English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR)

Report 2019 to 2020
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Executive summary

The incidence of bloodstream infection in key species has increased 17% between 2015 and 2019. This change is primarily driven by the Gram-negative bacterial species *Escherichia coli* and *Klebsiella pneumoniae* and the Gram-positive bacterial genera *Enterococcus* spp.

There has been a 32% increase in the estimated number of antibiotic resistant bloodstream infections from key bacterial species between 2015 and 2019.

Twenty-one out of 100 people with bacteraemia caused by one of the bacterial species under surveillance will have a bacteraemia caused by bacteria resistant to at least one key therapeutic antibiotic. This leads to an estimated 65,162 antibiotic resistant severe infections in 2019; equivalent to 178 new antibiotic resistant infections per day.

Following the closure of the Electronic Reporting System (ERS) for the enhanced surveillance of carbapenemase producing Gram-negative bacteria in April 2019, Public Health England (PHE) has been supporting diagnostic laboratories to establish reporting of locally identified acquired carbapenemase producers to its national microbiology database, the Second Generation Surveillance System (SGSS).

To improve the surveillance of carbapenemase producers (including carbapenemase-producing Enterobacteriaceae (CPE)) PHE worked closely with the Department of Health and Social Care (DHSC) to add ‘acquired-carbapenemase-producing Gram-negative bacteria’ to the list of causative agents under Schedule 2 of the Health Protection (Notifications) Regulations 2010. The submission was presented to and approved by Ministers on 6 July 2020; the change in legislation is effective from 1 October 2020.

A full draft of the ‘Framework of actions to contain carbapenemase-producing Enterobacterales’ was published for consultation on 7 January 2020. The consultation closed on 14 February 2020, with over 300 comments received during the consultation period. The CPE Framework was published on 30 September 2020.

Antibiotic consumption has been falling since the peak in 2014. From 2015 to 2019, the total use decreased from 19.4 to 17.9 defined daily doses (DDDs) per 1,000 inhabitants per day.

Most antibiotics were prescribed in general practices; although consumption in this setting as well as in the dental sector has continued to decrease. Hospital and other community settings saw increases in usage.

Items prescribed in the community continued to decline, from 1.9 to 1.7 items per 1,000 inhabitants per day. On average, there were 8.6 DDDs per item, per 1,000 inhabitants per day, in 2019.

Antibiotic use in hospitals (by hospital admissions) increased by 3.5% over the last 5 years.

In 2019/20 the National Health Service (NHS) Oversight Framework and NHS Standard Contract had positive impacts on antibiotic prescribing in Clinical Commissioning Groups (CCGs) and NHS acute Trusts respectively.

Half (50%) of CCGs met or exceeded the national target to reduce antibacterial items/STAR-PU to at or below 0.965. The majority (90%) of CCGs met or exceeded the national targets to reduce the proportion of co-amoxiclav, cephalosporins and quinolones to ≤10%. Both measures are improvements upon the previous financial year.

In 2019/20 43 (30%) acute NHS Trusts met or exceeded the NHS Standard Contract requirement to deliver a 1% or greater reduction in total antibiotic consumption from their 2018 calendar year baseline value.

The Treat Antibiotics Responsibly, Guidance, Education, Tools (TARGET) antibiotics toolkit suite of antimicrobial stewardship (AMS) resources hosted on the Royal College of General Practitioners website remains the most accessed section of their website throughout 2019/20. The ‘Leaflets for Patients’ section and ‘Urinary Tract Infection (UTI) Resource show a 3.5-fold increase in visits compared to the previous year.

Self-Reported Antimicrobial Stewardship Practices in Primary Care showed an increase in clinicians engaging in positive AMS practices since the previous assessment including; using patient-facing resources (94%, increase 23%), conducting antibiotic audits in the last 2 years (98%, increase 53%) and keeping written records and action plans (81%, increase 19%).

Imperial College London in collaboration with PHE trialled the TARGET Treating Your Infection patient information leaflets in the community pharmacy setting. Key findings included; 25% of service users with urinary symptoms had sought help first from a pharmacist and 65% of the service users were comfortable discussing their urinary symptoms in private settings with pharmacists.
The assessment of United Kingdom (UK) healthcare worker (HCW) knowledge, attitudes and behaviour on antibiotics had 2,404 participants. 80% of healthcare workers agreed that guidelines on managing infections were easily accessible. 68% of healthcare workers felt they had easy access to the materials needed to give advice on prudent antibiotic use and antibiotic resistance.

Survey on antimicrobial prescribing in private dental practice in the Thames Valley found that the proportion of antibiotic prescribing by drug is similar to that of NHS prescribing across England and in Thames Valley. In the last national adult dental health survey, 27% of respondents reported that type of dental service that they had used for their last completed course of treatment was private dental care.

The TARGET Train the trainer antimicrobial stewardship programme to develop accredited TARGET trainers was established in 2019. The first four workshops resulted in newly accredited trainers cascading the AMS training to further 11 areas / 151 prescribers.

During 2019, the Antibiotic Guardian (AG) campaign website has been visited 82,992 times, this resulted in 9,289 pledges from 146 countries. In collaboration with Africa CDC, the Africa AG page was launched, and the Australia page was launched in collaboration with Agriculture Victoria.

In 2019/20 Health Education England (HEE) antimicrobial resistance (AMR) Innovation awarded funding for the second consecutive year. This included funding for the rollout of a previous Innovation fund project, where the Royal Pharmaceutical Society (RPS) ran pharmacist AMS training. In the first year a total of 19 improvement projects in primary (6) and secondary (13) care were undertaken by learners, addressing key areas of AMS.

The keeping antibiotics working campaign ran for its third consecutive year. Campaign research found public awareness is high, with 83% of their audience agreeing that “taking antibiotics when you don’t need them, puts you and your family at risk of antibiotic resistant infections”.

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Infographic 1. ESPAUR Oversight Group

ESPAUR: English Surveillance Programme for Antimicrobial Utilisation and Resistance

Multi-professional and Multi-organisation group led by PHE

All devolved administrations, lay representation and 19 member organisations

53 author contributions (2019 report)

6 reports since established in 2013

107 peer review publications of projects that featured in ESPAUR report between 2013 and 2019
Infographic 2. The burden of infection in numbers and the burden of antibiotic resistance

**The burden of infection in numbers**

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases</td>
<td>75,231</td>
<td>81,683</td>
<td>83,849</td>
<td>85,832</td>
<td>87,890</td>
</tr>
</tbody>
</table>

- **an INCREASE of 16.9%**

  *In key pathogen* Bloodstream infection (BSI) since 2015

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases</td>
<td>13,671</td>
<td>14,840</td>
<td>16,180</td>
<td>17,469</td>
<td>18,110</td>
</tr>
</tbody>
</table>

- **an INCREASE of 32.5%**

  *in resistant† key pathogen BSI since 2015*

**The burden of antibiotic resistance**

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Susceptible</td>
<td><img src="image1" alt="Susceptible 2015" /></td>
<td><img src="image2" alt="Susceptible 2019" /></td>
</tr>
<tr>
<td>Resistant†</td>
<td><img src="image3" alt="Resistant 2015" /></td>
<td><img src="image4" alt="Resistant 2019" /></td>
</tr>
</tbody>
</table>

- **an INCREASE of 2.4%**

  *in the proportion of resistant key pathogen BSI since 2015*

  This means that **21 out of 100** people with a key pathogen BSI had a resistant infection in 2019

---

* key pathogens include: *E. coli*, *K. pneumoniae*, *K. oxytoca*, *Acinetobacter* spp. *Pseudomonas* spp., *Enterococcus* spp., *S. aureus* and *S. pneumoniae*.

† *E. coli*, *K. pneumoniae* and *K. oxytoca*: resistant to any of: carbapenems, third-generation cephalosporin, aminoglycosides or fluoroquinolones; *Acinetobacter* spp: resistant to aminoglycosides and fluoroquinolones, or carbapenems; *Pseudomonas* spp, resistant to three or more antimicrobial groups, or carbapenems; *Enterococcus* spp. resistant to glycopeptides; *S. aureus* resistant to meticillin; *S. pneumoniae* resistant to penicillin and macrolides, or penicillin.
Infographic 3. Total consumption of antibiotics

Total consumption of antibiotics continued to decline

<table>
<thead>
<tr>
<th>Year</th>
<th>Consumption (DDD per 1,000 inhabitants per day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>19.4</td>
</tr>
<tr>
<td>2017</td>
<td>18.7</td>
</tr>
<tr>
<td>2019</td>
<td>17.9</td>
</tr>
</tbody>
</table>

(DDDs per 1,000 inhabitants per day)

Infographic 4. Total antibiotic consumption and trends by prescriber setting

Total antibiotic consumption by prescriber setting as proportion of overall prescribing, England, 2019

- General practice: 71%
- Hospital inpatients: 13%
- Hospital outpatients: 8%
- Other community settings: 4%
- Dental practices: 3%

Trends in total antibiotic consumption by prescriber setting, England, 2015-2019

<table>
<thead>
<tr>
<th>Prescriber Setting</th>
<th>% Change (DDD per 1,000 inhabitants per day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Practice</td>
<td>-12.2%</td>
</tr>
<tr>
<td>Dental practices</td>
<td>-19.5%</td>
</tr>
<tr>
<td>Other community settings</td>
<td>28.7%</td>
</tr>
<tr>
<td>Hospital Inpatients</td>
<td>13.4%</td>
</tr>
<tr>
<td>Hospital Outpatients</td>
<td>1.7%</td>
</tr>
</tbody>
</table>

% change (DDDs per 1,000 inhabitants per day)
Infographic 5. Items prescribed in primary care and average DDDs/item in primary care

<table>
<thead>
<tr>
<th>Items prescribed in primary care continued to decline</th>
<th>Average DDDs/item prescribed in primary care, 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.9</td>
<td>8.6 DDDs per 1 x Item</td>
</tr>
<tr>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>1.7</td>
<td></td>
</tr>
</tbody>
</table>

(Items per 1,000 inhabitants per day)

Infographic 6. Being A WaRe

**Being A WaRe**

**Access**
First and second choice antibiotics for treating the most common infections.
Includes: amoxicillin for pneumonia and penicillin for Streptococcal sore throat

**Watch**
Antibiotics with higher resistance potential, that should only be prescribed for specific indications.
Includes: ciprofloxacin in the treatment of complicated UTI

**Reserve**
Antibiotics that are last-resort options that should only be used in severe circumstances, when other options have failed.
Includes: colistin and IV parenteral fosfomycin
Infographic 7. Increased usage in the newly licensed antibiotics in hospitals

Increased usage in the newly licensed antibiotics in hospitals

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceftazidime/avibactam</td>
<td></td>
<td></td>
<td>0.1</td>
<td>0.3</td>
<td>0.5</td>
</tr>
<tr>
<td>Ceftolozane/tazobactam</td>
<td>0.1</td>
<td>0.2</td>
<td>0.4</td>
<td>0.5</td>
<td></td>
</tr>
</tbody>
</table>

*Was not authorised for use in the UK

Infographic 8. Antimicrobial resistance CQUIN scheme 2019/20

Antimicrobial resistance CQUIN scheme 2019/20

Lower Urinary Tract Infections in Older People

- 41% of antibiotics that were prescribed to 23,531 hospital patients aged 65+ with a UTI were given in accordance with NICE guidelines following a documented diagnosis without use of a dipstick test and with a urine sample sent to microbiology.

