East of England, NHS England

² NHS England

³ Health Protection Team, UKHSA East of England

⁴ UKHSA

⁵ Antimicrobial Prescribing and Medicines Optimisation Team, NHS England

⁶ AMR Programme, Medical Directorate, NHS England

Background

The East of England region is the highest prescriber of intravenous (IV) antibiotics nationally. This is a collaborative initiative with NHS England leading and UKHSA EoE HCAI/AMR forum supporting with project planning, raising awareness and through contribution to regional workshops and the development of supporting materials.

Aim

This project aims to reduce the percentage of IV antibiotics prescribed by supporting timely IV to oral switch (IVOS). The project uses quality improvement methodology to identify challenges to implementing IVOS and offers support to trusts to identify and develop regional tools to support IVOS.

Methods

A rapid literature review was carried out to identify barriers to and effective interventions that enable timely IVOS. The aim of the literature search was to provide an overview of the information in the scientific literature on barriers and effective interventions for IVOS to provide evidence to support the project. The review concluded that most common barriers to IVOS appeared to be cultural, followed by operational barriers. Although it was difficult to identify a single best intervention to support a timely IVOS, the review found evidence that printed reminders, technological interventions, interventions by people and education and training can all be effective.

The project team are supporting trusts to implement action plans developed at the first stakeholder workshop. NHS England organised a second IVOS Stakeholder Engagement event in April 2023, where learning from local trusts who have implemented IVOS actions plans was shared, including different interventions and their successes including discussions on enablers and barriers to success of projects.

This work has been used to develop supportive resources for the nationally agreed CQUIN for IVOS 2023 to 2024 accessible on future NHS. The infographics developed by UKHSA and NHS England colleagues has now received national endorsement from ESPAUR and will be published on Future NHS webpage.

4. Stronger laboratory capacity and surveillance of AMR in humans

Health inequalities on the epidemiology of acquired carbapenemase-producing Gram-negative bacteria in England

Poster at European Society of Clinical Microbiology and Infectious Diseases (ECCMID) 2023

Authors

Katherine Henderson¹, Rebecca Guy¹, Amelia Andrews¹, Diane Ashiru-Oredope¹, Berit Muller-Pebody¹, Colin Brown¹, Sarah Gerver¹

¹ UKHSA, London

Substantial variation of aCPGNB was identified by ethnicity, varying most in London across all carbapenemase families.

The majority of reported *Klebsiella pneumoniae* carbapenemase (KPC), New Delhi metallo- β -lactamase (NDM) and Verona integron-encoded metallo- β -lactamase (VIM) occurred in urban major conurbations, accounting for 36% of England's population.

Further assessment of carbapenemase risk factors, in particular the incidence of household clustering, should be undertaken to help understand this disease burden.

In conclusion, this work has captured valuable information on the burden of aCPGNB in differing population within England; developing awareness of health inequalities for better targeting of health interventions.

Creating new visualisations of multi-antibiotic resistant (MDR) patterns using England surveillance data

UKHSA conference 2022 oral presentation

Authors

Hannah Higgins¹, Rebecca Guy¹, Katherine Henderson¹, Alicia Demirjian¹, Sarah Gerver¹

¹ UKHSA, London

The work explores and presents visualisations of multi-drug resistance in *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* to ascertain and detect changes in resistance patterns across time, place (regional sub-categories), and person (ethnicity, age, and sex sub-categories and deprivation quintiles). The presentation of this data enables the depiction of complex, multi-layered information to be expressed visually, which is crucial to understand the evolving MDR picture and would be of interest to local and regional

colleagues. The diagrams communicate and highlight health inequalities existent in England and will be a powerful tool for motivating behaviour change. The results show the pathogen antibiograms can vary geographically; understanding local epidemiology of resistance is critical to enable local area teams to review their local policy to ensure that appropriate therapy.

Laboratory surveillance of paediatric bloodstream infections and antimicrobial resistance in England: 2017 to 2021

Authors

Sarah Leaver¹, Rebecca Guy¹, Katherine Henderson¹, Berit Muller-Pebody¹, Alicia Demirjian¹

¹ UKHSA, London

This is the first health protection report (HPR) looking at Paediatric AMR by agegroup. It is planned that this HPR will be updated for publication with this 2023 ESPAUR Report.

This was also presented at the European Society For Paediatric Infectious Diseases (ESPID) 2023 conference in May 2023.

Long-read nanopore sequencing of resistant isolates of Enterobacterales

Authors

Jane Turton¹, Claire Perry², Kim McGowan², Jack Turton¹

¹ HCAI, Fungal, AMR, AMU and Sepsis Division, UKHSA, London

² Public Health Microbiology, UKHSA, London

The Opportunistic Pathogens team have been carrying out long-read nanopore sequencing of resistant isolates of *Enterobacterales* using the new q20 high-accuracy chemistry to provide complete assemblies of both the chromosome and plasmids. Of particular note is the increasing prevalence of conjugative hybrid resistance or virulence plasmids in *Klebsiella pneumoniae* ST147, an international 'high-risk clone' often carrying an NDM or OXA-48-like carbapenemase gene, or both.

We first described these hybrid plasmids in an isolate of ST147 in 2016 ([Turton and colleagues Journal of Medical Microbiology 2018: volume 67, pages 118 to 128](#)) when their presence was remarkable. Unfortunately, of the representatives of this type from 39 patients received by the reference laboratory from 17 different hospital groups during 2022 and the first half of 2023, some 44 % (from 10 different hospitals) carried these plasmids. Most worryingly, many contained a fragment carrying *bla*_{NDM-5} and at least 10 other resistance genes in an IncFIB/IncHI1B conjugative plasmid carrying multiple virulence elements (including the aerobactin siderophore cluster, *ompA* and *ompA2*), that was highly similar to that described in plasmids from isolates of ST383 and ST48 from 2018 ([Turton and colleagues, Microorganisms](#)

[2019: volume 7 \(9\)](#)). This work highlights that representatives of ST147 may pose a particular risk for their potential to cause invasive infections with few therapeutic options.

Antimicrobial resistance in invasive *Streptococcus pyogenes*: England, 2016 to 2022

Authors

Rebecca Guy¹, Juliana Coelho¹, Bruno Pichon¹, Katherine Henderson¹, Colin Brown¹, Theresa Lamagni¹

¹ UKHSA, London

Introduction

A recent review of antibiotic resistance (AMR) in invasive group A streptococcal (iGAS; *Streptococcus pyogenes*) disease identified increasing AMR to therapeutic agents used for treatment in penicillin-allergic patients. We assessed iGAS susceptibilities to macrolide (erythromycin), lincosamide (clindamycin) and tetracycline antibiotics and emm type distribution alongside epidemiological data in England.

Methods

Patient demographics, AMR and strain typing of iGAS clinical sterile-site isolates from England were assessed for AMR trends over time by strain-type and patient demographic.

Discussion

In recent years there has been increased diversity in circulating emm types in England. This is partly a reflection of increasing numbers of GAS outbreaks amongst more marginalised populations, particularly homeless, injecting drug users and prisoners. Outbreaks in these groups have involved different emm types (66.0, 108.1, 77.0) to those previously circulating. The increasing prevalence of AMR-associated strains are concerning and require monitoring, adding to the importance of local and national surveillance, and using antibiogram data for treatment choice in patients with penicillin-allergy.

Looking at whole genome sequencing data for emerging mechanisms as well as considering combinational and inducible resistance is important to further understand the trends. The use of broad-spectrum antibiotics in patients labelled as 'penicillin-allergic' is associated with increased health costs, risk of AMR and suboptimal antibiotic therapy.

Monitoring resistance mechanisms would be important to understand transmissibility, whilst also informing effective antimicrobial stewardship and treatment regimens.

In light of variable resistance patterns, efforts should be made to review drug allergies, with de-escalation or drug allergy testing where appropriate.

Use of whole genome sequencing for the investigation of unusual antimicrobial resistance

Authors

Katie L Hopkins¹, Jane Turton¹, Zeynab Yusuf¹, Shazad Mushtaq¹, Daniele Meunier¹

¹ UKHSA, London

The Antimicrobial Resistance and Healthcare Associated Infections (AMRHAI) Reference Unit receives bacterial isolates from diagnostic laboratories for the investigation of unusual antimicrobial resistance (AMR). Depending on the laboratory's request, carbapenem resistant isolates are subjected to multiplex polymerase chain reaction (PCR) to screen for select acquired carbapenemase genes and/or phenotypic antibiotic susceptibility testing including interpretive reading of the resulting antibiogram to help infer underlying resistance mechanisms. However, occasionally mismatches between the 2 testing approaches are observed, such as phenotypic testing suggesting presence of carbapenemase activity that cannot be explained by PCR.

In 2022, AMRHAI implemented whole genome sequencing (WGS) for investigation of unusual antimicrobial resistance. WGS can determine the complete resistance gene complement (compared to multiplex PCR, which targets only the carbapenemase genes known to be circulating within the UK) and mutations associated with AMR. Short-read sequencing has been able to rule out the presence of acquired carbapenemase genes in many isolates with carbapenem resistance attributable instead to ESBL activity together with mutations in outer membrane proteins leading to impermeability. However, in one isolate of *Pseudomonas* sp. a novel metallo-carbapenemase gene has been identified and further characterisation of the isolate and carbapenemase is currently underway. Long-read sequencing is also being used to inform our understanding of the mobile genetic elements associated with carbapenemase genes and therefore help us assess further transmissibility. For example, long-read sequencing revealed that the GIM carbapenemase gene reported for the first time in 2022 in a clinical isolate referred to AMRHAI (see [chapter 2](#)) was located in a different genetic environment in each isolate, ruling out a common plasmid involved in transmission. Similarly, long-read sequencing has helped inform our understanding of the genetic environment associated with the novel metallo-carbapenemase gene identified in the *Pseudomonas* sp. described above.

Ongoing project: *Escherichia coli* bloodstream infections during the COVID-19 pandemic

Lead author

Amelia Andrews (UKHSA, London)

The incidence of *Escherichia coli* bacteraemia increased each year from the start of the mandatory surveillance in 2011 to the beginning of the COVID-19 pandemic in 2020. A reduction was observed at the start of the pandemic for community-onset cases, whereas the

incidence rate of hospital-onset cases remained largely stable. To quantify the effect of COVID-19 on *E. coli* bacteraemia, the difference between the observed and expected (using the underlying trend prior to COVID-19) cases has been calculated. The analysis will explore whether the gap in cases could be explained by the following: (i) competing risk from COVID-19, (ii) undiagnosed *E. coli* bacteraemia, and (iii) reduced healthcare interactions.

5. Development of new therapeutics

Novel immunotherapies for tuberculosis and other mycobacterial diseases

Authors

Steve Thomas¹, Steven Taylor¹, Michael Maynard-Smith¹, Joanna Bacon¹

¹ Porton AMR Network, UKHSA, Porton Down, Salisbury, Wiltshire

The Aerosol Infection Microbiology Group are a partner in the new international consortium for Novel Immunotherapies for Tuberculosis and other Mycobacterial Diseases (ITHEMYC), which has 11 partners worldwide, and is funded by the Horizon Europe programme to establish a critical path for selection of promising innovative adjunct Tuberculosis (TB) immunotherapies and progress 2 of these immunotherapies to completion of preclinical proof of concept in a non-human primate model. For decades, TB treatment has been primarily based on “kill-the-bug” approaches. There has been a steady realisation in the field that these approaches that solely look for new drugs to treat TB have inherent limitations in terms of the length and complexity of treatment. Immunotherapies offer a complementary approach for attacking TB in a way that could result in superior results for patients. The rationale for using immunotherapeutic agents is to modulate the immune response to TB and accelerate bacillary clearance. The ITHEMYC project advances beyond the current state of the art by combining existing TB drug treatment regimens and immunotherapies to develop novel therapeutic options with the potential to shorten treatment duration, improve outcomes, and prevent relapse. The group at UKHSA is providing the models with which to evaluate new immunotherapeutics in this consortium.

Discovery of potentiators that boost the activity of pyrazinamide against *Mycobacterium tuberculosis*

Authors

Steve Thomas¹, Steven Taylor¹, Michael Maynard-Smith¹, Joanna Bacon¹

¹ Porton AMR Network, UKHSA, Porton Down, Salisbury, Wiltshire

The Discovery Group at UKHSA, Porton Down, has developed technologies and assays that are rapid, modernised, relevant to the pathogen or disease state, and higher throughput. The assays are optimised for the screening of compound libraries for the discovery of new drug hits, that are followed up in secondary characterisations, MedChem optimisation, and efficacy in-vivo. Through GlaxoSmithKline (GSK) Openlab Foundation funding, the Discovery group has

developed a defined, and standardised, high throughput screen to evaluate libraries of compounds against *Mycobacterium tuberculosis*. The assay was tech-transferred to GSK Tres Cantos in 2022 to 2023, and 35,000 compounds were screened. Candidate drugs were identified for further development. This technology is now being applied for screening libraries against other AMR pathogens including *Neisseria gonorrhoeae*, *Pseudomonas aeruginosa*, *Mycobacterium abscessus*, and viral threats such as coronaviruses and Coalition for Epidemic Preparedness Innovations (CEPI) priority pathogens. The assay method will be published as a chapter in 'Antibiotic Resistance Protocols' Fourth Edition, in 2023 to 2024.

Pathogenesis and Immunotherapeutics for *Clostridioides difficile*

Authors

Steve Thomas¹, Steven Taylor¹, Michael Maynard-Smith¹, Joanna Bacon¹

¹ Porton AMR Network, UKHSA, Porton Down, Salisbury, Wiltshire

The Antigen Research Team based at UKHSA Porton has an ongoing programme of *Clostridioides difficile* work. This pathogen disproportionately affects people taking antibiotics which disrupt the microbiome, it is a significant cause of morbidity and mortality in the UK. Relapse rates from the current treatments of vancomycin, metronidazole and fidaxomicin are unacceptably high. The objective of the programme is to develop vaccines and antibody-based therapeutics for the treatment of *C. difficile* infection. This should reduce the need for antibiotic usage for these infections. Vaccine antigens and sheep-based antibody formulations have been developed and patented. This year the work programme is seeking funding, alongside our commercial partners, to carry out clinical trials up to Phase 2 for our orally delivered therapeutic "OraCab".

6. Wider access to therapeutics for those who need them

Impact of sociodemographic status and UTI symptoms on women's health-seeking and management during the COVID-19 pandemic

Authors

Emily Cooper¹, Brieze Read¹, Leigh Sanyaolu², Harry Ahmed³, Donna Lecky^{1,2}

¹ Primary Care and Interventions Unit, UKHSA, Gloucester,

² School of Medicine, Cardiff University

³ Division of Population Medicine, Cardiff University

Background

Multiple factors may influence women's experience of UTI and their clinical management.

Aim

Explore how a woman's background, UTI symptoms or severity influence UTI reporting and management.

Method

Internet questionnaire targeting women in England, focusing on UTI symptoms, care-seeking and management were distributed. A total of 1,069 women aged ≥ 16 years with UTI symptoms in the previous year completed the questionnaire (March/April 2021). Multivariable logistic regression was used to estimate the odds of relevant outcomes whilst adjusting for background characteristics.

Results

Women with children in their household, under 45-years old or married/co-habiting were more likely to experience UTI symptoms. The odds of antibiotic prescribing were lower if women reported dysuria (AOR 0.65, 95%CI: 0.49-0.85), frequency (AOR 0.63, 95%CI: 0.48-0.83), or vaginal discharge (AOR 0.69, 95%CI: 0.50-0.96), but higher if reporting haematuria (AOR 2.81, 95%CI: 1.79-4.41), confusion (AOR 2.14, 95%CI: 1.16-3.94), abdominal pain (AOR 1.35, 95%CI: 1.04-1.74) or systemic symptoms (AOR 2.04, 95%CI: 1.56-2.69). Those with abdominal pain or 2 or more of nocturia, dysuria, or cloudy urine had lower odds of receiving a delayed antibiotic, while those with incontinence, confusion, unsteadiness, or low temperature had higher odds of a delayed prescription. Increasing symptom severity was associated with greater odds of receiving antibiotics.

Conclusion

Except for reduced prescribing if a woman had dysuria and frequency, antibiotic prescribing followed an expected pattern, aligning generally with national guidance. Symptom severity and the likelihood of systemic infection likely influenced care-seeking and prescribing. Sexual intercourse and childbirth may be key times to target women with messages about UTI prevention.

Impact of menopausal status and recurrent UTIs on symptoms, severity, and daily life: findings from an online survey of women reporting a recent UTI

Authors

Leigh Sanyaolu^{1*}, Emily Cooper^{2*}, Brieze Read², Haroon Ahmed¹, Donna Lecky^{2,3}

*Joint first authors

¹ Division of Population Medicine, Cardiff University, Cardiff

² Primary Care and Interventions Unit, UKHSA, Gloucester

³ School of Medicine, Cardiff University, Cardiff

Introduction

Current UKHSA UTI guidance advises empirical antibiotics if 2 of the following symptoms are present: cloudy urine, dysuria, and new onset nocturia. Hormonal changes during menopause

may impact UTI symptoms and qualitative studies suggest women with recurrent UTIs may present with different UTI symptoms. This study aims to assess whether menopausal status and the presence of recurrent UTIs impacts UTI symptoms in women.

Methods

An e-survey was conducted between 13 March 2021 and 13 April 2021. Women aged 16 years or older with a history of a UTI in the last year were eligible for inclusion. Menopause was defined as those aged 45 to 64 years; pre-menopause as those less than 45 years; and post-menopause as those 65 years and older. Recurrent UTIs were defined as 3 or more UTIs in the last year. Data was weighted to be representative of the UK population. Crude unadjusted and adjusted odds ratios were estimated using logistic regression.

Results

A total of 1,096 women reported a UTI in the last year. There were significant differences in UTI symptoms based on menopausal status and the presence of recurrent UTIs. Post-menopausal women self-reported more incontinence (OR 2.76, 95%CI: 1.50-5.09) whereas menopausal women report more nocturia. Women with recurrent UTIs report less dysuria, more severe symptoms (OR 1.93, 95%CI: 1.37-2.73) and a greater impact on daily life (OR 1.68, 95%CI: 1.19-2.37).

Conclusion

This survey provides evidence that acute UTIs present differently based on menopausal status and in women with recurrent UTIs. It is important healthcare professionals are aware of these differences when assessing women presenting with an acute UTI.

7. Development of and access to diagnostics

Ongoing project: Open Innovation for AMR

Lead author

Mark Sutton (UKHSA, London)

There is a need to drive innovation to develop new therapeutics using novel approaches. Infrastructure funding from the DHSC, (NIHR200658) allowed for development of new capabilities to evaluate non-traditional antimicrobial agents. The Open Innovation programme builds on work at UKHSA, with academia and industry, in the UK and internationally. In the last year, this work has developed new interventions for AMR, including both small molecule and non-traditional therapeutics, targeting bacterial and fungal pathogens. An EU Marie Skłodowska-Curie Actions (MSCA) project is developing single and mixed species biofilm models for acute and chronic infections in wounds.

Innovative approaches, using bacterial impedance cytometry, are developing new antimicrobial susceptibility test platforms for clinical and research use.

Ongoing project: Rapid antibiotic susceptibility testing for urinary tract infections in secondary care in England: a cost-effectiveness analysis

Authors

Ross D. Booton, Emily Agnew, Diane Pople, Stephanie Evans, Lucy Bock, Mark Sutton, Julie Robotham*, Nichola Naylor* (¹ UKHSA, London)

*Joint last authors

The aim of this research was to perform a model-based cost-effectiveness evaluation of a rapid antimicrobial susceptibility test (iFAST) implemented for inpatients with urinary tract infections (UTI) in acute NHS trusts in England, from the perspective of the NHS Healthcare system, at a national level. A Markov model was developed to simulate a cohort of (adult) inpatients in an average acute, non-specialist NHS hospital trust in England with clinical suspicion of UTI, and their transition through health states according to testing (rapid and standard) and associated antibiotic treatment. The model considers complicated and uncomplicated UTI across age groups and sexes and both oral and IV treatment regimens. Sensitivity analyses and scenario analyses of the impact of changing resistance rates to the cost-effectiveness of the diagnostic were conducted. Model outputs suggest implementation of iFAST would be cost-effective from the NHS healthcare system perspective.

8. Development and access to vaccines

The development of novel vaccines for *Neisseria gonorrhoeae*

Authors

Steve Thomas, Steven Taylor, Michael Maynard-Smith, Joanna Bacon (Porton AMR Network, UKHSA, Porton Down, Salisbury, Wiltshire)

The Pathogen Immunology group at UKHSA, Porton Down has various small projects with academic and industrial partners supporting the development of novel vaccines for *Neisseria gonorrhoeae*, which is the cause of gonorrhoea, a sexually transmitted infection which can cause severe disease, particularly in women, including infertility. It disproportionately affects low- and middle-income countries, but is also on the rise in the UK, with an increase in the number of cases that are antibiotic resistant. The team is developing high throughput killing assays that are analysed by flow cytometry and high content imaging. These projects will continue to investigate complement deposition on *N. gonorrhoeae* strains and the impact of IgG subclass on bactericidal function to understand the impact of non-bactericidal antibodies.

Development of high-throughput opsonophagocytosis killing assays for evaluation of Group B streptococcus vaccines

Authors

Steve Thomas, Steven Taylor, Michael Maynard-Smith, Joanna Bacon (Porton AMR Network, UKHSA, Porton Down, Salisbury, Wiltshire)

In 2022 to 2023, The Pathogen Immunology Group, at UKHSA, Porton Down was awarded continued Bill and Melinda Gates Foundation funding as part of an international public health, academic and pharmaceutical partners consortium to develop standardised laboratory correlates of protection to aid licensure of new Group B *Streptococcus* (GBS) vaccines. This project aims to develop a higher-throughput opsonophagocytosis killing assays (OPKA) suitable for Phase II/III clinical trials and to provide international reference serum samples with defined units of opsonophagocytic activity. The role of UKHSA will be to develop a high-throughput OPKA and assign titres to the reference sera. The high throughput OPKA is required as the current assay method is very labour-intensive limiting the number of sera that can be analysed in vaccine studies. Licensure of a GBS vaccine will have a direct impact on reducing the need for intrapartum antibiotics during childbirth. As part of this project, the team is also developing an OPKA for GBS serotype VI, which will be used in a follow-up PATH-funded Phase I/II clinical study of a novel 6-valent GBS vaccine currently being developed. Licensure of a GBS vaccine will have a direct impact on reducing the need for intrapartum antibiotics during childbirth.