Antibiotic Prophylaxis in Colorectal Surgery

- 82% of antibiotics that were prescribed to 16,106 adult hospital patients undergoing colorectal surgery were given as a single dose and in accordance with local antibiotic guidelines.
Infographic 9. TARGET Toolkit

The TARGET Toolkit

- Promoted by 99% of CCGs
- Over 112,000 visits in 2019/20
- Over 52,700 patient information leaflets were downloaded
- Over 13,500 audits were viewed
- On average, users spend over 9.5 minutes on the website

www.rcgp.org.uk/targetantibiotics

Infographic 10. Healthcare Workers Survey – Access

Access

- 80% I have easy access to the guidelines I need on managing infections
- 68% I have easy access to the materials I need to give advice on prudent antibiotic use and antibiotic resistance
- 62% I have good opportunities to provide advice on prudent antibiotic use to individuals
Infographic 11. Healthcare Workers Survey – Behaviour

**Behaviour**

- **21%** Gave out resources on antibiotic use at least once in the previous week
- **61%** Gave out advice on the prudent use of antibiotics at least once in the previous week

Infographic 12. Healthcare Workers Survey – Barriers

**Barriers**

The barriers to providing advice or resources on prudent antibiotic use or management of infections

- **7%** Patient uninterested in the information
- **19%** Lack of resources
- **11%** Insufficient time
Infographic 13. Healthcare Workers Survey – Capability

Capability

% of respondents answering all 7 knowledge test questions correctly (by profession) - UK

<table>
<thead>
<tr>
<th>Professional</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical doctors</td>
<td>80%</td>
</tr>
<tr>
<td>Pharmacist</td>
<td>74%</td>
</tr>
<tr>
<td>Dentist</td>
<td>68%</td>
</tr>
<tr>
<td>Scientist</td>
<td>62%</td>
</tr>
<tr>
<td>Nursing and midwifery</td>
<td>52%</td>
</tr>
<tr>
<td>Allied health professionals</td>
<td>42%</td>
</tr>
<tr>
<td>Pharmacy technicians</td>
<td>41%</td>
</tr>
<tr>
<td>Other HCWs (Nursing associates, dental care professionals, unknown, other)</td>
<td>28%</td>
</tr>
</tbody>
</table>

Infographic 14. e-Bug

- 1.5 million views in 2019/20
- Translated into 25 different languages
- Recommended resource to teach about hygiene, infections and antibiotics in:
  - coronavirus (COVID-19): .GOV guidance for educational settings
  - NICE guidance on Antimicrobial stewardship: changing risk-related
- Supports the National Curriculum for science, design and technology, PSHE, art and design
- Recognised in the UK AMR 5 year National Action Plan
- Training provided to 550 educators in 2019/20

Operated by Public Health England
1. Introduction

Welcome to the seventh English Surveillance Programme for Antimicrobial Use and Resistance report. Despite this year’s COVID-19 pandemic, the team have produced another fantastic review of the epidemiology and outputs from the programme, working collaboratively across PHE, NHS England and our external stakeholders. Professor Dame Sally Davies has compared COVID-19 to putting a lobster in boiling water and AMR to putting the same poor lobster into cold water and slowly heating it up. We all understand how COVID-19 is affecting our life’s every day now but without concrete action, AMR is highly likely to do this for many years to come.

Chapter 2 highlights the ongoing threat of antimicrobial resistant infection, driven predominantly by the rise in incidence of Gram-negative infections. In 2019, 13,162 bloodstream infections were resistant to at least one of the key antibiotics that the UK government and the World Health Organisation (WHO) is currently recommending monitoring. This demonstrates the need to continue to focus on both preventing infections (through infection prevention and control) and reducing antimicrobial use (through antimicrobial stewardship).

Over the last 12 months, work has continued to progress to improve surveillance of carbapenemase producing Gram-negative bacteria and improving the actions that are taken to prevent these infections spreading in healthcare settings. This has culminated with the inclusion of carbapenem resistant and carbapenamase producing bacteria in the ‘The Health Protection (Notification) Regulations 2020’ where it is now a duty as part of regulation 4 to report “any resistance mechanism and antimicrobial susceptibility results” and within Schedule 2 (Causative Agents), the specific inclusion of “Acquired carbapenemase-producing Gram-negative bacteria”². This is the first time that antibiotic resistant bacteria are legally reportable in England. Alongside the regulations, the CPE Framework³ was published in October 2020 and provides a framework to prevent and control these multi-drug resistant bacteria in healthcare settings.

The new 5-year AMR National Action plan⁴, published in January 2019, announced new antibiotic reduction targets. The current ambitions are to reduce overall antibiotic use by 15% from 2014 to 2024; with reductions in both antibiotic prescriptions in primary care and broad-spectrum antibiotics in secondary care. Chapter 4 demonstrates the achievements

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³ https://www.gov.uk/government/publications/actions-to-contain-carbapenemase-producing-enterobacterales-cpe
in reducing overall antibiotic use; between 2018 and 2019 a further 1.5% reduction in total defined daily doses (DDDs) per 1,000 inhabitants per day; driven by significant ongoing reductions in primary care across all antibiotic categories apart from tetracyclines.

General practice continues to prescribe the majority of antibiotics (86% of total use in England) but has declined antibiotic use by 14% from 2015 to 2019. Dental practices also continued to make significant reductions (25%). Although other community healthcare prescribing is only a small proportion (4%) of total prescribing, this sector continues to increase. However, antibiotic use continues to climb in secondary care (3.5% increase from 2015 to 2019 by hospital admissions), albeit at a slower rate of increase than the previous 5 years (6% from 2010 to 2014)\(^5\).

PHE continues to work with NHS England to monitor the impact of quality improvement activity in primary and secondary care and these are reported in Chapter 5. The urinary tract infection targets were difficult to both implement and achieve in secondary care compared to surgical prophylaxis. This demonstrates that determining the population of interest and being able to target interventions appropriately are important considerations when introducing quality improvement initiatives to complex processes.

PHE continues to engage with our stakeholders to improve the reach and impact of our work in educating, training and raising awareness with healthcare professionals and the public. Chapter 7 outlines the world-leading work from the TARGET team to deliver a Future Learn with the British Society for Antimicrobial Chemotherapy, Train the Trainers workshops and the communications campaign with Royal College of General Practice. The outcome of the work with community pharmacy teams through webinars and e-learning modules is presented. And of course, e-Bug celebrated its tenth anniversary at the start of 2020 and continues to deliver training to local authorities, community members working with children, and producing engaging content and materials on its website for use globally. Finally, ongoing engagement continues with work demonstrated by events and activities such as the Antibiotic Guardian shared learning events and resources, NICE management of common infections workshop and Healthcare Student conference, World Antibiotic Awareness Week, European Antibiotic Awareness Day and twitter activity promoting our work.

Across all our teams, research and development work on antimicrobial resistance (AMR) and utilisation continues apace. The importance of this work was recognised by the National Institute of Health Research, re-awarding further five-year awards to PHE and 2

academic organisations (namely Imperial College London and the University of Oxford) and building on the work delivered from the previous awards.

Our research can be grouped into four major priority areas:

1.1 **Data science.** This includes enhanced data collection, linkage and sharing of existing data, development of infrastructure and automation of processes and development of methods to gain insight into the epidemiology and burden of AMR.

1.2 **Transmission.** This comprises work aimed at quantifying and understanding the burden, risk factors, drivers and mechanisms/dynamics of spread of AMR.

1.3 **Translational science.** Examples include research and development work on new rapid diagnostics and antimicrobials, characterisation of novel resistance mechanisms, and improved understanding of the links between genome, phenotype, and resistance.

1.4 **Interventions and evaluation.** This includes research into the design and evaluation of infection prevention and control (IPC) measures and antimicrobial stewardship (including educational and behavioural research), new diagnostics and antimicrobials, as well as novel alternatives such as vaccines, with research on health economics underpinning this priority area.

We will be focussing on:

- improved understanding of populations most at-risk from AMR-related public health threats, particularly in terms of health inequalities, through exploitation of large-scale linkage of electronic health record data from multiple sources
- developing and testing interventions to reduce risks of AMR, and assessing how these can be targeted to at-risk populations (personalised approaches)
- identifying the contexts in which AMR and HCAI proliferate, in order to manage and reduce their influence
- for priority pathogens, understanding (i) risk factors and strains/resistance mechanisms of most concern, (ii) transmission pathways, (iii) currently unrecognised emerging or existing trends, (iv) innovation for early detection and diagnostics, and (v) optimal models for NHS adoption
- developing and investigating the role of novel, technological solutions allowing individualised antibiotic prescribing (precision prescribing)
- developing bespoke antimicrobial stewardship and infection prevention and control solutions informed by social science/implementation research

As always, we could not deliver our activities without the wide engagement from our ESPAUR oversight group including our stakeholders. The activities of the organisations included in our oversight group are included in Chapter 8 and shows the breadth of work being delivered in the UK. We thank all of you who continue to be active members of the oversight group to support the ESPAUR delivery of the UK five-year National Action Plan.
2. Antimicrobial resistance

Introduction

This chapter presents key updates on the antimicrobial resistance (AMR) surveillance activities and actions undertaken by Public Health England (PHE), with a focus on the trends in resistance for the drug/bug combinations recommended for surveillance by the Advisory Committee on Antimicrobial Prescribing, Resistance and Healthcare-Associated Infections (APRHAI).6,7

The data presented cover the period from 2015 to 2019. The primary data source used in this chapter is different to that used in previous reports, with a full description of the differences is presented in Box 2.1. An overview of the data sources and analytical methods used in Chapter 2 are described in the Annex.