Health protection research units (HPRUs)

The National Institute for Health Research (NIHR)-funded health protection research units (HPRUs) in HCAI and AMR, led by Imperial College London and University of Oxford, both in partnership with UKHSA, have continued to produce a wealth of translational research outputs intended to impact public health policy and practice.

Imperial College London HPRU

As described fully in the 2021 to 2022 ESPAUR report, the HPRU at Imperial College London consists of 4 themes: priority pathogens; precision prescribing; practice, design and engineering and population health and policy. Over the past year the HPRU has undertaken the following research:

[New interventions, diagnostics and optimised prescribing tools with a focus on applying the latest developments in technology and artificial intelligence \(AI\)](#)

Notable outputs this year include: the development of rapid liquid chromatography-tandem mass spectrometry (LC/MS) methods for the simultaneous quantification of cefiderocol and meropenem and a method for the clinical measurement of β -lactam antibiotics in serum and interstitial fluid. Both have the potential to optimise treatment whilst minimising the risk of development of antibiotic resistance. An AI-driven model has been developed to estimate patient outcomes if they were to stop or continue antibiotic treatment in the intensive care unit (ICU) and a successful in silico study demonstrating the potential of a proportional-integral-derivative closed-loop controller for continuous piperacillin delivery. Recruitment for testing in humans is also complete. Assessment of antimicrobial target attainment in under-researched settings has been completed, including outpatient parenteral antimicrobial therapy (OPAT) and central nervous systems (CNS) infections as has a clinical trial on probenecid in healthy volunteers. Other work in the Lancet Digital health illustrated how cross-disciplinary working

with the Department of Mathematics has successfully delivered a prediction model of hospital-onset COVID-19 infections using dynamic networks of patient contact.

Novel use of health data to understand the direct and indirect impact of the pandemic on antimicrobial prescribing and AMR, and on infections and their management and outcomes:

This ongoing strand of work has continued to yield important results for future pandemic preparedness research and planning and for informing policy for healthcare resilience and recovery. A study of prescribing in primary care was the first to report the significant reduction in GP antibiotic prescribing, leading to a further investigation of potential unintended consequences associated with reduced antibiotic use, especially that associated with delayed or missed case identification and treatment. Analysis of GP consultations for UTI before and during the pandemic found no significant increase in the risk of developing bacteraemia within 60 days despite the patients who consulted GPs during the pandemic being older, more multi-morbid and managed remotely. However, managing UTI remotely during the pandemic was associated with antibiotic courses of longer duration being prescribed. The long-term impact on AMR needs further examination.

Jointly, using a systems approach, the work also includes estimation of the economic costs associated with antibiotic-resistant UTIs. Linked individual-level patient records allowed for the assessment of medical costs incurred in multiple healthcare settings in both primary and secondary care using micro-costing and case-matching. This novel approach helps elucidate the burden on health and economic systems caused by AMR. The data used in these analyses are de-identified, near real-time electronic patient records linked for primary and secondary care. The whole data linkage and access process has been streamlined to support pandemic response work providing legacy for the data infrastructure established during the pandemic which has now been transitioned into a routine AMR research resource.

University of Oxford HPRU

The HPRU at University of Oxford also consists of 4 research themes: Populations; Interventions; Contexts; and Sequencing. It aims to bring together increasingly rich types of data from electronic health records, sequencing of microbes' genetic code and health psychology and behavioural, economic and statistical modelling, to work out the most efficient and cost-effective approaches for detection, surveillance, investigation and reduction of AMR and HCAs.

Highlights and achievements in 2022 to 2023 include extensions of work done as part of the emergency response to COVID-19 to directly inform and identify ways to improve public health more broadly. These include:

- testing ways to automatically monitor the quality of electronic healthcare data streams, and then use these routinely collected electronic data, within UKHSA, for the surveillance of microbiologically determined HCAs, including through monitoring 'dashboards'. COVID-19 demonstrated the enormous power of routinely collected

electronic data; this research aims to reduce data collection burden on hospital staff, for example, avoids relying on infection control nurses having to collect and enter data largely manually

- extending methods developed to identify 'at risk populations' for SARS-CoV-2 infections to other healthcare-associated and antimicrobial-resistant infections
- the SIREN healthcare worker study continues to provide vital information on the longer-term impact of SARS-CoV-2 including COVID-19 immunity and vaccine effectiveness, supported by major grant awards to support this ongoing work. The SIREN cohort has also been expanded to consider other respiratory tract infections such as influenza and respiratory syncytial virus (RSV), with analysis currently underway
- combined use of both qualitative and quantitative methods to explore the potential for a novel approach to reduce antibiotic use in primary care, 'stopping antibiotics when the patient feels better'
- further development and use of models to study the priority healthcare threat posed by carbapenemase-producing Enterobacterales, at different levels: both within patients (exploring resistance spread between bacteria) and between patients in hospitals. These studies have informed guideline development on screening and outbreak surveillance planning in UKHSA advisory groups
- SinkBug has continued to combine excellence in experimental design with collaboration and training through an exciting collaborative study with the National Infection Teams Collaborative for Audit and Research (NITCAR), enabling local junior infection doctors and other allied health professionals to sample hospital sinks and assess sink design to investigate the potential role of sinks as reservoirs for antimicrobial-resistant organisms in hospitals and build a network which could test different ways to manage this in future
- recognising that other microbes continue to have major impacts on human health, the HPRU has also continued its programme of work looking at how AMR genes in bacteria found in humans, healthcare-associated environments, wastewater and animals relate to each other
- research to explore the value of using wastewater-based epidemiology as a public health tool for AMR surveillance at the population-level has allowed the HPRU to validate different methodological approaches to facilitate better standardisation of methods
- the HPRU's Global Pathogen Analysis Service (GPAS) for SARS-CoV-2 is a turnkey solution that can be operated by routine Lab Scientists anywhere; an evaluation was conducted with users in the UK, the USA, Chile, Australia, Vietnam, South Africa and Senegal; these included research institutions, hospitals and national health bodies; beyond SARS-CoV-2, the HPRU is developing a GPAS *Mycobacterium tuberculosis* (TB) pipeline

Chapter 8. Stakeholder engagement

Main messages

A total of 18 stakeholders have contributed to this year's ESPAUR report.

Stakeholders have undertaken a range of activities, including but not limited to: ongoing antimicrobial stewardship (AMS) programmes promoting appropriate use of antimicrobials; publishing evidence-based guidance, guidelines and articles; producing workshops, conferences and educational resources; providing support to national and international networks; public and political engagement; promoting pharmacy resources such as the TARGET antibiotics toolkit.

The ESPAUR Oversight Group comprises over 20 stakeholder organisations including the UK nations and national organisations, professional and educational bodies, healthcare providers and regulators. Stakeholders have continued to contribute to tackling antimicrobial resistance (AMR) and promote good antimicrobial stewardship (AMS).

British Dental Association (BDA)

The British Dental Association (BDA) continues to work nationally and internationally to address the role of dentistry in AMR. Within the UK, the BDA has campaigned on the importance of investing in oral disease prevention and tackling system-level barriers to support a reduction in unnecessary antibiotic prescribing. The BDA continues to campaign for improved access to oral healthcare, including appropriately funded time to treat acute dental pain and infection as remote antibiotic prescribing for dental conditions, introduced as part of the emergency COVID-19 pandemic response, is not in accordance with UK clinical guidelines and no longer appropriate. The BDA supports the preservation of access to face-to-face dental care in future pandemics for certain indications such as pain, to avoid inappropriate antibiotic prescribing, subsequent implications on AMR and increased patient expectations for antibiotics for clinically inappropriate indications. Internationally, the BDA plays an important role in the AMS work of the Council of European Dentists and World Dental Federation (FDI).

Chaired by Dr Wendy Thompson, a member of BDA Health and Science Committee, FDI's AMR working group were awarded the UK HSA Antibiotic Guardian Award for Community Communications. Dr Thompson was lead author of [FDI's policy statement on Noma](#) and working group members developed an [Antibiotic Stewardship Core Outcome Set \(COS\)](#), which sets out an agreed standardised international COS to be used in studies about dental antibiotic stewardship, representing the minimum set of outcomes to be reported. The BDA also supports the development of national AMR action plans (NAPs) and contributed to the Department of

Health and Social Care's call for evidence, highlighting the need for dentistry's inclusion in the UK National Action Plan (NAP) refresh.

British Infection Association (BIA)

The [British Infection Association](#) (BIA) is the professional body representing NHS Infection Specialists and trainees in Microbiology, Virology and Infectious diseases. It works closely with the [Royal College of Physicians](#) through its Joint Specialist Committee for Infectious Diseases.

The Association also has a growing Associate Membership made up of allied healthcare professionals working broadly in the field of infection medicine. It publishes the prestigious [Journal of Infection](#) (impact factor ranked third out of 128 journals in Infectious Diseases during 2022) and [Clinical Infection in Practice](#) (CLIP) an open-access journal focused the advancement of knowledge and discussion of clinical infection in practice.

The Association's work includes; providing expert opinion to the governments of the 4 UK nations, the Royal Colleges, NICE, statutory medical and other professional bodies; setting and reviewing standards; supporting good practice.

During the past year the Association has completed production of its one-page Infection Quick Reference Guides ([74](#)) supporting clinicians making diagnostic test and treatment decisions for patients with Pneumonia, Meningitis, Sepsis and Cellulitis. Further guides are being developed in collaboration with the UK Health Security Agency's [Standards for Microbiology Investigations](#). We have contributed to the nationwide professional conversation about the [future configuration of infection services](#), published a [workforce survey highlighting challenges for sustainability of infection services](#) and expertise across the NHS. We are contributing to the new NHS England (NHSE) [Transform Clinical Reference Group](#) which is providing advice to NHSE in support of commissioning of specialist services.

The Association is contributing to the AMR NAP One Health Stakeholder Group and is a stakeholder contributing to the new AMR National Action Plan and the Chief Scientific Officer's UTI implementation Oversight Group.

Among new initiatives planned for the coming year is a new partnership with the Intensive Care Society developing educational and guideline content to improve management of infection in the critical care setting.

British National Formulary (BNF)

The BNF continues to update content in line with NICE's management of common infections guidance and any relevant national guidance on the use of antimicrobials. These updates are highlighted to BNF users by the inclusion in the BNF changes record which is published monthly. BNF Publications hosted the NICE and UKHSA summary of antimicrobial prescribing

guidance on managing common infections. This resource, from June 2023, will be hosted on the [Royal College of General Practitioners eLearning website](#).

British Society for Antimicrobial Chemotherapy (BSAC)

The [British Society for Antimicrobial Chemotherapy \(BSAC\)](#) represents one of the world's most influential networks of infection specialists. Membership includes, but is not limited to, infectious disease physicians, microbiologists, pharmacists, researchers and, more recently, individuals engaged across one health sectors in veterinary practice, environmental science, animal husbandry and aquaculture.

It provides high-quality open access support to the global antimicrobial chemotherapy community which takes many forms: free membership, workshops, conferences, and research publications via its [Journal of Antimicrobial Chemotherapy](#), and the online open access education and research journal, [JAC-Antimicrobial Resistance](#).

The society has a rich portfolio of activities that includes:

1. The [UK Antimicrobial Registry](#), developed in partnership with the University of Aberdeen, to capture real world usage of antimicrobial agents and identify where the clinical unmet need lies.
2. A national susceptibility testing programme, supporting harmonisation of methodologies with EUCAST.
3. 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.
4. The [Global AMS Partnership Hub](#), (GASPh) bringing organisations together to collaborate on initiatives that support effective prescribing and reduce the burden of AMR.
5. The [UK Outpatient Parenteral Antimicrobial Therapy \(OPAT\)](#) programme, bringing care closer to home; BSAC is currently supporting NHSE in developing a cost calculator to support the establishment of new services and an expansion of existing services.
6. An [open access Infection Learning Hub](#) which includes over 60 open access e-learning courses with translations into 6 languages for some courses.
7. Publication of evidence-based guidelines and good practice recommendations
8. The secretariat for the [All-Party Parliamentary Group on Antibiotics](#); meetings with UK Government representatives and the NHS; public engagement through [The Mould that Changed the World](#) and global campaign partnerships through [Stop Superbugs](#)

The Society is a registered NIHR partner and serves, and is available to serve, as an implementation partner on large consortia research projects and RCTs.

Care Quality Commission (CQC)

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.

CQC's regulatory activity was modified during the early part of 2023 to support the NHS and social care during the winter ([CQC response to winter pressures](#)) which allowed us to focus on increasing capacity in care services and support hospital discharges. The CQC supported World Antimicrobial Awareness Week by promoting resources and messages with our operational teams. Adult social care inspection teams were briefed on the hydration pilots in care settings to reduce urinary tract infections and the relevance of this work to patient care.

The CQC is changing how it regulates services, information is available on our website ([How we will regulate](#)), introducing a single assessment framework for all services and new evidence categories. We will use a range of data sources to support our evidence, including antimicrobial use in primary and secondary care. We have been testing and modifying the assessment framework for Integrated Care Systems (ICS) [ICS Assessment](#). As part of this work, we have been collaborating with NHSE antimicrobial leads on governance at integrated care board level.

College of General Dentistry (CGDent)

During the World Antibiotic Awareness Week (WAAW) 2022, the College of General Dentistry (CGDent) coordinated 17 organisations to highlight the importance of working together to tackle AMR, with the message: "Everyone delivering and supporting oral healthcare has a role to play."

These organisation included: Association of Clinical Oral Microbiologists, Faculty of Dental Surgery of the Royal College of Surgeons of England (FDS RCS Eng), Association of Dental Hospitals, British Academy of Cosmetic Dentistry, British Association of Dental Nurses, British Association of Dental Therapists, British Association of Oral Surgeons, British Association of Private Dentistry, BDA, British Endodontic Society, British and Irish Society of Oral Medicine, BSAC, British Society of Dental Hygiene and Therapy, British Society of Periodontology and Implant Dentistry, the Faculty of Dental Surgery of the Royal College of Physicians and Surgeons of Glasgow and the Faculty of Dental Surgery of the Royal College of Surgeons of Edinburgh.

Together with FDS RCS Eng, CGDent also co-published a chairside synopsis of [Antimicrobial Prescribing in Dentistry: Good Practice Guidelines](#). The one-page synopsis summarises the recommended treatments for 7 types of infection, including indications for the use of antimicrobials, and the first-choice antimicrobial where use is indicated, with dosages and duration for adult patients.

CGDent has continued to deliver online professional development events about dental antibiotic prescribing, resistance and stewardship in its role to maintain standards for the general dental profession. These were free to view online for all dental professionals, with on-demand access to the recordings also available.

ESPAUR Dental Subgroup

The ESPAUR dental subgroup continued to meet after reconvening in 2021. The dental subgroup is composed of dental stakeholders who represent dental care commissioners and providers, regulatory organisations, professional and educational bodies. In 2022/23, the dental subgroup has reviewed the existing toolkit and then worked with a larger group of stakeholders to inform and pilot new additions to the toolkit. The new toolkit is expected to be published in 2023. The dental subgroup has also fed into the new 5-year NAP for AMR due to run from 2024 until 2029.

National Institute for Health and Care Excellence (NICE)

Following 2 successful pilot evaluations that were published in 2022, NICE has been working with NHSE and the DHSC to implement a routine subscription model for the purchase of antimicrobials that target difficult-to-treat multidrug-resistant pathogens. The proposed Antimicrobial Products Subscription Model would be the first of its kind and, if widely adopted internationally, would have the potential to provide the 'market pull' incentive to stimulate increased investment in the development of new antimicrobials.

The pilot project provided the first health economic quantification of the full value of 2 important antimicrobial products, by capturing the population health benefits that extend beyond the benefits for people receiving the drug. NHSE and NICE have subsequently developed a more pragmatic approach to determine the value of the contract payments that is anchored in the pilot economic modelling but shortens the time between products coming to market and contracts being in place. This approach uses clinical award criteria with a points-based scoring system.

The national bodies for the NHS in each devolved nation of the UK are participating in the subscription model, with NHSE initially acting as the lead authority running the procurement process and issuing the invitations to tender. NICE has been commissioned to provide expert clinical input to the assessment of product eligibility and establish a standing panel of clinical experts from across the UK to evaluate each product against the award criteria. The proposals detailing the procurement process and award criteria are currently undergoing a public consultation between July and October 2023. There has been a high level of international interest in the project and the project team is working with the DHSC Global and Public Health Group to collaborate with international partners in promoting similar models.

NICE worked with UKHSA (formerly PHE) to develop antimicrobial prescribing guidelines (APGs) for managing common infections. The guidelines offer evidence-based guidance for primary and secondary care and provide recommendations for appropriate antimicrobial use in the context of tackling AMR. A NICE Committee produced these guidelines which are jointly badged by both NICE and UKHSA. This work is now part of the overall guideline programme within NICE, and any updates to content will be done in accordance with NICE's surveillance and updates process. No updates were published in 2022 to 2023.

In January 2017, NICE published a guideline Antimicrobial stewardship (AMS): changing risk-related behaviours in the general population (NG63) aiming to change people's behaviour to reduce AMR. It also includes measures to prevent and control infection. This guidance is complementary to the NICE guideline on AMS: systems and processes for effective antimicrobial medicine use (NG15) which provides recommendations about how to correctly use antimicrobial medicines and the hazards associated with their overuse and misuse.

NICE work on COVID-19

Since March 2020, NICE has produced 25 COVID-19 rapid guidelines. These include guidelines on managing COVID-19, guidelines on service delivery during the pandemic and guidance on conditions which require the use of drugs that affect the immune response.

In March 2021, 7 of these original individual guidelines were integrated into one guideline: managing COVID-19 (NG191). The NICE COVID-19 team also developed guidance on the management of the long-term effects of COVID-19 and was responsible for maintaining and updating the NHSE&I specialty guides relating to COVID-19. NICE reviewed and updated the NICE COVID guidance using a 'living guidelines' approach.

The following workstreams in the COVID-19 team link into AMS activities:

Living guideline approach to the COVID-19 rapid guidelines

The suite of COVID-19 rapid guidelines underwent continuous review for emerging evidence that may warrant a change to recommendations. Emerging evidence was reviewed, the likely impact on extant recommendations was assessed by the COVID-19 expert panel. Any changes to recommendations were published typically within a 4-week timescale of the evidence becoming available.

Managing COVID-19

As part of creating the integrated guideline on managing COVID-19, guidance was updated on the use of antibiotics within the COVID-19 rapid guidelines managing suspected or confirmed pneumonia in adults in the community and antibiotics for pneumonia in adults in hospital. The panel decided that it was appropriate to refer to the existing NICE antimicrobial guidelines for the management of hospital and community acquired pneumonia (NG138 and NG139) Where secondary bacterial pneumonia was likely, then the antibiotic choices in the existing NICE APGs

apply, therefore providing clear and consistent guidance on choice of antibiotics and aiming to improve AMS.

Therapeutics process and links with Rapid C-19 initiative

NICE evidence reviews were used to help inform NHSE&I's commissioning policy on COVID-19. This allowed the development of guidance that linked with the priorities of managing COVID-19 in a rapid way. Recommending only those effective therapeutic interventions for the management of COVID-19 serves to reduce the inappropriate use of antibiotics where benefits are unlikely to be seen.

Published recommendations include those on the inappropriate use of azithromycin, doxycycline, and ivermectin in the treatment of COVID-19. Continuous surveillance was carried out during 2022 to 2023 but no additional antibiotics were reviewed. The evidence review on ivermectin underwent an update in June 2022 in the light of new evidence but the recommendation for this remained against its use to treat COVID-19 except as part of an ongoing clinical trial.

NICE also develops national guidance on new medical devices and diagnostics. The Medical Technologies Evaluation Programme published in 2021 to 2022 final positive guidance in 2 topics that are relevant to AMS: [ClearGuard](#) HD an antimicrobial barrier cap for use with central venous catheters in haemodialysis and [Plus Sutures](#) a range of synthetic, absorbable sutures that are either impregnated with or coated with triclosan, a purified medical grade antimicrobial. Guidance on [Faecal microbiota transplant](#) in people who have recurrent or refractory *Clostridioides difficile* infections is also in development. NICE also develops national guidance on new medical devices and diagnostics. The Medical Technologies Evaluation Programme published in 2021 to 2022 final positive guidance in 2 topics that are relevant to AMS: [ClearGuard](#) HD an antimicrobial barrier cap for use with central venous catheters in haemodialysis and [Plus Sutures](#) a range of synthetic, absorbable sutures that are either impregnated with or coated with triclosan, a purified medical grade antimicrobial. Guidance on [Faecal microbiota transplant](#) in people who have recurrent or refractory *Clostridioides difficile* infections is also in development.

The Diagnostics Assessment Programme also represents NICE on the NHSE AMR diagnostics programme board which brings together partners across the system to deliver England's diagnostic ambitions for AMR. Our Early Value Assessment pilot included an AMR-related topic by looking at novel tests for helping to diagnose [urinary tract infections](#).

NICE also develops national guidance on new medical devices and diagnostics. The Medical Technologies Evaluation Programme published in 2022 to 2023 final positive guidance on one topic that is relevant to AMS: [Faecal microbiota transplant](#) in people who have recurrent or refractory *C. difficile* infections, also further research recommendations on [UroShield for preventing catheter-associated urinary tract infections](#) were published. This device uses ultrasonic waves to reduce bacteria build up on indwelling catheters to reduce infections. [Kurin Lock for Blood Collection](#) is also in development, this is a blood collection device which has

potential to reduce the number of false positives in blood culture results, this is due to publish in February 2024.