The 2019 to 2024 national action plan for AMR8 focusses on reducing the burden of antibiotic resistance; in support of this action plan baseline estimates of the burden of AMR in bloodstream infections (BSI) comprise core components of this chapter. Detailed trend data, including numbers reported as susceptible, intermediate or resistant to key antibiotics are available online in the data tables and PowerPoint presentations published alongside this report.

Trends in antimicrobial resistance

The incidence of BSI for the key pathogens highlighted in the previous 5-year Strategy9,10 increased between 2015 and 2019 (Figure 2.1). The biggest increase in
incidence was noted for *Klebsiella pneumoniae*, which increased by 39% from 9.5 cases per 100,000 to 13.2 per 100,000 population; this equated to a 71% increase from 7.7 cases per 100,000 population in 2009 (as reported in the ESPAUR report 2015).\(^{11}\)

*E. coli* remains the commonest cause of BSI and increased from 68.3 cases per 100,000 population in 2015 to 77.5 cases per 100,000 population in 2019, an increase of 14%. This is a 28% increase from the first full financial year of mandatory surveillance of *E. coli* BSI (April 2012 to March 2013), where the incidence was 60.4 per 100,000 population.\(^{12}\)

**Figure 2.1. Incidence per 100,000 population for key pathogen bloodstream infections in England, 2015 to 2019**

With the year-on-year increase in incidence of BSI, for most pathogens, shown in Figure 2.1, the burden of resistance, as reflected by the numbers of resistant infections, also increased over time. Using the methodology and pathogen/antibiotic combinations described in Annex - Chapter 2, the estimated total numbers of BSIs caused by pathogens resistant to one or more key antibiotics increased from 13,671 in 2015 to

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18,110 in 2019, a rise of 32% (Figure 2.2). Detailed information for infections that occurred in 2017, 2018 and 2019 are provided in the online web appendix for Chapter 2.

Figure 2.2. Annual estimated burden of antibiotic resistant bloodstream infections; England 2015 to 2019

The increasing burden of antibiotic resistant BSI is particularly marked for those caused by Enterobacterales, while remaining relatively unchanged or decreased for Gram-positive infections. The proportion of the key pathogens included in the AMR burden estimation that were resistant to the key antibiotic combinations under review has varied by species over time (Figure 2.3). For some pathogens the driver for the change in the proportion of BSIs that are resistant to any of the combinations under review has been due primarily to increased resistance single antibiotic, whereas for other pathogens a more heterogeneous pattern of resistance resulting in an overall increase has been noted (online appendix table for Chapter 2).
Using the methodology defined by Cassini et al., as adapted for the ESPAUR report 2018-2019, the estimated total number of resistant infections in England in 2019 was 65,162, up from an estimated 61,946 in 2018. This estimate is based on a ratio which relates to the number of antibiotic resistant BSI to the number of antibiotic resistant surgical site infections, antibiotic resistant urinary tract infections and antibiotic-resistant respiratory infections using point prevalence survey data alongside BSI data reported through European Centre for Disease Prevention and Control (ECDC) surveillance schemes.

The five-year trends in the proportion of clinically important Gram-negative and Gram-positive pathogens causing BSI which are reported as resistant to key antibiotics are available in the online data tables and PowerPoint presentations published alongside this report.

**Figure 2.3. Proportion of bloodstream infections, by causative species*, resistant to one or more key antibiotic combination;**

*as used in the AMR burden analyses presented in Annex Table 2.3

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15 *E. coli, K pneumoniae* and *K. oxytoca*: resistant to any of: carbapenems, third-generation cephalosporin, aminoglycosides or fluoroquinolones; *Acinetobacter spp*: resistant to aminoglycosides and fluoroquinolones, or...
Box 2.1 – Difference between AMR data (used for this year’s ESPAUR report) and Communicable Disease Report (CDR) data (used for previous ESPAUR reports)\(^{16,17,18,19}\) captured by the PHE Second Generation Surveillance System (SGSS)\(^{20}\)

Data on resistance of BSI isolates flows into SGSS via 2 different streams:

* the CDR data collection (previously LabBase2) holds antibiotic susceptibility information provided from the laboratory to the requesting clinician – this means that CDR only collected information that was released to the clinicians and excluded antibiotics that were masked or removed from the report; this is a common method of antimicrobial stewardship to limit the use of certain antibiotics

* the AMR data collection (previously called AmSurv)\(^{21}\) holds information on the result of all susceptibility tests undertaken by the laboratory. Reporting coverage increased to >90% laboratories once incorporated into SGSS in late 2014.\(^{22}\)

For trends in resistance in previous ESPAUR reports, the CDR data collection was used as it allowed analysis of results from the same data source for the five-year period.

carbapenems; *Pseudomonas* spp. resistant to three or more antimicrobial groups, or carbapenems; *Enterococcus* spp. resistant to glycopeptides; *S. aureus* resistant to methicillin; *S. pneumoniae* resistant to penicillin and macrolides, or penicillin.


As 5 years of data are now available in the SGSS AMR data collection the present report now uses this more robust data source.

Comparison of the data from each source shows that the overall number of BSI episodes for key causative species are similar (Annex table 2.1).

When estimating the burden of resistance, both datasets show similar increasing trends in resistance between 2015 and 2019 (Annex table 2.2). However, the AMR data collection identified 307 additional resistant BSI isolates in 2019 compared to the CDR data collection. A detailed breakdown of the data by bacterial species is available in Annex table 2.3.

**Gram-negative infections**

In 2019, there were an estimated 13,162 infections resistant to at least one of the antibiotics used in the AMR burden analyses (listed in Annex table 2.5), among 43,641 reported *E. coli* BSIs, equating to 3 out of every 10 people with an *E. coli* BSI having had an infection resistant to at least one key antibiotic. In the 2018-2019 ESPAUR report, an increase in resistance to third-generation cephalosporins in *E. coli* BSIs between 2016 and 2018 was reported, potentially associated with a significant increase in usage of this antibiotic group as an alternative treatment to piperacillin/tazobactam, which was in short supply in 2017. This trend has continued (Figure 2.4), with resistance to third-generation cephalosporins in *E. coli* causing BSIs increasing from 12% to 15% between 2015 and 2019; however, usage of third-, fourth- and fifth-generation cephalosporins in secondary care, while elevated, did not increase at the same rate between 2018 and 2019 (see Chapter 4). The changes in resistance for *E. coli* BSIs were more pronounced in the London region compared with the rest of the country, increasing from 17.1% in 2016 to 22.0% in 2019, notwithstanding the higher baseline resistance (Figure 2.4).24


Figure 2.4. Proportion of *E. coli* BSI resistant to third-generation cephalosporins; a) England and b) by region, 2015 to 2019

Other significant changes in resistance in *E. coli* causing BSIs between 2015 and 2019 were for ciprofloxacin (18% to 20% between 2015 and 2019), and co-amoxiclav (42% to 44%) (Figure 2.5).

Between 2015 and 2019, resistance to ciprofloxacin in *K. pneumoniae* BSIs increased from 9% to 16%, resistance to third-generation cephalosporins increased from 10% to 16%, and co-amoxiclav resistance increased from 27% to 32% (Figure 2.5 and online Figures appendix). Of the estimated 8,521 *K. pneumoniae* BSIs, 2,033 were resistant (24%) to one or more of the key antibiotics used in the AMR burden analyses (Figure 2.2); an increase of 86% from the 1,094 estimated resistant infection reported in 2015.

Figure 2.5. Proportion of *E. coli*, *K. pneumoniae* and *K. oxytoca* BSI resistant to key antibiotics, England, 2015 to 2019
The number of *Pseudomonas* spp. BSIs estimated as resistant to a key antibiotic in 2019 was 501 (out of 5,271 estimated BSI) (Figure 2.2), equating to 1 in 10 people with a *Pseudomonas* spp. BSI having a resistant infection. Between 2015 and 2019 the proportion of *Pseudomonas* spp. resistant to key antibiotics remained the same or increased slightly (online Figures appendix), the most marked increase being for carbapenems, which increased from 7% in 2015 to 9% in 2019.

In 2019, an estimated one in 10 people with an *Acinetobacter* spp. BSI had an aminoglycoside and fluoroquinolone resistant infection (Figure 2.3). Between 2015 and 2019 the proportion of *Acinetobacter* spp. reported as resistant to gentamicin remained stable at around 5% while the proportion resistant to ciprofloxacin increased from 6% to 8% of infections (Figure 2.6). In 2018 the *Acinetobacter* spp. and ciprofloxacin breakpoint was lowered, which is likely to explain the large increase in intermediate results noted in 2019 (Figure 2.6).

**Figure 2.6. Proportion of Acinetobacter spp. BSI resistant to key antibiotics, England, 2015 to 2019**

![Graph showing proportion of Acinetobacter spp. BSI resistant to key antibiotics from 2015 to 2019.]

The proportion of *E. coli* BSI resistant to combinations of 3 or more key antibiotic groups (third-generation cephalosporins, quinolones, aminoglycosides and piperacillin/tazobactam) remained relatively stable between 2015 and 2019 (Figure 2.7).

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A different picture of multi resistance was noted for *K. pneumoniae* BSI isolates between 2015 and 2019 (Figure 2.7), with overall increases for all four of the antibiotic combinations reviewed, albeit with slight reductions noted between 2018 and 2019. The increase between 2016 and 2018 coincides with an increase in resistance to third-generation cephalosporins. In 2019, resistance to third-generation cephalosporins, aminoglycosides and piperacillin/tazobactam was 8%, compared to 6% in 2015.