The Diagnostics Assessment Programme also represents NICE on the NHSE AMR diagnostics programme board which brings together key partners across the system to deliver England's diagnostic ambitions for AMR. Our Early Value Assessment pilot included an AMR related topic by looking at novel tests for helping to diagnose [urinary tract infections](#).

Royal College of General Practitioners (RCGP)

The RCGP continues to host the TARGET toolkit. In addition, the RCGP incorporates AMS topics within the clinical learning programme.

Topics in 2022 to 2023 included:

- one-day essential online course Child Health, included ENT, ill child, childhood infections
- one-day essential online course Respiratory Health included AMR, acute respiratory infections in children, Influenza, scarlet fever and invasive group A Streptococci
- e-learning: Essential Knowledge Update including UTI, diagnosis and management in people under 16 years
- e-learning: Kawasaki disease updated
- Blog: Diphtheria

GPs have on-going access to prescribing and antimicrobial stewardship RCGP e-learning content, including vaccination, COVID-19, and common infection topics.

Royal College of Nursing (RCN)

The RCN continues to deliver its master's level Education programme on infection prevention and control (IPC) and using AMS competencies developed with the University of Cardiff as a framework for addressing nursing practice implications of managing and preventing AMR and infections as a result of antibiotic-resistant organisms. This programme is currently undergoing a review to incorporate UK and wider European learning from the COVID-19 pandemic. The RCN continues to support wider AMS programmes including ongoing review of Higher Education Institutes curricula on pre-registration nursing education and a feasibility study investigating the effect of educational interventions to support prescribing decisions by nurse prescribers.

As a stakeholder in broader health and social care programmes of work with implications for antimicrobial stewardship the RCN maintains its membership of the National Overprescribing Review Group, UK AMR diagnostics board in addition to ESPAUR.

Wider prevention activity remains focused on supporting nursing practice priorities, aligning and promoting RCN activity on climate change with AMR where appropriate.

Royal Pharmaceutical Society (RPS)

The Royal Pharmaceutical Society's vision is to become the world leader in the safe and effective use of medicine and we remain committed to the global strategy for AMR through the UK NAP and 20 year vision.

Our mission is to put pharmacy at the forefront of healthcare. From April 2022 to March 2023 our AMR activity has included:

Advisory group activity

The RPS Antimicrobial Expert Advisory Group (AmEAG) meets regularly and advises on AMR, infection prevention and management, AMS and any other issues that affect the pharmacy profession and the public. It provides a central point for requests for advice, expertise, sharing best practice and input and comment from government and other organisations.

Contribution to WAAW/ EEAD

As part of 2022 (WAAW/EAAD) we updated our AAMR and AMS pharmacy guide and resources webpages with useful resources and information to help promote learning.

Antibiotic Amnesty

We also updated our pages to promote this campaign and include areas on setting up and running an antibiotic amnesty, plus videos and content to download for ease of promotion.
Pharmacy consultations

We continue to respond to consultations relevant to AMR and AMS:

- International Pharmaceutical Federation (FIP) AMR Education case study submitted
- Call for Evidence on AMR future action plan submitted

Rx-info

Rx-info compiles, processes, standardises and reports secondary care medicines data on a daily basis to assist hospitals understand their medicines usage.

The Rx-info systems are used daily by all hospitals in England, Scotland and Northern Ireland, and the generated data supports antimicrobial surveillance across the hospital setting helping pharmacists, data scientists and doctors understand how they are performing in this essential task and benchmarking their progress.

In addition to the native IT systems a regular feed of standardised antimicrobial data has been provided to UKHSA as well as bespoke data to better understand antimicrobial usage for the winter group A *Streptococcus* outbreak, use of specialist commissioned broad-spectrum antimicrobials and continued Covid monitoring.

Specialist Pharmacy Service (SPS)

The SPS provided advice on [using solid oral dosage form antibiotics in children](#). This gives information about strategies to encourage children to swallow solid oral dosage forms, along with specific information about crushing or dispersing whole tablets or opening capsules of antibiotics. This 'off-label' practice may be required for a variety of reasons but was written particularly to support safe medicines use in patients with group A streptococcal infections.

In October 2022, as part of our '[On the Couch](#)' webinar series aimed at Primary Care colleagues, Dr Kieran Hand (AMR: National Pharmacy and Prescribing Clinical Lead, NHS England) outlined the current vision and strategy for antimicrobial stewardship from the NHSE AMR programme and asked for feedback from webinar attendees. A discussion with primary care pharmacy colleagues explored the challenges around the management of antibiotics in primary care and discussed potential strategies for meeting these challenges.

In conjunction with NHS England, SPS hosted an online mini conference on 7 March 2023 [Antimicrobial Stewardship \(AMS\): unlocking the potential](#)

Approximately 450 people registered for the event and either attended live or listened to the recording.

Expert speakers covered the following:

- the NHS England strategy and vision for Antimicrobial Prescribing and Medicines Optimisation (APMO) and progress so far
- the new data dashboards and standard reports that can help in clinical practice
- prompt Intravenous to Oral Switch (IVOS) and the NHS England CQUIN, including how it will benefit patients, health professionals, NHS trusts and health systems
- sharing learning and ideas to achieve prompt IVOS and successfully achieve the NHSE CQUIN

SPS continues to work with NHS England colleagues on the development of PGD templates to support care pathways which use antimicrobials. We are currently working with NHSE to develop PGD templates to support the supply of antimicrobials required within the Pharmacy First clinical pathways for the following conditions: sinusitis; sore throat; earache; infected insect bites; impetigo; shingles; and uncomplicated urinary tract infections in women (the PGD templates for treatment of UTI were published in January 2023).

As part of the NHS England Preventive Medicines in Pregnancy programme SPS has published a PGD template for benzylpenicillin for administration to individuals in labour where there has been an identified risk of early onset Group B Streptococcal (GBS) infection developing in the neonate.

In support of sexual and reproductive service, SPS developed a suite of PGD templates. Those used to treat chlamydia were reviewed, revised and published in January 2023. Those for the treatment of Bacterial vaginosis and trichomonas vaginalis, Neisseria gonorrhoeae were reviewed, revised and published in April 2023.

Veterinary Medicines Directorate (VMD) and Department for Environment, Food and Rural Affairs (DEFRA)

The latest [Veterinary Antimicrobial Resistance and Sales Surveillance \(VARSS\) report](#) presents data collected in 2021 and shows there is a continued downward trend in the use of veterinary antibiotics in the UK. Since 2014, sales of veterinary antibiotics for food producing animals have reduced by 55%, with the UK continuing to be one of the lowest users of veterinary antibiotics across Europe. These reductions accompany changes in veterinary prescribing and disease management practices throughout the livestock sectors, demonstrating how antibiotic stewardship has become an important feature of UK farm management, with a focus that “prevention of disease is better than cure”.

Importantly, veterinary sales of antibiotics classed as the highest priority of critical importance to human health (HP-CIAs), which includes third and fourth generation cephalosporins, colistin and fluoroquinolones, have continued to fall, with an 83% reduction in food producing animals since 2014, and now account for just 0.4% of total sales of veterinary antibiotics. This demonstrates the veterinary profession’s and agriculture industry’s continued commitment to protect these medicines in their sector stewardship plans and ensure they are only used as a last resort.

The VMD works closely with stakeholders across the animal sector to support collaborative efforts to reduce unnecessary antibiotic use, whilst maintaining animal health and welfare. This is exemplified by the, VMD funded, Farm Vet Champions initiative. This project is led by RCVS Knowledge, a charity partner of the veterinary profession’s regulatory body (Royal College of Veterinary Surgeons) and brings together a community of farm animal veterinary professionals to collaborate and share knowledge to embed good antibiotic prescribing principles and practices. This now includes an online SMART goals tool, to allow individual vets and veterinary practices to set goals and track progress, to help bring learning into practice.

The VARSS report also presents results from the 2 UK AMR surveillance programmes. First, is the Harmonised Monitoring Programme which reports on 4 internationally comparable

resistance indicators and provides a standardised way to assess progress made in addressing AMR across Europe. Results show that the UK has achieved some of the biggest reductions in resistance in Europe, with all indicators at more favourable levels than when monitoring began in 2014. The substantial reductions in antibiotic use achieved by the livestock sectors and veterinary profession since 2014 are likely to be behind the decreasing levels of resistance we are seeing. The second programme is Clinical Surveillance which tests for resistance in diagnostic samples by veterinarians and farmers. We have expanded the list of veterinary pathogens for which we are conducting gold-standard minimum inhibitory concentration (MIC) testing and so increasing our ability to detect emerging resistance issues in bacteria that cause disease in animals in the UK, helping to support responsible prescribing of veterinary antibiotics.

Integrated One Health surveillance of AMR is an ambition of the UK AMR National Action Plan. The VMD is facilitating cross-government working across human and animal health, food safety and the environment through the One Health Integrated Surveillance (OHIS) sub-group of DARC (Defra AMR Coordination group) to develop integrated AMR surveillance in the UK. In addition, the VMD is a partner organisation in the [PATH-SAFE](#) (Pathogen Surveillance in Agriculture, Food and the Environment) project, led by the Food Standards Agency (FSA), which aims to develop a model national genomic surveillance network and includes several projects on AMR across agri-food systems. In 2023, the VMD, in conjunction with UKHSA, will publish the latest One Health Report on AMR in animals, people, food, and the environment, which will underline the importance of an integrated approach to AMR surveillance and control.

The VMD are coordinating the development of Animal, Plant, Food and Environmental elements of the 2024 to 2029 AMR National Action Plan (NAP), which has commenced this year, and a series of engagement events and meetings are being held to collate evidence across policy areas and develop One Health commitments. Outputs from the OHIS group and PATH-SAFE, alongside other research and evidence, are being fed into the development of the new action plan.

In November 2022, VMD colleagues joined the UK delegation at the Third Ministerial Conference on AMR held in Muscat, Oman. This conference entitled 'AMR From Policy to One Health Action' welcomed health and agriculture ministers from around the globe, with the UK being represented by UK Special Envoy on AMR, Dame Sally Davies. The outcome of the meeting was the Muscat Manifesto which commits countries to targets on use of antibiotics in humans and animals and sets out commitments to develop and implement National Action plans and strengthen AMR and AMU surveillance.

Public Health Wales (PHW)

The HCAI, AMR and Prescribing (HARP) Programme, PHW, provides professional support to the NHS to reduce the burden of HCAIs and AMR across Wales. This is delivered through feedback of surveillance data for antimicrobial usage, resistance and HCAI to the NHS and Welsh Government as well as providing technical expertise in microbiology, AMS and IPC. The

HARP team supports and advises the Wales AMR and HCAI Steering Group, chaired by the Deputy CMO Wales, as well as the AMR and HCAI Delivery Boards, set up to deliver the UK AMR strategy in Wales.

As well as providing annual updates against the UK AMR NAP ambitions and the Welsh Government annual Welsh Health Circular targets, Public Health Wales also publishes antimicrobial usage via the Antibiotic Data Library for Wales, the 'Antibiotic Eye'. This data library is currently available to all health boards in Wales and provides quarterly primary care antimicrobial usage data down to individual practice level, as well as being aggregated at cluster, health board and All Wales levels. Monthly data is now being validated by PHW and the portal updated, and it is intended that this monthly data be published to the portal later in 2023. The resistance section of the data portal was launched in June 2023 and provides antimicrobial resistance data for a range of common pathogens, at cluster, health board and all-Wales levels in primary care and acute hospital, health board and all-Wales levels in secondary care. For HCAI surveillance, the HARP team provides the NHS and Welsh Government with a monthly dashboard of HCAI. Wales data is also provided to the UK AMR delivery board and WHO GLASS.

PHW provides a comprehensive, integrated microbiology service for Wales including a network of diagnostic laboratories, reference laboratories and an active genomics programme. Wales has a dedicated AMR Reference Laboratory (Specialist Antimicrobial Chemotherapy Unit), which provides molecular confirmation of AMR, including carbapenemase-producing Gram-negative bacteria. The unit analyse and report targeted surveillance on the mechanisms of resistance to third-generation cephalosporins in Gram-negatives, and drivers of carbapenem use.

The AMR delivery board has collaborated with Health Education and Improvement Wales (HEIW) to deliver a range of educational materials including an AMS module for all prescribers in Wales, mandated for all community pharmacist independent prescribers. HEIW have also sponsored the delivery of a range of webinars around AMR, AMS and common infections. Swansea University runs a specialist infection management course each November.

On-going initiatives in primary care include the addition of AMS related content into clinical messaging systems, the development of a good practice guide for back-up prescribing, the development of a UTI patient pathway to support appropriate diagnosis and treatment of UTI in primary care, and the development and delivery of dental AMS. In secondary care, the ARK chart has been successfully rolled out across all acute hospitals in Wales, an ARK / prescribing chart for patients in long term care is being tested, and a data portal for the audit and feedback of Start Smart then Focus and ARK is in development.

For EAAD / WAAW 2022, multi-disciplinary IV to Oral switch ward rounds were performed in most acute hospital sites, and 2 of these hospitals have now adopted these ward rounds routinely. In primary care, a social media campaign was run aimed at encouraging the appropriate use and disposal of antimicrobials.

Each November, the Welsh health boards also participate in a national point prevalence study of secondary care antimicrobial prescribing, and in 2022 the study included basic antimicrobial prescribing statistics, a comparison of RTI prescribing with the previous year, and an in-depth focus on UTI infections, including risk factors and management.

More information, including all our published reports, can be found on the HARP programme webpage.

Public Health Agency Northern Ireland

The Northern Ireland Public Health Agency (PHA) continues to support efforts to decrease MRSA bloodstream infections, CDI, Gram-negative blood stream infections and promote appropriate use of antimicrobials. While the Regional HCAI and AMS Improvement Board for Northern Ireland (chaired by PHA) remained paused due to pandemic pressures in 2022, the HCAI/AMR surveillance team in PHA continued routine surveillance including providing information about incidence of HCA infections and antimicrobial use to local healthcare trusts.

The Strategic Planning and Performance Group (SPPG), continued to promote responsible use of antibiotics as a priority, specifically around World Antibiotic Awareness Week sharing messages surrounding antibiotic resistance with SPPG staff and Family Practitioner Services (general practice, community pharmacy, dental and optometry). Messages included antibiotic resistance, antimicrobial stewardship, the importance of not treating common self-limiting conditions with an antibiotic, encouraging safe disposal of antibiotics and raising awareness of appropriate penicillin allergy labelling. In secondary care, work was undertaken to raise the profile of antimicrobial stewardship, including themed quizzes, newsletters, display stands and promotion via AMS conferences in local universities.

SPPG continued providing education and training to FPS on antimicrobial stewardship, appropriate use of antimicrobials and antimicrobial resistance. Other engagement work in 2022 included encouraging primary care practices to address antibiotic prescribing using the NI antimicrobial formulary and TARGET resources as an action point in their annual SPPG pharmacy adviser prescribing meetings. All antimicrobials newsletter supplements and links to resources were uploaded to the NI Formulary website to improve accessibility for FPS and the public.

Scottish One Health Antimicrobial Use and Antimicrobial Resistance (SONAAR)

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 in primary care and 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; the Scottish Microbiology and Virology Network (SMVN) 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 2022 report will be published in November 2023 and will be available online.

NHS England (NHSE)

The NHS England Antimicrobial Prescribing and Medicines Optimisation (APMO) team was established in 2021. Led by the National Antimicrobial Resistance (AMR) Pharmacy and Prescribing Clinical Lead, the team consists of a core national team, and regional Antimicrobial Stewardship (AMS) Leads in each of the 7 regions of the NHS in England. During 2022–2023 good progress has been made across all 3 areas of the APMO behaviour change strategy – Capability, Opportunity, and Motivation. These are enablers for national, regional, system, and place level improvements for the optimised use of antimicrobial medicines.

The section below provides a highlight of activities delivered by the team during 2022 to 2023:

Public and patient empowerment

A COPD Prevention of Exacerbation Toolkit (COPD-PET) has been developed to support the review of patients prescribed long term, or repeated courses, of antibiotics. The COPD-PET is being piloted within GP practices and a respiratory hub in the East of England. The pilot will evaluate patient outcomes, patient and staff satisfaction, and support consideration of adoption and spread in other regions if successful.

Workforce capacity and capability

An AMS workforce survey was carried out across all primary and secondary healthcare organisations in England. Education enablers and barriers were explored during the survey and focus groups. The insight generated will support review of AMS capacity and capability within organisations to strengthen AMS activities.

Working with UKHSA, all regional AMS leads have been trained to deliver TARGET train the trainer sessions, with training being disseminated to AMS leads within Integrated Care systems (ICS) and Integrated Care Boards (ICB).

NHS England have worked with the National AMS Pharmacy Education Group (NAPEG) to develop an undergraduate competency framework that is suitable for pharmacists qualifying as

prescribers, which can be used by schools of pharmacy to shape their curricula for initial education and training.

Knowledge mobilisation

To support AMS teams with improvement activities across policy, practice and research an AMS Evidence Observatory was set up. Led by NHS England, the Evidence Observatory's editorial team also consists of representation from UKHSA, NICE and Healthcare Improvement Scotland. Since its launch in July 2022, 9 e-bulletins have been published via the FutureNHS AMR workspace, highlighting 260 articles, and providing in depth spotlight reviews for a further 12 articles.

Alongside the e-bulletin, the first evidence bundle, with a focus on Penicillin Allergy De-labelling (PADL), was published in March 2023. An evidence bundle is a detailed review of the research evidence relating to a specific AMS topic.

During World Antimicrobial Awareness Week (WAAW), a series of daily webinars were delivered, with over 250 delegates registered to attend each session. A dedicated FutureNHS workspace was set up to allow registered users access to WAAW webinar recordings and associated resources, which have been accessed over 4000 times. Additionally, a co-signed letter from NHS England and UKHSA was sent to healthcare leaders in all care sectors to raise awareness of AMR and share messages and actions to support antimicrobial stewardship.

The Health and Social Care Act 2008: Code of Practice for Infection Prevention and Control has been updated to strengthen recommendations for optimising AMS, ensuring these are in line with best practice. The revised code was published in December 2022.

In collaboration with UKHSA, standard criteria for patient eligibility for antimicrobial intravenous-to-oral switch (IVOS) were derived and validated via a national consensus process.

Data-driven improvement

A focus has been to enable data-driven improvement providing healthcare systems with access to data to improve patient outcomes and population health. Three dashboards have been developed, tested, and launched during 2022 to 2023, with expert guidance from the APMO team:

The NHS England AMR dashboard

The NHS England AMR dashboard launched in February 2022. The dashboard provides a mechanism for the NHS to identify variation in the patterns of infection, treatment and patient outcomes across different care settings and pathways, with the ability to present clear and informative data – based on patient-level data from multiple sources. Users can view national, regional, system and local patterns of data and can disaggregate by specific demographics (age, ethnicity, sex and deprivation level).

[The NHS Model Health System Antimicrobial Resistance dashboard](#)

The NHS Model Health System Antimicrobial Resistance dashboard replaced the previous RightCare UTI dashboard. The AMR content includes a variety of metrics for 3 infection pathways: urinary tract infection, skin and soft tissue infection, and gastrointestinal infection. Metrics are reported for NHS England regions and ICBs. The dashboard identifies variation within and between organisations, and reports trends over time.

[The PrescQIPP Optimising Antimicrobial use dashboard](#)

The [PrescQIPP Optimising Antimicrobial use](#) dashboard uses routine primary care antimicrobial prescribing data accessed from NHSBSA ePACT2 analysis to report novel metrics that can be used to optimise duration of antibiotic use in primary care. Optimising duration of antibiotic use supports delivery of the UK 5-year National Action Plan ambition to reduce antimicrobial use in humans by 15% by 2024. Metrics have been developed by the NHS England AMR Programme using NICE antimicrobial stewardship guidance content for dose and duration of selected antibiotic formulations which are reported monthly at a variety of NHS organisational levels. There are 3 antibiotic metrics in current use (reducing from 7 day to a 5-day duration): amoxicillin 500mg capsules; doxycycline 100mg capsules; and flucloxacillin 500mg capsules.

Digital and medical technology

In-depth research was undertaken to better understand how the use of existing GP digital IT systems and secondary care digital IT systems, and their bolt-on clinical decision support tools, can support safe and effective AMS. Six focus groups and 3 in-depth interviews were conducted with healthcare staff working in primary and secondary care during December 2022.

Additionally, 419 responses were received to a national stakeholder survey, which was open for 3 weeks during February 2023. The findings of this research will inform future work of the Digital Vision workstream.

Policy and commissioning

NHS England policy and commissioning schemes are described in detail within chapter 5 of this report.

A national survey of Outpatient Parenteral Antimicrobial Therapy (OPAT) services in England was undertaken as part of the NHS England Infusions and Special Medicines Programme. The aim of the survey was to gather information on the current landscape of OPAT services in England and identify variation in access to services. 116 trusts responded to the survey, with 100 trusts stating they delivered an OPAT service.

Supportive oversight

NHS England regional AMS leads have been in post for a year. They have established active and visible leadership roles within regional AMS committees, in many cases sub-committees of the Regional Medicines Optimisation Committee (RMOC), to promote collaboration and sharing of best practice. The regional AMS leads have also joined or contributed to the establishment of

multi-professional regional AMR committees in collaboration with regional medical directors and chief pharmacists, regional IPC leads, and regional healthcare scientist diagnostics leads.

AMR Senior Responsible Officers (SROs) have been appointed in the 42 Integrated Care Systems in England. Regional AMS leads have been working with SROs on the design and implementation of governance systems and processes to ensure effective antimicrobial stewardship, and the drafting of system plans to address AMR, including workforce plans.