Between 2018 and 2019 there was an increase in the estimated proportion of *K. pneumoniae* resistant to a key antibiotic (Figure 2.2), and a slight reduction, or stabilisation, in the proportion of *K. pneumoniae* BSI resistant to multiple antibiotics (Figure 2.6). It is important to undertake susceptibility tests (including looking for

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resistance mechanisms; Chapter 3) and assess the antibiotics used for treatment according to local stewardship protocols and national recommendations.

Multiresistance in *Pseudomonas* spp. BSI has remained stable between 2015 and 2019 (Figure 2.7), with the highest combination resistance being seen in the third-generation cephalosporin, aminoglycoside and piperacillin/tazobactam combination, at 5% of *Pseudomonas* spp. BSI.

Use of novel antibiotic combinations, such as ceftazidime/avibactam and ceftaroline/tazobactam is increasing (Chapter 4). Although susceptibility testing for these newer antibiotic combinations is currently selective (susceptibility tests only performed when resistance to first- and second-line treatment antibiotics has been detected), resistance has nonetheless been recorded. In 2019, 1,723 (5%) *E. coli*, 444 (6%) *K. pneumoniae* and 233 (5%) *Pseudomonas* spp. BSI from blood were tested for ceftazidime/avibactam susceptibility, and 9 (0.5%), 11 (2%) and 23 (10%) were reported as resistant, respectively. Similarly, for ceftaroline/tazobactam, in 2019, 431 (1%), 152 (2%) and 203 (4%) of *E. coli*, *K. pneumoniae* and *Pseudomonas* spp. BSI respectively were tested for susceptibility, and 38 (9%), 60 (39%) and 22 (11%) were resistant. To fully interpret the results additional data on the presence of specific carbapenemases is required; further information on carbapenemase surveillance is presented in Chapter 3 of this report.

**Gram-positive infections**

The proportion of bloodstream isolates of enterococci reported as resistant to glycopeptides decreased between 2015 and 2019, from 17% to 15% (Figure 2.8). *Enterococcus* spp. bacteraemia resistance to linezolid remained steady between 2015 and 2019 at 1%.

For *S. aureus*, the burden of resistance continued to slowly decline in 2019, with only 6% of BSI isolates being methicillin-resistant. However, the burden of infection nonetheless increased as the incidence of *S. aureus* increased by 14%, from 20.5 per 100,000 population in 2015, to 23.5 per 100,000 population in 2019. *S. aureus* data trends are described in more detail in PHE’s mandatory surveillance annual reports.27

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The proportions of *Streptococcus pneumoniae* BSI isolates resistant to penicillin, tetracycline and to erythromycin remained stable between 2015 and 2019, at 2%, 7% and 6% respectively (Figure 2.9).

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28 Ampicillin/Amoxicillin susceptibility result provided to give an idea of the proportion of *Enterococcus* spp. BSI are likely to be due to *Enterococcus faecium*. 
Surveillance of antimicrobial resistance in *Neisseria gonorrhoeae*

Surveillance of antimicrobial resistance in *Neisseria gonorrhoeae* is monitored through the Gonococcal Resistance to Antimicrobials Surveillance Programme (GRASP), which comprises a suite of surveillance systems to detect and monitor AMR in *N. gonorrhoeae* and to record potential treatment failures. Trend data are derived from the national sentinel surveillance system which collects gonococcal isolates from consecutive patients attending a network of 27 participating sexual health clinics (SHCs) (25 in England, 2 in Wales) and their 21 associated laboratories over a 2 month period each year. Gonococcal isolates are referred to the PHE antimicrobial resistance in sexually transmitted infections (AMRSTI) national reference laboratory 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 2018 and 2019, there was a decrease in reduced susceptibility to ceftriaxone (MIC >0.03 mg/L), the current first-line therapy, from 7.1% in 2018 to 2.9% in 2019. This contrasts with the steady rise in reduced susceptibility observed from 2013 to 2018 (0.3% to 7.1%). Although no instances of ceftriaxone resistance (MIC >0.125 mg/L) were observed in the sentinel programme in 2019, 3 cases of ceftriaxone resistance were confirmed by the PHE AMRSTI national reference laboratory on direct referral in 2019. These 3 cases were not related, though all were associated with travel from the Asia Pacific region. All patients were successfully treated with first-line therapy and there was no onward transmission within the UK.

While resistance to ciprofloxacin, penicillin and tetracycline continues to rise, the proportion of *N. gonorrhoeae* isolates with resistance (MIC >0.5 mg/L) to azithromycin has marginally declined, from 9.8% in 2018 to 9.3% in 2019. The greatest reduction in resistance was observed for cefixime; 2.2% in 2018 to 0.8% in 2019, the lowest value recorded since 2007. No isolates displayed spectinomycin resistance, a continuation of the trend from 2000. Antimicrobial susceptibility testing for the sentinel surveillance system included gentamicin for the first time in 2019. No resistance breakpoint currently exists for gentamicin, but the modal MIC was low (4mg/L).

Prescribing data demonstrated optimal adherence with the 2019 updated British Association for Sexual Health and HIV (BASHH) UK guideline for managing infection with *N. gonorrhoeae*29, with 94.6% of individuals receiving the recommended first-line

therapy of ceftriaxone 1g intramuscular monotherapy in 2019.

Further data on AMR in \textit{N. gonorrhoeae} are available online in the GRASP report.\textsuperscript{30}

\textbf{Figure 2.10. Percentage of \textit{N. gonorrhoeae} isolates in the GRASP sentinel surveillance system that were resistant to selected antimicrobials, England and Wales, 2000 to 2019†}

† Due to changes in the diagnostic sensitivity (DST) medium used to test antimicrobial susceptibility of sentinel surveillance isolates, MICs for the 2015-2019 collections are not directly comparable with those from previous years. Trends from 2000-2014 compared to 2015-2019 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). The 5% threshold (≥5% of infections resistant to the first-line therapy) at which the WHO recommends that first-line treatment guidelines should be changed is indicated by the horizontal dashed red line.

UK participation in international surveillance of AMR

The ECDC EARS-Net surveillance collects data on resistance to key antibiotics in blood culture and cerebrospinal fluid (CSF) isolates for 8 organisms (E. coli, K. pneumoniae, P. aeruginosa, Acinetobacter spp., S. pneumoniae, S. aureus, E. faecalis, and E. faecium).

In June 2020 the UK antimicrobial susceptibility testing data from 67 laboratories in England was submitted along with data from Northern Ireland, Scotland and Wales, covering the year 2019 to the EARS-Net surveillance scheme. The EARS-Net report will be published on European Antibiotics Awareness Day in November 2020, and in the online Surveillance Atlas of Infectious Diseases.31

These data are also used, along with resistance in Neisseria gonorrhoeae and AMR in pathogens form urine isolates, for the Global Antimicrobial Resistance Surveillance System (GLASS). The third World Health Organization (WHO) GLASS report was published in May 2020, covering data for 2018.32 One of the goals of the GLASS is to support the development of standardised and comparable AMR surveillance globally as well as surveying laboratories to identify possibly needs for laboratory support.

The next phase of the UK’s data submission to GLASS plans to include additional organisms, namely Shigella spp. and Salmonella spp. from stool samples.

PHE has been supporting the Oxford GBD (Global Burden of Disease) Group to develop global models of AMR through developing an agreement with the GBD- Global Research on Antimicrobial Resistance (GRAM) project, enabling data access, data linkage and data analysis of PHE’s unique datasets.

Discussion

Data presented show that the burden of AMR assessed in terms of the numbers of infections caused by pathogens resistant to one or more key antibiotics continues to rise, driven predominantly by increases in the last few years in the number of Gram-negative BSIs resistant to third-generation cephalosporins and quinolones. Early work indicates that this could partly be driven by increases in use of these antibiotics in

secondary care. Further investigations into regional differences, patient demographics and healthcare interactions are now being undertaken to develop a better understanding of these changes, which will be critical to identifying areas for intervention.

As demonstrated by the AMR burden analyses as well as the trends in resistance to specific antibiotic combinations, multiresistance in Gram-negative pathogens remains an issue. Resistance to multiple first-line agents leads to increased use of antibiotics of last resort, including newly launched antibiotics (Chapter 4).

Although new antibiotic/inhibitor therapeutic options are now available in England, surveillance has already shown that resistance to ceftazidime/avibactam and ceftaroline/tazobactam has emerged during the short period of their availability. This highlights the importance of stringent antibiotic stewardship activities, and local laboratory capacity to identify emerging resistance for any new antibiotics (or combinations) as well as the importance of identifying resistance mechanisms (Chapter 3).

In the ESPAUR report for 2018-2019, initial work on the modelling of excess morbidity and mortality due to AMR were presented; this work is now being continued to better understand risks associated with AMR.33 Additional factors such as indices of deprivation and patient comorbidities for community-associated infections, and surgical procedures for healthcare-associated infections are being analysed. Development of the unified infection dataset (UID) will enable more granular investigations into prescribing and resistance (more information in Chapter 4).

The change in EUCAST guidance for interpreting and recording the S, I and R susceptibility results introduced in 2019.34 While this brings a positive change therapeutically, by indicating that treatment using the agent is still possible with an appropriate dose it limits the ability to fully interpret trends in resistance through routine surveillance,35 as demonstrated by the Acinetobacter spp. and ciprofloxacin trend shown in Figure 2.6.

After the UK’s exit from the European Union it remains unclear if participation in European programme’s such as EARS-Net will continue following the end of the transition period in December 2020.

**Future actions**

ESPAUR will continue to:

- monitor and investigate the increasing trend of third-generation cephalosporin resistance
- develop methods to estimate the clinical burden in terms of resistant infections, excess morbidity (resulting in hospitalisation and increased length of hospital stay) and mortality
- develop a new infrastructure to assess antimicrobial prescribing and resistance at patient level
- participate in the GBD-GRAM project
- investigate the impact of the Covid-19 pandemic on antimicrobial resistance in key bacterial species
3. Carbapenemase-producing Enterobacterales

Introduction

Increasing levels of antimicrobial resistance (AMR) pose a significant threat to healthcare and economic stability globally. Carbapenems are antibiotics that can treat infections caused by a wide range of bacteria; they are often referred to as “antibiotics of last resort” due to their activity against multi-resistant bacteria. Carbapenem resistance due to the emergence of genes encoding acquired carbapenemases (enzymes that can break down carbapenem antibiotics) is of particular concern due to their ability to transfer between different bacteria.