To support oversight and improvement, AMS and IPC data packs for ICB AMS leads have been developed. These were initially created by the South East regional team for use within the region to highlight performance against national AMS metrics (for example, the NHS Oversight Framework and NHS Standard Contract) and other indicators (for example, antibiotic prescribing for UTIs). The reports were designed to bring together performance metrics in a single report. As a result of excellent user feedback, the data packs have been expanded to cover all ICBs nationally and include ICB performance against healthcare-associated infection goals. The reports were first published in September 2022 for the 6 South East ICBs, and available to all ICBs nationally since January 2023. During this period, 150 reports have been produced and disseminated.

References

1. Budd E. Advisory Committee on Antimicrobial Prescribing, Resistance and Healthcare Associated Infection Annual report 2015
2. DHSC, editor. 'Tackling antimicrobial resistance 2019 to 2024: the UK's 5-year national action plan' January 2019
3. Public Health England (PHE). '[English Surveillance Programme for Antimicrobial Utilisation and Resistance \(ESPAUR\) report, 2019 to 2020](#)' 18 November 2020.
4. UKHSA. 'English surveillance programme for antimicrobial utilisation and resistance (ESPAUR) report 2020 to 2021 (2021)
5. UKHSA. 'English surveillance programme for antimicrobial utilisation and resistance (ESPAUR) report 2021 to 2022' (2022)
6. Cassini A, Hogberg LD, Plachouras D, Quattrocchi A, Hoxha A, Simonsen GS and others. 'Attributable deaths and disability-adjusted life-years caused by infections with antibiotic-resistant bacteria in the EU and the European Economic Area in 2015: a population-level modelling analysis' *Lancet Infectious Disease* 2019: volume 19, pages 56 to 66
7. UKHSA (2023). 'Quarterly epidemiological commentary: mandatory Gram-negative bacteraemia, MRSA, MSSA and CDI infections (data up to October to December 2022)'
8. PHE. 'New statutory duty on reporting results of antimicrobials susceptibility testing' *Health Protection Report* 2020
9. UKHSA (2022). 'Quarterly laboratory surveillance of acquired carbapenemase-producing Gram-negative bacteria in England: October 2020 to December 2021'
10. Chen Z, Fang H, Wang L, Sun F, Wang Y, Yin Z, and others. 'IMP-1 encoded by a novel Tn402-like class 1 integron in clinical *Achromobacter xylosoxidans*, China' *Scientific Reports* 2014: volume 4, page 7,212
11. Manohar P, Leptihn S, Lopes BS, Nachimuthu R. 'Dissemination of carbapenem resistance and plasmids encoding carbapenemases in Gram-negative bacteria isolated in India' *JAC Antimicrobial Resistance* 2021: volume 3, issue 1, dlab015
12. Vali P, Shahcheraghi F, Seyfipour M, Zamani MA, Allahyar MR, Feizabadi MM. 'Phenotypic and genetic characterization of Carbapenemase and ESBLs producing Gram-negative bacteria (GNB) isolated from patients with cystic fibrosis (CF) in Tehran Hospitals' *Journal of Clinical and Diagnostic Research* 2014: volume 8, issue1, pages 26 to 30
13. Yamamoto M, Matsumura Y, Gomi R, Matsuda T, Tanaka M, Nagao M and others. 'Interspecies dissemination of a mobilizable plasmid harboring bla_{IMP}-19 and the possibility of horizontal gene transfer in a single patient' *Antimicrobial Agents and Chemotherapy* 2016: volume 60, issue 9, pages 5,412 to 5,419
14. Guy R, Henderson KL, Coelho J, Hughes H, Mason EL, Gerver SM and others. 'Increase in invasive group A streptococcal infection notifications, England, 2022' *Eurosurveillance* 2023: volume 28, issue 1

15. Guy R, Henderson KL, Coelho J, Hughes H, Mason EL, Gerver SM. 'Post-pandemic surge in group A streptococcal infections in children in England' European Society of Clinical Microbiology and Infectious Diseases 2023
16. Turnidge J, Kahlmeter G, Canton R, MacGowan A, Giske CG, European Committee on Antimicrobial Susceptibility. 'T. Daptomycin in the treatment of enterococcal bloodstream infections and endocarditis: a EUCAST position paper' Clinical Microbiological Infection 2020: volume 26, issue 8, pages 1,039 to 1,043
17. Unemo M, Lahra MM, Escher M, Eremin S, Cole MJ, Galarza P and others. 'WHO global antimicrobial resistance surveillance for *Neisseria gonorrhoeae* 2017 to 2018: a retrospective observational study' Lancet Microbe 2021: volume 2, issue 11, pages e627 to e36
18. UKHSA. '[Surveillance of antimicrobials resistance in *Neisseria gonorrhoeae*, 2016](#)'
19. Govorkova EA, Takashita E, Daniels RS, Fujisaki S, Presser LD, Patel MC and others. 'Global update on the susceptibilities of human influenza viruses to neuraminidase inhibitors and the cap-dependent endonuclease inhibitor baloxavir, 2018 to 2020' Antiviral Research 2022: volume 200, page 105,281
20. Noedl H, Se Y, Sriwichai S, Schaecher K, Teja-Isavadharm P, Smith B and others. 'Artemisinin resistance in Cambodia: a clinical trial designed to address an emerging problem in Southeast Asia' Clinical Infectious Diseases 2010: volume 51, issue 11, pages e82 to e89
21. Arie F, Witkowski B, Amaratunga C, Beghain J, Langlois AC, Khim N and others. 'A molecular marker of artemisinin-resistant *Plasmodium falciparum* malaria' Nature 2014: volume 505, issue 7,481, pages 50 to 55
22. Menard D, Khim N, Beghain J, Adegnik AA, Shafiul-Alam M, Amodu O, and others. 'A worldwide map of *Plasmodium falciparum* K13-propeller polymorphisms' New England Journal of Medicine 2016: volume 374, issue 25, pages 2,453 to 2,464
23. Uwimana A, Legrand E, Stokes BH, Ndikumana JM, Warsame M, Umulisa N and others. 'Emergence and clonal expansion of in vitro artemisinin-resistant *Plasmodium falciparum* kelch13 R561H mutant parasites in Rwanda' Nature Medicine 2020: volume 26, issue 10, pages 1,602 to 1,608
24. Balikagala B, Fukuda N, Ikeda M, Katuro OT, Tachibana SI, Yamauchi M, and others. 'Evidence of artemisinin-resistant malaria in Africa' New England Journal of Medicine 2021: volume 385, issue 13, pages 1,163 to 1,171
25. WHO Collaborating Centre for Drug Statistics and Methodology. '[Guidelines for ATC Classification and DDD Assignment](#)' Oslo, Norway 2003
26. UKHSA (2023). '[Surveillance of influenza and other seasonal respiratory viruses in winter 2021 to 2022](#)'
27. Bou-Antoun S. Age-related decline in antibiotic prescribing for uncomplicated respiratory tract infections in primary care in England following the introduction of a national financial incentive (the Quality Premium) for health commissioners to reduce use of antibiotics in the community: an interrupted time series analysis' Journal of Antimicrobial Chemotherapy 2018: volume 73, issue 10, pages 2,883 to 2,892

28. UKHSA (2022). [‘Quarterly epidemiology commentary: mandatory Gram-negative bacteraemia, MRSA, MSSA and C. difficile infections data \(October 2020 to December 2022\)’](#)
29. Dolk FCK, Pouwels KB, Smith DRM, Robotham JV, Smieszek T. ‘Antibiotics in primary care in England: which antibiotics are prescribed and for which conditions?’ Journal of Antimicrobial Chemotherapy 2018: volume 73, supplement 2, pages :ii2 to ii10
30. Falola A, Demirjian A, Thompson W, Brown CS, Gerver S, Bou-Antoun S. ‘The impact of COVID-19 national restrictions on dental antibiotic dispensing trends and treatment activity in England: January 2016 to July 2021’ JAC Antimicrobial Resistance 2023: volume 5, issue 4, page :dlad081
31. Budd E and others. ‘Adaptation of the WHO essential medicines list for national antibiotic stewardship policy in England: being AWaRe.’ Journal of Antimicrobial Chemotherapy 2019: volume 74, issue 11, pages 3,384 to 3,389
32. NHS England (2016). [‘Commissioning for Quality and Innovation \(CQUIN\) Guidance for 2017 to 19’](#)
33. NHS England (2022). [‘NHS Standard contract 2022 to 2023’](#)
34. UKHSA. [‘AMR local indicators’](#)
35. NICE. [‘Pneumonia \(hospital-acquired\): antimicrobial prescribing NG139’](#)
36. Chemotherapy BSfA. [‘DH advises on Piperacillin-Tazobactam infection supply problems 2017’](#)
37. Medicines and Healthcare products Regulatory Agency (MHRA) (2022). [‘Central Alerting System CMO Messaging’](#)
38. UKHSA. [‘UK Coronavirus Dashboard: the official UK government website for data and insights on coronavirus \(COVID-19\)’](#)
39. UKHSA. [‘Hepatitis C in the UK 2023: working to eliminate hepatitis C as a public health threat 2023’](#)
40. Thomson K, Berry R, Robinson T, Brown H, Bamba C, Todd A. An examination of trends in antibiotic prescribing in primary care and the association with area-level deprivation in England. BMC Public Health. 2020;20(1):1148.
41. Adekanmbi V, Jones H, Farewell D, Francis NA. Antibiotic use and deprivation: an analysis of Welsh primary care antibiotic prescribing data by socioeconomic status. J Antimicrob Chemother. 2020;75(8):2363-71.
42. Curtis HJ, Walker AJ, Mahtani KR, Goldacre B. Time trends and geographical variation in prescribing of antibiotics in England 1998-2017. J Antimicrob Chemother. 2019;74(1):242-50.
43. Royal College of General Practitioners (2023). [TARGET antibiotics toolkit hub](#)
44. Public Health England (2013). ‘Advisory Committee on Antimicrobial Resistance and Healthcare Associated Infection (ARHAI): Fourth Annual Report, February 2012 to March 2013’
45. Atkins L, Francis J, Islam R, O’Connor D, Patey A, Ivers N, and others. ‘A guide to using the Theoretical Domains Framework of behaviour change to investigate implementation problems’ Implementation Science 2017: volume 12, issue 1, page 77