A comprehensive chapter on carbapenemase-producing Enterobacterales (CPE) was published in last year’s ESPAUR report. In May 2019 PHE received its remit letter outlining its deliverables in support of commitments made in ‘Tackling antimicrobial resistance 2019-2024: The UK’s five-year national action plan’.36 This year’s CPE chapter will provide an update on progress made to contain and control the spread of CPE in England.

Reference laboratory

Recent years have seen an increase in the number of diagnostic laboratories that are performing local detection of the UK’s four major carbapenemase families (KPC, OXA-48-like, NDM and VIM) and until 2019, laboratories were encouraged by the Antimicrobial Resistance and Healthcare Associated Infections (AMRHAI) Reference Unit to continue to send in all their confirmed isolates for inclusion within the national strain archive and to inform our knowledge of the national epidemiology of carbapenemase-producing Gram-negative bacteria. However, the ongoing need for this was reconsidered given the increasing numbers of isolates encountered in England and the impact of this on the workload of the AMRHAI reference unit to archive all the isolates received. As of January 2019, laboratories have been requested to refer only locally-confirmed carbapenemase producers from normally sterile sites. Consequently, the numbers of confirmed CPE referred in 2019 dropped dramatically compared to

previous years, with 1,051 isolates confirmed as positive for at least one carbapenemase by AMRHAI, regional PHE or NHS laboratories (Figure 3.1a). As in previous years, most isolates represent colonisations but understandably because of the changing AMRHAI referral criteria the proportion of CPE has risen compared with previous years, with 8.9% of CPE referred in 2019 originating from blood. The ‘big 5’ carbapenemase families (KPC, OXA-48-like, NDM, VIM and IMP), and combinations thereof, still account for >98% of CPE. The OXA-48-like family continue to predominate, accounting for 36.5% of confirmed CPE in 2019, followed by NDM (36.2%), KPC (12.5%), IMP (4.5%) and VIM (2.5%). CPE were referred from all 9 PHE regions, but with foci in London (37.8% of CPE), the South East (11.1%), the North West (10.2%) and the East (10%) of England.

Figure 3.1. a) Number of confirmed CPE isolates referred to PHE’s AMRHAI Reference Unit (excluding blood cultures), 2010 to 2019; b) Number of confirmed CPE blood culture isolates referred to PHE’s AMRHAI Reference Unit, 2010 to 2019

Change in referral criteria
Isolates from the Gastrointestinal Bacteria Reference Unit

Among 9,767 *Salmonella* isolates referred to PHE’s Gastrointestinal Bacteria Reference Unit and sequenced in 2019, five *Salmonella* spp. originating from two patients were found to harbour carbapenemase genes. *Salmonella enterica* serovar Oranienburg producing OXA-244 was referred from one patient (this isolate was also referred to AMRHAI and therefore features in the AMRHAI CPE total for 2019) and four *S. enterica* serovar Rissen isolates producing OXA-48 were from the second patient; travel history was unavailable for these patients. Two diarrhoeagenic *E. coli* isolates were found to produce OXA-181 among 2597 isolates sequenced in 2019. Both were isolated from patients in the community and belonged to sequence types 10 and 443. Both patients had a history of travel in the previous four weeks; one patient to Egypt but the country where the other patient travelled to was unknown. No carbapenemase genes were identified among 1,646 sequenced *Shigella* spp.

Assays for detection of acquired carbapenemases

In May 2019, PHE’s ‘Commercial Assays for the Detection of Acquired Carbapenemases’ report was published, which provided evidence-based guidance to enable diagnostic laboratories to make an informed choice in their selection of a commercially available method for the detection of carbapenemase-producing Gram-negative bacteria. Molecular and immunochromatographic commercial assays available in the UK were listed, together with information on assay coverage, sample types validated by the manufacturer, workflow, equipment required and points to consider for implementation. The report strongly recommended that frontline diagnostic laboratories should implement an assay allowing detection of the ‘big 4’ (KPC, OXA-48-like, NDM and VIM) carbapenemases so that the resulting rapid turnaround time would have maximal impact on patient management to prevent onwards transmission and effective clinical treatment. To assist with local verification of commercial assays a panel of CPE isolates representing common variants of KPC, OXA-48-like, NDM, VIM and IMP carbapenemases known to be circulating in the UK has been deposited with the National Collection of Type Cultures (NCTC).

Isolates that meet EUCAST criteria for carbapenemase screening but are negative for the ‘big 4’ carbapenemase families should still be referred to AMRHAI for extended molecular screening with a multiplex PCR. As of January 2020, our assay screens for class A (KPC, IMI/NMC-A, GES, FRI and SME), class B (DIM, GIM, IMP, NDM, SIM, SPM and VIM) and class D (OXA-48-like) carbapenemases, thereby detecting all

38 https://www.eucast.org/resistance_mechanisms/
carbapenemase gene families identified amongst >17,000 CPE submitted to AMRHAI from UK laboratories since 2000. In addition, this assay detects the most common OXA carbapenemase gene families identified in *Acinetobacter* spp. (OXA-23-like, OXA-40-like, OXA-51-like and OXA-58-like) and the most common ESBL gene families occurring in *Pseudomonas* spp. (VEB, PER and GES), which can account for resistance to ceftolozane/tazobactam in the absence of a class B carbapenemase. The Reference Unit monitors for the emergence of novel resistance mechanisms not covered by this assay by more detailed investigation of PCR-negative isolates from other specimen types.

**Surveillance**

**Establishing reporting of acquired carbapenemases**

Following the closure of the Electronic Reporting System (ERS) for the enhanced surveillance of carbapenemase producing Gram-negative bacteria in April 2019, PHE has been supporting diagnostic laboratories to establish reporting of locally identified acquired carbapenemase producers to its national microbiology database, the Second Generation Surveillance System (SGSS).

One of the deliverables was to update SGSS to enable reporting from laboratories performing local assays for the detection carbapenemase. The target was to have 80% of diagnostic laboratories who conducted local testing reporting to SGSS by March 2020. This ambition was achieved in December 2019, when 82% of laboratories conducting local testing were reporting to SGSS.

**Addition of acquired carbapenemase producers to the Health Protection (Notifications) Regulations 2010 list of causative agents**

In May 2019 PHE was tasked with providing the technical expertise to the Department of Health and Social Care (DHSC) and Ministers to effect a change in national legislation to include carbapenem-resistant Gram-negative invasive infections on the list of causative organisms within the Health Protection (Notifications) Regulations 2010. Members of PHE’s CPE Steering Group and CPE Surveillance Working Group developed a definition for addition to the list of causative agents, namely “acquired carbapenemase-producing Gram-negative bacteria causing invasive infection”. This definition was proposed because:

- acquired carbapenemases pose a significant threat to public health due to their ability to transfer within and between bacterial genera, enhancing their ability to

disseminate.\textsuperscript{40,41} to future-proof the definition, the list of mechanisms would not be restricted to the most prevalent mechanisms

- an increasing number of diagnostic laboratories are able to identify the most commonly identified acquired carbapenemase families to mechanism-level (PHE survey conducted July to August 2018, 55/113 surveyed laboratories; 49\%)\textsuperscript{42}
- carbapenem minimum inhibitory concentrations for some carbapenemase-producers may be below clinical breakpoints\textsuperscript{43} – furthermore, carbapenem resistance can result from other resistance mechanisms for example ESBL or AmpC expression together with porin loss
- there is evidence that poorer outcomes are associated with infections caused by acquired carbapenemase-producing Gram-negative bacteria compared to infections caused by non-carbapenemase-producing carbapenem-resistant Gram-negative bacteria\textsuperscript{44}
- acquired carbapenemases have been identified across several bacterial genera in the UK, including Enterobacterales,\textsuperscript{45,46,47,48} 
Pseudomonas spp.\textsuperscript{49,50} and Acinetobacter

\textsuperscript{40} Goren, M. G., Carmeli, Y., Schwarber, M. J. \textit{et al.} Transfer of carbapenem-resistant plasmid from \textit{Klebsiella pneumoniae} ST258 to \textit{Escherichia coli} in patient. \textit{Emerg Infect Dis}. 2010; \textbf{16}: 1014-7
\textsuperscript{43} Nordmann P., Gniadkowski, M., Giske, C. G. \textit{et al.} Identification and screening of carbapenemase-producing Enterobacteriaceae. \textit{Clin Microbiol Infect}, 2012; \textbf{18}: 432-438
\textsuperscript{44} Tamma, P. D., Goodman, K. E., Harris, A. D. \textit{et al.} Comparing the outcomes of patients with carbapenemase-producing and non-carbapenemase-producing carbapenem-resistant Enterobacteriaceae bacteraemia. \textit{Clin Infect Dis}, 2017; \textbf{64}: 257-264
\textsuperscript{46} Nordmann P., Gniadkowski, M., Giske, C. G. \textit{et al.} Identification and screening of carbapenemase-producing Enterobacteriaceae. \textit{Clin Microbiol Infect}, 2012; \textbf{18}: 432-438
\textsuperscript{47} Tamma, P. D., Goodman, K. E., Harris, A. D. \textit{et al.} Comparing the outcomes of patients with carbapenemase-producing and non-carbapenemase-producing carbapenem-resistant Enterobacteriaceae bacteraemia. \textit{Clin Infect Dis}, 2017; \textbf{64}: 257-264
\textsuperscript{48} Trepanier, P., Mallard, K., Meunier, D. \textit{et al.} Carbapenemase-producing Enterobacteriaceae in the UK: a national study (EuSCAPE-UK) on prevalence, incidence, laboratory detection methods and infection control measures. \textit{J Antimicrob Chemother}, 2017; \textbf{72}: 596-603
spp. – acquired carbapenemases have also been identified in bacteria with intrinsic chromosomal carbapenemases albeit very rare globally and not yet in the UK.\textsuperscript{52,53} invasive infections are associated with a high rate of mortality,\textsuperscript{54} with evidence to suggest that mortality associated with invasive infections is higher than non-invasive infections.\textsuperscript{55}

PHE hosted a workshop to propose the definition and ascertain the views of healthcare professionals across the UK. The workshop was attended by 27 experts and 10 facilitators. Attendees represented a range of professions, organisations and geographies.

The consensus view from the delegates suggested that the definition for addition to the list of causative agents should not focus on invasive infection since this would underestimate the burden of acquired carbapenemase producers and potentially delay action being taken to contain and control transmission locally.

Following further consultation with colleagues and discussions associated with the definition proposed at the workshop, PHE presented 3 options for addition to the list of causative agents to the Advisory Committee on Antimicrobial Prescribing, Resistance and Healthcare Associated Infection (APRHAI) in September 2019. The options presented to APRHAI were:

- notification of acquired carbapenemase-producing Gram-negative bacteria isolated from all specimen sites
- notification of acquired carbapenemase-producing Gram-negative bacteria isolated from specimen sites representing infection (either invasive or non-invasive)
- notification of acquired carbapenemase-producing Gram-negative bacteria isolated from sterile sites

\textsuperscript{51} Woodford, N., Ellington, M. J., Coelho, J. M. \textit{et al.} Multiplex PCR for genes encoding prevalent OXA carbapenemases in \textit{Acinetobacter} spp. \textit{Int J Antimicrob Agents}, 2006; \textbf{27}: 351-3

\textsuperscript{52} Furlan, J. P. R., Pitondo-Silva, A. and Stehling, E. G. Detection of \textit{blaNDM-1} in \textit{Stenotromas maltophilia} isolated from Brazilian soil. \textit{Mem Inst Oswaldo Cruz}, 2018; \textbf{113}: e170558. doi: 10.1590/0074-02760170558

\textsuperscript{53} Libisch, B., Giske, C. G., Kovács, B. \textit{et al.} Identification of the first VIM metallo-\textit{β}-lactamase-producing multiresistant \textit{Aeromonas hydrophilia} strain. \textit{J Clin Microbiol}, 2008; \textbf{46}: 1878-80


APRHAI considered the options and endorsed the addition of ‘acquired carbapenemase-producing Gram-negative bacteria’ isolated from any specimen site to the list of causative agents listed under the Health Protection (Notifications) Regulations.

PHE worked closely with the DHSC to prepare relevant documentation to make the legislative change, including running a consultation with operators of diagnostic laboratories in May to June 2020. The submission was presented to and approved by Ministers on 6 July 2020. The change in legislation will be effective from 1 October 2020.

**CPE framework**

A full draft of the ‘Framework of actions to contain carbapenemase-producing Enterobacterales’ was published for consultation on 7 January 2020. The consultation closed on 14 February 2020, with over 300 comments received during the consultation period.

The final version of the CPE Framework is due to be published prior to the enforcement of legislation making acquired carbapenemase-producing Gram-negative bacteria reportable to PHE.
4. Antibiotic consumption

Introduction

Building on the previous UK five-year antimicrobial resistance (AMR) strategy\(^5\) from 2013 to 2018, a new five-year National Action Plan (NAP)\(^6\) between 2019 and 2024 was published in 2019. Together with the UK 20-year vision of AMR,\(^7\) it sets out the UK Government’s ambitions to tackle AMR, by optimising the appropriate use of antimicrobials in humans to provide safe and effective patient care.

The overall target is to reduce total UK antimicrobial use in humans by 15% by 2024 from the 2014 baseline including:

- a 25% reduction in antibiotic use in the community from the 2013 baseline
- a 10% reduction in use of antibiotics from the World Health Organization’s (WHO) ‘Reserve’ and ‘Watch’ categories\(^8\) adopted for UK use in hospitals from the 2017 baseline

Developing and maintaining surveillance systems for continuous monitoring trends in antimicrobial use across different prescribing settings over time is therefore essential to determine the level of use and the effectiveness of antimicrobial stewardship programmes.

Antibiotic consumption in England between 2015 and 2019 by primary and secondary care is presented in this chapter. Prescribing settings include general practice (GP), dental practice, out-of-hours services, and inpatient and outpatient services in hospitals. Methods and research activities can be found in the Annex for Chapter 4. Data and figures presented in the chapter are available in the online chapter data tables and figures appendix.

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Total antibiotic consumption

Total antibiotic consumption in England continues to decrease. Total consumption of antibiotics declined by 7.5% between 2015 and 2019. A reduction (-1.5%) in total consumption occurred between 2018 and 2019 from 18.2 to 17.9 Defined Daily Doses (DDDs) per 1,000 inhabitants per day (DID).

Most antibiotics were prescribed in the GP setting (71.4% of overall prescribing with 12.8 DID) in 2019, although prescribing in the GP setting has continued to decrease (12.2%) over the past 5 years. This is followed by prescribing in hospital inpatient (13.3%; 2.4 DID) and hospital outpatient settings (7.7%; 1.4 DID). However, both hospital settings have seen an increase in antibiotic prescribing from 2015 to 2019 (13.4% and 1.7% respectively); an 8.8% increase was observed for the combined hospital settings between 2015 and 2019. A small proportion of antibiotics were prescribed in other community settings (4.1%; 0.737 DID) and dental practices (3.4%; 0.611 DID) in 2019, with increases of 28.7% and decrease of 19.5% respectively compared to 2015 (Figure 4.1).

Figure 4.1. Total antibiotic consumption by setting, expressed as DDDs per 1,000 inhabitants per day, England, 2015 to 2019

Between 2015 and 2019, consumption of third, fourth and fifth-generation cephalosporins and ‘other antibacterials’ (see Annex Chapter 4 for full definitions),
particularly nitrofurantoin, increased significantly. Reduction or plateauing of consumption has been seen for most of the antibiotic groups over this time period though (Table 4.1).

In 2019, the 3 most predominantly prescribed antibiotic groups were, as in previous years, penicillins (37.8%), tetracyclines (26.4%) and macrolides (15.3%).

Table 4.1 Total antibiotic consumption by antibiotic groups, expressed as DDDs per 1,000 inhabitants per day, 2015 to 2019

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Penicillins (excluding inhibitors)</td>
<td>6.161</td>
<td>6.233</td>
<td>6.027</td>
<td>5.826</td>
<td>5.653</td>
<td></td>
<td>0.018+</td>
</tr>
<tr>
<td>Penicillins (inhibitor combinations only)</td>
<td>1.208</td>
<td>1.145</td>
<td>1.102</td>
<td>1.118</td>
<td>1.106</td>
<td></td>
<td>0.078</td>
</tr>
<tr>
<td>First and second-generation cephalosporins</td>
<td>0.301</td>
<td>0.268</td>
<td>0.257</td>
<td>0.243</td>
<td>0.238</td>
<td></td>
<td>0.012+</td>
</tr>
<tr>
<td>Third, fourth and fifth-generation cephalosporins</td>
<td>0.057</td>
<td>0.063</td>
<td>0.074</td>
<td>0.079</td>
<td>0.078</td>
<td></td>
<td>0.015+</td>
</tr>
<tr>
<td>Carbapenems</td>
<td>0.058</td>
<td>0.056</td>
<td>0.056</td>
<td>0.052</td>
<td>0.052</td>
<td></td>
<td>0.012+</td>
</tr>
<tr>
<td>Tetracyclines</td>
<td>4.828</td>
<td>4.734</td>
<td>4.682</td>
<td>4.596</td>
<td>4.730</td>
<td></td>
<td>0.260</td>
</tr>
<tr>
<td>Macrolides, lincosamides and streptogramans</td>
<td>3.230</td>
<td>3.204</td>
<td>3.082</td>
<td>2.873</td>
<td>2.730</td>
<td></td>
<td>0.006+</td>
</tr>
<tr>
<td>Sulfonamides and trimethoprim</td>
<td>1.357</td>
<td>1.266</td>
<td>1.055</td>
<td>0.850</td>
<td>0.777</td>
<td></td>
<td>0.002+</td>
</tr>
<tr>
<td>Quinolone antibacterials</td>
<td>0.519</td>
<td>0.515</td>
<td>0.522</td>
<td>0.548</td>
<td>0.499</td>
<td></td>
<td>0.914</td>
</tr>
<tr>
<td>Anti-<em>Clostridioides difficile</em> agents*</td>
<td>0.004</td>
<td>0.004</td>
<td>0.004</td>
<td>0.004</td>
<td>0.004</td>
<td></td>
<td>0.310</td>
</tr>
<tr>
<td>Oral metronidazole</td>
<td>0.359</td>
<td>0.336</td>
<td>0.322</td>
<td>0.306</td>
<td>0.298</td>
<td></td>
<td>0.002+</td>
</tr>
<tr>
<td>Other antibacterials*</td>
<td>1.156</td>
<td>1.227</td>
<td>1.397</td>
<td>1.549</td>
<td>1.603</td>
<td></td>
<td>0.002+</td>
</tr>
</tbody>
</table>

+ Statistically significant p-value for trend from 2015 to 2019
^ Anti-*Clostridioides difficile* agents: oral vancomycin and fidaxomicin
* Other antibacterials (ATC 3rd level pharmacological subgroup ‘J01X’) include: glycopeptide antibacterials, polymyxin, steroid antibacterials, imidazole derivatives, nitrofuran derivatives, other antibacterials (full list in chapter Annex)

Penicillins

Penicillins are the most commonly prescribed antibiotics in England, accounting for 37.8% of total antibiotic prescribing in 2019. Over the last 5-years, consumption has decreased by 8.3% from 7.4 to 6.8 DIDs. General practice prescribing was the main driver for the decrease in penicillin use (-13.6%) between 2015 and 2019; decreases were also observed in dental practices (-19.2%) and hospital outpatients (-3.1%). However, there has been a steady increase in penicillin prescribing over the same period in the other community (29.3%) and hospital inpatient (11.1%) settings.
The most commonly used penicillin in 2019 remained amoxicillin (3.0 DID) but its use has been steadily decreasing since 2015 (-15.2%). Prescribing for piperacillin/tazobactam is still lower when compared to 2015 (-27.5%) but its use has been steadily increasing since the 2017 supply shortage,\(^{62}\) with an increase of 19.0% from 2017 to 2019.