46. Michie S, Van Stralen MM, West R. 'The behaviour change wheel: a new method for characterising and designing behaviour change interventions' *Implementation Science* 2011: volume 6, issue 1, page 42
47. Accurx. [Florey: Questions for UTI questionnaire](#) (partnered - TARGET) 2023
48. Sonnex K, Thornley T, Fleming N, Lakha A, Lecky DM, Pillay I and others. 'Perceived current and future roles of UK-based community pharmacy professionals in the long-term management of acne' *Exploratory Research in Clinical and Social Pharmacy* 2023: volume 11, page 100310
49. Davey P, Marwick CA, Scott CL, Charani E, McNeil K, Brown E and others. 'Interventions to improve antibiotic prescribing practices for hospital inpatients' *Cochrane Database System Review* 2017: volume 2, issue 2, page CD003543
50. MacDougall C, Polk RE. 'Antimicrobial stewardship programs in health care systems' *Clinical Microbiology Review* 2005: volume 18, issue 4, pages 638 to 656
51. Schuts EC, Hulscher M, Mouton JW, Verduin CM, Stuart J, Overdiek H and others. 'Current evidence on hospital antimicrobial stewardship objectives: a systematic review and meta-analysis' *Lancet Infectious Diseases* 2016: volume 16, issue 7, pages 847 to 856
52. Michie S, van Stralen MM, West R. 'The behaviour change wheel: a new method for characterising and designing behaviour change interventions' *Implementation Science* 2011, volume 6, issue 42
53. Powell BJ, Waltz TJ, Chinman MJ, Damschroder LJ, Smith JL, Matthieu MM and others. 'A refined compilation of implementation strategies: results from the Expert Recommendations for Implementing Change (ERIC) project' *Implementation Science* 2015: volume 10, issue 1, page 21
54. FutureLearn. [TARGET Antibiotics: Prescribing in Primary Care 2023](#)
55. Ministry of Housing CLG. ['English indices of deprivation 2019'](#). In: Ministry of Housing CLG
56. Noar SM. 'An audience–channel–message–evaluation (ACME) framework for health communication campaigns' *Health Promotion Practice* 2012: volume 13, issue 4, pages 481 to 488
57. Dekker ARJ, van der Velden AW, Luijken J, Verheij TJM, van Giessen A. 'Cost-effectiveness analysis of a GP and parent directed intervention to reduce antibiotic prescribing for children with respiratory tract infections in primary care' *Journal of Antimicrobial Chemotherapy* 2019: volume 74, issue 4, pages 1,137 to 1,142
58. Mamun A, Zhao B, McCabe M, Dreher K, Otterstatter M, Smith N, and others. 'Cost-benefit analysis of a population-based education program on the wise use of antibiotics' *Canadian Journal of Public Health* 2019: volume 110, issue 6, pages 732 to 740
59. D'Hulster E, De Burghgraeve T, Luyten J, Verbakel JY. 'Cost-effectiveness of point-of-care interventions to tackle inappropriate prescribing of antibiotics in high- and middle-income countries: a systematic review' *Journal of Antimicrobial Chemotherapy* 2023: volume 78, issue 4, pages 893 to 912
60. Wubishet BL, Merlo G, Ghahreman-Falconer N, Hall L, Comans T. 'Economic evaluation of antimicrobial stewardship in primary care: a systematic review and quality assessment' *Journal of Antimicrobial Chemotherapy* 2022: volume 77, issue 9, pages 2,373 to 2,388

61. Painter C, Faradiba D, Chavarina KK, Sari EN, Teerawattananon Y, Aluzait K and others. 'A systematic literature review of economic evaluation studies of interventions impacting antimicrobial resistance' *Antimicrobial Resistance and Infection Control* 2023: volume 12, issue 1, page 69
62. Coast J, Smith R, Karcher AM, Wilton P, Millar M. 'Superbugs II: how should economic evaluation be conducted for interventions which aim to contain antimicrobial resistance?' *Health Economics* 2002: volume 11, issue 7, pages 637 to 647
63. [Advisory Committee on Antimicrobial Prescribing Resistance and Healthcare Associated Infection](#)
64. Barchitta M, Quattrocchi A, Maugeri A, La Rosa MC, La Mastra C, Basile G and others. 'The "Obiettivo Antibiotico" campaign on prudent use of antibiotics in Sicily, Italy: the pilot phase' *International Journal of Environmental Research and Public Health* 2020: volume 17, issue 9, page 3,077
65. Morgan BL, Bettencourt H, May L. 'Interrupted time-series analysis to evaluate the impact of a behavioral change outpatient antibiotic stewardship intervention' *Antimicrobial Stewardship and Healthcare Epidemiology* 2021: volume 1, issue 1, page e37
66. Khoshgoftar M, Zamani-Alavijeh F, Kasaian N, Shahzamani K, Rostami S, Nakhodian Z, and others. 'The effect of public health educational campaign regarding antibiotic use and microbial resistance on knowledge, attitude, and practice in the Iran' *Journal of Education and Health Promotion* 2021: volume 10
67. Hayes C, Young V, Brown C, Touboul Lundgren P, Gennimata D, Holt J and others. 'International promotion of e-Bug, an infection prevention and control educational intervention: survey of partners across 14 countries' *JAC Antimicrobial Resistance* 2020: volume 2, issue 1, page :dlaa003
68. Bhattacharya A, Hopkins S, Sallis A, Budd EL, Ashiru-Oredope D. 'A process evaluation of the UK-wide Antibiotic Guardian campaign: developing engagement on antimicrobial resistance' *Journal of Public Health* 2017: volume 39, issue 2, pages e40 to e47
69. Frey E, Bonfiglioli C, Brunner M, Frawley J. 'Parents' use of social media as a health information source for their children: a scoping review' *Academic Pediatrics* 2022: volume 22, issue 4, pages 526 to 539
70. Zowawi HM, Abedalthagafi M, Mar FA, Almalki T, Kutbi AH, Harris-Brown T, and others. 'The potential role of social media platforms in community awareness of antibiotic use in the Gulf Cooperation Council States: luxury or necessity?' *Journal of Medical Internet Research* 2015: volume 17, issue 10, page e3,891
71. Andersen B, Hair L, Groshek J, Krishna A, Walker D. 'Understanding and diagnosing antimicrobial resistance on social media: a yearlong overview of data and analytics' *Health Communication* 2019: volume 34, issue 2, pages 248 to 258
72. Cumbras-Sánchez MJ, Hermoso R, Iñiguez D, Paño-Pardo JR, Bandres MÁA, Martinez MPL. 'Qualitative and quantitative evaluation of the use of Twitter as a tool of antimicrobial stewardship' *International Journal Of Medical Informatics* 2019: volume 131, page 103,955
73. Volkmer I (2021). 'Social media and COVID-19: a global study of digital crisis interaction among Gen Z and millennials'
74. Association BI. ['Investigation of sepsis in adult hospital Patients'](#)

Acknowledgements

An asterix (*) denotes the chapter leads.

Executive summary

Tehreem Mohiyuddin*, Diane Ashiru-Oredope*, Susan Hopkins*, Russell Hope, Colin Brown.

Chapter 1. Introduction

Fatima Dalal, Susan Hopkins.

Chapter 2. Antimicrobial resistance

Katherine Henderson*, Hannah Higgins, Emily Mason, Ben Simmons, Emma Budd, Rebecca Guy, Katie Hopkins, Daniele Meunier, Laura Maynard-Smith, Colin Brown, Russell Hope, Susan Hopkins, Alicia Demirjian, Mariyam Mirfenderesky*.

Chapter 3. Antimicrobial consumption

Sabine Bou-Antoun*, Angela Falola, Emma Budd, Hanna Squire, Colin Brown, Russell Hope, Susan Hopkins, Berit Muller-Pebody, Alicia Demirjian*.

Chapter 4. Antimicrobial stewardship

Ellie Gilham*, Catherine Hayes*, Donna Lecky, Luke O'Neil, Eirwen Sides, Emily Cooper, Fionna Pursey, Ruth Riley, Tanya Miah, Kimberley Sonnex, Abimbola Ayorinde, Diane Ashiru-Oredope*

Chapter 5. NHS England: improvement and assurance schemes

Sabina Khanom*, Elizabeth Beech, Jeff Featherstone, Sejal Parekh, Naomi Fleming, Philip Howard, Laura Whitney, Kieran Hand*.

Chapter 6. Professional education and training and public engagement

Eirwen Sides*, Catherine Hayes, Jordan Charlesworth, Diane Ashiru-Oredope, Ellie Gilham, Abimbola Ayorinde, Emily Cooper, Brieze Read, Sarah Leaver, Donna Lecky*.

Chapter 7. Research

Emily Agnew*, Juliet Allibone, Amelia Andrews, Diane Ashiru-Oredope, Joanna Bacon, Simon Clark, Michelle Cole, Emily Cooper, Jackie Gibbey, Ellie Gilham, Rebecca Guy, Katherine Henderson, Hannah Higgins, Katie Hopkins, Smita Kapadia, Donna Lecky, Michael Maynard-Smith, Ginny Moore, Aysha Roohi, Eirwen Sides, Mark Sutton, Stephen Taylor, Steve Thomas, Jane Turton, Julie Robotham*.

Chapter 8. Stakeholder engagement

Carry Triggs-Hodge*, Elaine Boylan, Nicholas Brown, Mary Collier, Julia Lacey, Judith Ewing, Chris Nugent, Tracey Guise, Rose Gallagher, Kieran Hand, Martin Llewelyn, William Malcolm, Sannah Malik, Nicholas Reid, Tracy Rogers, Sabina Khanom, Wendy Thompson, Jonathan Underhill, Fiona Watson, Rose Gallagher, Tessa Lewis, Aisling Glennie, Diane Ashiru-Oredope*.

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Contributors

Chapter 1. Introduction

Russell Hope, Colin Brown, Diane Ashiru-Oredope.

Chapter 2. Antimicrobial resistance

Gauri Godbole, Grace King, Christopher Jones, Elizabeth Johnson, Daniel Bradshaw, Tamy Mbisa, Peter Chiodini, Colin Sutherland, Katja Hoschler, Angie Lackenby, Joyeeta Palit, Eliza Alexander.

Chapter 3. Antimicrobial consumption

Peter Chiodini, Colin Sutherland, Rachel Freeman, Chris Pilsbury.

Chapter 4. Antimicrobial stewardship

Iman Ghosh, Junaid Shaikh, Victoria Adetunji, Anna Brown, Mary Jordan, Daniel Todkill, Tracey Thornley, Naomi Fleming, Alisha Lakha, Indira Pillay, Shazia Patel, Claire Anderson, Matthew Boyd.

Chapter 5. NHS England: improvement and assurance schemes

Conor Jamieson, Gillian Damant, Philip Howard, Laura Whitney, Preety Ramdutt, Monsey McLeod, Fiona Marshall, Sarah Newsome, Hugh Attwood, Alishah Lakha, Sam Kelly, Amanda Ridgeway, Cleo Gurbuz, Diane Ashiru-Oredope, Donna Lecky, Sabine Bou-Antoun, Emma Budd, NHS Business Services Authority, Rx-info.

Chapter 6. Professional education and training and public engagement

Fionna Pursey, Magda Hann, Claire Neill, Gillian Hayes, Rose Hadden, Sarah Tonkin-Crine, Nicola Pearce-Smith, Vanessa Carter, Mary Jordan, Iman Ghosh, Junaid Shaikh, Victoria Adetunji, Anna Brown, Dan Todkill.

Chapter 7. Research

None.

Chapter 8. Stakeholder engagement

NHS England AMR Programme.

About the UK Health Security Agency

The UKHSA is responsible for protecting every member of every community from the impact of infectious diseases, chemical, biological, radiological and nuclear incidents and other health threats. We provide intellectual, scientific and operational leadership at national and local level, as well as on the global stage, to make the nation health secure.

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