**Cephalosporins**

The overall consumption of cephalosporins declined by 11.7% from 2015 to 2019 (0.358 to 0.316 DID), mainly driven by the reduced use of cefalexin (-22.4%). The decrease in cefalexin use was especially noted in primary care (-25.3%), likely due to the NHS Outcomes Framework improvement policy\(^{63}\), although monitoring of the use of cefalexin is required as it was recommended as a first-line option for pyelonephritis in 2018.\(^{64}\)

First and second-generation cephalosporin consumption significantly decreased over the past 5 years (-21.0%), whereas the consumption of third, fourth and fifth-generation cephalosporins increased significantly over the same time period, most notably in 2017, then remained level between 2018 and 2019. Antibiotics from the third, fourth and fifth-generation cephalosporins group were used as alternative treatment when there was a shortage of piperacillin/tazobactam, particularly in secondary care. Although the use of cephalosporins is a known risk factor for *Clostridium difficile*-associated disease,\(^{65}\) it does not appear that *C. difficile* rates have increased from 2017.\(^{66}\)

**Tetracyclines**

Total tetracycline consumption slowly decreased (-2.0%) between 2015 and 2018 but showed a slight increase (2.9%) between 2018 and 2019. General practice is the main prescriber setting (85.9%) for tetracyclines.

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The predominant antibiotic used was doxycycline with an increased consumption of 16.6% in the last 5 years. Minocycline (-53.6%), oxytetracycline (-43.4%) and tetracycline (-41.1%) use however has decreased steadily since 2015. This may reflect the reduction of minocycline use for treating acne.\^67

**Quinolones**

The use of quinolones has been relatively stable with only a slight increase in 2018 (0.548 DID), followed by reduced consumption in 2019 (0.499 DID) This is likely due to the new recommendations by the Medicines and Healthcare products Regulatory Agency in 2019 for restricted fluoroquinolones use, due to adverse, although rare, drug reactions.\^68

Prescribing of quinolones remains highest in the GP setting (0.257 DID in 2019) but decreased by 15.9% in the past 5 years. In hospital inpatients, the use of quinolones increased from 2015 (0.082 DID) to 2019, driven by the piperacillin/tazobactam shortage (0.096 DID in 2017); the usage in 2019 (0.115 DID) was similar to 2018.

Ciprofloxacin is the most commonly prescribed quinolone, though its use has decreased (-12.6%) since 2015. The use of levofloxacin in contrast steadily increased (by 82.5%) over the same period, with use almost doubled in secondary care (0.061 DID in 2019). From 2019, the use of ciprofloxacin and levofloxacin are now no longer prescribed for uncomplicated cystitis, unless alternatives are inappropriate.\^69

**Macrolides**

Total consumption of macrolides decreased (-15.5%) over the past 5 years. The most commonly used antibiotic of the group was clarithromycin, although its use in both primary and secondary care have steadily declined since 2016. Erythromycin use has almost halved (-47.3%) over the past 5 years; with the larger decrease observed in primary care (from 0.795 to 0.413 DID). Azithromycin usage steadily increased (17.8%) and exceeded that of erythromycin in 2019 (0.543 DID for azithromycin compared to 0.444 for erythromycin).

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Sulfonamides, nitrofurantoin and trimethoprim

Between 2015 and 2019, the total consumption of sulfonamides and trimethoprim continued to decrease (-42.7%) across all settings, whereas it has risen significantly for nitrofurantoin. The change was in line with the National Institute for Health and Care Excellence (NICE) guideline, which recommends nitrofurantoin instead of trimethoprim as the first-line treatment of lower uncomplicated urinary tract infections in adults since 2014.70 Furthermore, the decrease was likely to be due to the inclusion of the Quality Premium 2017/18 and 2018/19 targets,71 which aimed at reducing the trimethoprim-to-nitrofurantoin ratio and subsequently at a reduction in trimethoprim use for patients over the age of 70.

Aminoglycosides

There was a 7.2% rise in prescribing for amin{}<sub>n</sub>o{}<sub>g</sub>lycosides between 2015 and 2019, from 0.119 to 0.127 DID. Hospital inpatient and outpatient wards have been the main prescriber settings and the use has continued to increase over the past 5 years (10.7% and 22.3% respectively). Aminoglycoside prescribing in the General Practice setting has decreased from 2015 to 2018 (-54.7%) and remained stable in 2019 (with 0.005 DID).

Parenteral glycopeptides and daptomycin

The use of parenteral glycopeptides (vancomycin and teicoplanin) and daptomycin occurs almost completely in the hospital setting (99.7%). It is used in the hospital inpatient setting, where use has continued to increase from 2015 (16.2%). Consumption for these antibiotics has increased (11.8%) over the past 5 years, particularly as a result of the rise in the use of teicoplanin (15.9%).

Colistin

Use of colistin, one of the last-resort antibiotics for multidrug-resistant infections, has remained low, although it increased marginally from 0.037 to 0.040 DID between 2015 and 2019. There was a decrease in GP prescribing from 2015 to 2018 but it remained stable in 2019 at 0.020 DID. On the other hand, use of colistin in hospital outpatients has increased further and almost doubled in the 5 years (0.010 to 0.018 DID), which may be

related to the specialised clinical commissioning policy of inhaled colistin for use in the treatment of bronchiectasis.\textsuperscript{72}

**Oral metronidazole**

Consumption of oral metronidazole decreased by -16.9% over the past 5 years (from 0.359 to 0.298 DID), driven by a decrease in all settings, except for other community and hospital inpatients, where prescribing remained largely stable at 0.005 DID and 0.050 DID respectively.

**Prescribing in primary care (in items)**

The total antibiotic prescribing in primary care settings measured by antibiotic items decreased by 13.7%, a drop from 1.912 to 1.650 items per 1,000 inhabitants per day from 2015 to 2019. On average, there were 8.6 DDDs per item, per 1,000 inhabitants per day in 2019, an increase of 3.0% compared to 2015.

Of all primary care prescribing settings, general practices prescribed the vast majority of items (85.6% of all antibiotics) in England in 2019, though this has reduced (-14.3%) since 2015. A reduction also occurred within dental practices (-24.7%). However, prescribing of antibiotic items in the other community settings continued to increase (18.4%), although the number of items prescribed remained low at 0.109 items per 1,000 inhabitants per day in 2019.

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General practice

In general practices, penicillins were the most prescribed antibiotic group accounting for 47.4% of prescriptions (0.670 items per 1,000 inhabitants per day) in England in 2019. The decline in penicillin items prescribed (-18.0%) in the last 5 years has driven the overall reduction in this setting.

In terms of items, the next most commonly prescribed antibiotic groups in 2019 were tetracyclines (15.0%) and 'other antibacterials' (13.8%) (see Chapter Annex for definition); for both groups, usage increased between 2015 and 2019 (0.9% and 68.0% respectively) (Table 4.2). The increase in 'other antibacterials' primarily reflects prescribing of nitrofurantoin, which increased by 73.6% (to 0.203 items per 1,000 inhabitants per day in 2019), reflecting the impact of the NHS England Quality Premium scheme of incentivising the switch from trimethoprim to nitrofurantoin.73

The remaining antibiotic groups continued to show reductions in the number of items prescribed within the GP setting, especially for broad-spectrum antibiotics (cephalosporins, quinolones and co-amoxiclav) with quality improvement scheme74 (see

Chapter 5) aimed at reducing the proportion of broad-spectrum antibiotics prescribed in primary care; data at practice and Clinical Commissioning Group (CCG)-level is available on Fingertips.\textsuperscript{75}

Total antibiotic items prescribed across all age-groups (see Chapter Annex for age information) continue to decrease in general practices as seen in Figure 4.3, with the reductions observed in adults (15-64) being statistically significant.

**Table 4.2. Antibiotic items prescribed by GP, expressed as items per 1,000 inhabitants per day, England, 2015 to 2019**

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Penicillins (excluding inhibitors)</td>
<td>0.731</td>
<td>0.722</td>
<td>0.677</td>
<td>0.639</td>
<td>0.613</td>
<td></td>
<td>0.002\textsuperscript{+}</td>
</tr>
<tr>
<td>Penicillins (inhibitor combinations only)</td>
<td>0.086</td>
<td>0.071</td>
<td>0.066</td>
<td>0.061</td>
<td>0.056</td>
<td></td>
<td>0.009\textsuperscript{+}</td>
</tr>
<tr>
<td>First and second-generation cephalosporins</td>
<td>0.049</td>
<td>0.043</td>
<td>0.040</td>
<td>0.037</td>
<td>0.035</td>
<td></td>
<td>0.005\textsuperscript{+}</td>
</tr>
<tr>
<td>Third, fourth and fifth-generation cephalosporins</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td></td>
<td>&lt;0.001\textsuperscript{+}</td>
</tr>
<tr>
<td>Carbapenems</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td></td>
<td>&lt;0.001\textsuperscript{+}</td>
</tr>
<tr>
<td>Tetracyclines</td>
<td>0.210</td>
<td>0.212</td>
<td>0.210</td>
<td>0.205</td>
<td>0.212</td>
<td></td>
<td>0.788</td>
</tr>
<tr>
<td>Macrolides, lincosamides and streptogramins</td>
<td>0.209</td>
<td>0.203</td>
<td>0.190</td>
<td>0.174</td>
<td>0.165</td>
<td></td>
<td>&lt;0.001\textsuperscript{+}</td>
</tr>
<tr>
<td>Sulfonamides and trimethoprim</td>
<td>0.181</td>
<td>0.170</td>
<td>0.134</td>
<td>0.097</td>
<td>0.084</td>
<td></td>
<td>0.002\textsuperscript{+}</td>
</tr>
<tr>
<td>Quinolone antibacterials</td>
<td>0.033</td>
<td>0.031</td>
<td>0.030</td>
<td>0.030</td>
<td>0.026</td>
<td></td>
<td>0.022\textsuperscript{+}</td>
</tr>
<tr>
<td>Anti-\textit{Clostridioides difficile} agents\textsuperscript{^}</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td></td>
<td>0.357</td>
</tr>
<tr>
<td>Oral metronidazole</td>
<td>0.034</td>
<td>0.032</td>
<td>0.029</td>
<td>0.027</td>
<td>0.026</td>
<td></td>
<td>&lt;0.001\textsuperscript{+}</td>
</tr>
<tr>
<td>Other antibacterials\textsuperscript{*}</td>
<td>0.116</td>
<td>0.128</td>
<td>0.159</td>
<td>0.187</td>
<td>0.195</td>
<td></td>
<td>0.003\textsuperscript{+}</td>
</tr>
</tbody>
</table>

\textsuperscript{+} Statistically significant p-value for trend from 2015 to 2019

\textsuperscript{^} Anti-\textit{Clostridioides difficile} agents: oral vancomycin and fidaxomicin

\textsuperscript{*} Other antibacterials (ATC 3rd level pharmacological subgroup ‘J01X’) include: glycopeptide antibacterials, polymyxin, steroid antibacterials, imidazole derivatives, nitrofuran derivatives, other antibacterials (full list in chapter Annex)

\textsuperscript{75} PHE. Public Health Profiles – AMR local indicators. Available: https://fingertips.phe.org.uk/profile/amr-local-indicators
Figure 4.3. Total consumption in items in general practices by age-group, expressed as items per 1,000 inhabitants per day, England, 2016 to 2019

Other community

Other community prescribing (for full list of services see Annex Chapter 4) continued to rise (20.5%), from 0.090 to 0.109 antibiotic items per 1,000 inhabitants per day between 2015 and 2019, although the number of items prescribed remains low.

Out-of-hours services remained the other community setting showing the highest rates of antibiotic prescribing, accounting for nearly half of all items prescribed (49.8%). Although many other out-of-hours providers report into the CCG cost centre and therefore would not have been counted in the other community category. The antibiotic items prescribed in out-of-hours services showed a slight reduction (-5.3%) between 2015 and 2019, possibly due to GPs extending their hours of service.

Prescribing within walk-in centres remained stable during the same period, whilst other and urgent care services saw rises of 240.7% and 93.9% respectively, although the number of items prescribed remained relatively small and some walk-in centres would
prescribe via Patient Group Directions (PGD), which is not captured the same way as other prescriptions.76

**Dental**

There was a 24.7% decrease in NHS dental prescribing of antibiotic items from 2015 to 2019. The majority of items (94.9%) prescribed in dental practices were amoxicillin (66.2%) and metronidazole (28.7%), although consumption of both antibiotics has been decreasing measured in both items and DDDs. In contrast, prescribing of other key antibiotic items in the dental setting remained stable between 2015 and 2019 (Table 4.3).

For prescribing in private dental practices, see the results of the pilot project in the Antimicrobial Stewardship chapter.
### Table 4.3. Dental antibiotic consumption for the most commonly used antibiotics, expressed as items and DDDs per 1,000 inhabitants per day, 2015 to 2019

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Items</td>
<td>DDDs</td>
<td>Items</td>
<td>DDDs</td>
<td>Items</td>
</tr>
<tr>
<td>Amoxicillin</td>
<td>0.112</td>
<td>0.567</td>
<td>0.104</td>
<td>0.541</td>
<td>0.096</td>
</tr>
<tr>
<td>Co-amoxiclav</td>
<td>0.001</td>
<td>0.003</td>
<td>0.001</td>
<td>0.002</td>
<td>0.001</td>
</tr>
<tr>
<td>Clarithromycin</td>
<td>0.000</td>
<td>0.003</td>
<td>0.000</td>
<td>0.004</td>
<td>0.000</td>
</tr>
<tr>
<td>Clindamycin</td>
<td>0.000</td>
<td>0.003</td>
<td>0.000</td>
<td>0.002</td>
<td>0.000</td>
</tr>
<tr>
<td>Erythromycin</td>
<td>0.007</td>
<td>0.048</td>
<td>0.006</td>
<td>0.045</td>
<td>0.005</td>
</tr>
<tr>
<td>Oral Metronidazole</td>
<td>0.049</td>
<td>0.124</td>
<td>0.045</td>
<td>0.118</td>
<td>0.042</td>
</tr>
</tbody>
</table>
Prescribing in secondary care (by hospital admission)

Measuring antibiotic use in secondary care using hospital admissions as the denominator showed prescribing increased by 3.5% (from 4,572 to 4,730 DDDs per 1,000 admissions) between 2015 and 2019, despite various improvement schemes (see Chapter 5). This increase was driven by prescribing for hospital inpatients, which increased by 7.8%, in contrast to hospital outpatient prescribing which decreased by 3.3% over the same period. This increase in prescribing by Trusts may be due to the practice of replacing single broad-spectrum antibiotics, such as carbapenems or piperacillin/tazobactam (following the shortage in supply in 2017), with 2 or more narrow spectrum antibiotics that have the same clinical indication for use.

As Table 4.4 shows, there has been increased prescribing of penicillins with and without inhibitor combinations. Statistically significant increases in the last 5 years were also observed for tetracyclines and ‘other antibacterials’ (see Chapter Annex for definition), the latter reflecting increased use of nitrofurantoin (6.6%). Significant increases in consumption were also observed for third, fourth and fifth-generation cephalosporins, due to the reduction in piperacillin/tazobactam use. In 2019, (714.1 DDDs per 1,000 admissions) consumption of tetracyclines has overtaken macrolides, lincosamides and streptogramins (583.0 DDDs per 1,000 admissions), as the usage of these antibiotics continued to decrease.

A significant decrease in usage has been observed for carbapenems, sulphonamides and trimethoprim, and oral metronidazole between 2015 and 2019 (Table 4.4).

Shown in the online Annex, there are increasing trends in the prescribing by all acute Trust types (definitions in Chapter Annex) over the 5 years, besides consumption in multiservice Trusts, which has been decreasing since 2017.

AWaRe

The World Health Organization updated the Essential Medicine List (EML) in 2017 and classified key antibiotics into 3 categories (AWaRe):77 to improve access (Access), to monitor important antibiotics (Watch) and preserve ‘last resort’ antibiotics (Reserve).

The list was adopted for use in antimicrobial stewardship policies across the UK.\textsuperscript{78,79} The target to increase the proportion of antibiotic usage in the ‘Access’ category featured in the ‘Reducing the impact of serious infections (antimicrobial resistance and sepsis) of Commissioning for Quality and Innovation (CQUIN)\textsuperscript{80} scheme 2017-19’ for NHS Trusts.

To preserve the most important antibiotics, a target of 10\% reduction in the use of drugs in the ‘Reserve’ and ‘Watch’ categories was set out in the 5-year National Action Plan.\textsuperscript{81} The full AWaRe index of each antibiotic with ATC code is available in the paper describing the adaptation of WHO’s EML in England.\textsuperscript{82}

Fingertips\textsuperscript{83} indicators for monitoring the progress at NHS Trust level are available for ‘Access’, as well as ‘Reserve’ and ‘Watch’ antibiotics in due course.

\textsuperscript{81} World Health Organization. AWaRe. 2019. Available: https://adoptaware.org/
\textsuperscript{83} PHE. Public Health Profiles – AMR local indicators. Available: https://fingertips.phe.org.uk/profile/amr-local-indicators
### Table 4.4. Antibiotic consumption in Trusts by antibiotic group, expressed as DDDs per 1,000 admissions, England, 2015 to 2019

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Penicillins (excluding inhibitors)</td>
<td>1144.7</td>
<td>1165.2</td>
<td>1155.8</td>
<td>1151.5</td>
<td>1125.5</td>
<td>_____</td>
<td>0.333</td>
</tr>
<tr>
<td>Penicillins (inhibitor combinations only)</td>
<td>802.5</td>
<td>822.2</td>
<td>798.6</td>
<td>841.7</td>
<td>842.4</td>
<td>_____</td>
<td>0.140</td>
</tr>
<tr>
<td>First and second-generation cephalosporins</td>
<td>97.5</td>
<td>92.1</td>
<td>98.5</td>
<td>98.2</td>
<td>95.0</td>
<td>_____</td>
<td>0.923</td>
</tr>
<tr>
<td>Third, fourth and fifth-generation cephalosporins</td>
<td>72.7</td>
<td>80.4</td>
<td>94.9</td>
<td>100.3</td>
<td>97.3</td>
<td>_____</td>
<td>0.030†</td>
</tr>
<tr>
<td>Carbapenems</td>
<td>76.3</td>
<td>73.2</td>
<td>72.8</td>
<td>66.8</td>
<td>64.6</td>
<td>_____</td>
<td>0.007†</td>
</tr>
<tr>
<td>Tetracyclines</td>
<td>528.1</td>
<td>552.2</td>
<td>580.0</td>
<td>628.2</td>
<td>714.1</td>
<td>_____</td>
<td>0.009†</td>
</tr>
<tr>
<td>Macrolides, lincosamides and streptogramins</td>
<td>681.4</td>
<td>684.9</td>
<td>668.4</td>
<td>640.8</td>
<td>583.0</td>
<td>_____</td>
<td>0.035†</td>
</tr>
<tr>
<td>Sulfonamides and trimethoprim</td>
<td>290.0</td>
<td>277.3</td>
<td>255.5</td>
<td>248.9</td>
<td>245.5</td>
<td>_____</td>
<td>0.009†</td>
</tr>
<tr>
<td>Quinolone antibacterials</td>
<td>267.1</td>
<td>274.5</td>
<td>284.3</td>
<td>307.8</td>
<td>286.4</td>
<td>_____</td>
<td>0.154</td>
</tr>
<tr>
<td>Anti-<em>Clostridioides difficile</em> agents^</td>
<td>4.3</td>
<td>3.9</td>
<td>4.0</td>
<td>4.2</td>
<td>4.4</td>
<td>_____</td>
<td>0.422</td>
</tr>
<tr>
<td>Oral metronidazole</td>
<td>131.5</td>
<td>123.7</td>
<td>121.6</td>
<td>117.7</td>
<td>113.8</td>
<td>_____</td>
<td>0.003†</td>
</tr>
<tr>
<td>Other antibacterials*</td>
<td>323.4</td>
<td>334.7</td>
<td>366.6</td>
<td>386.9</td>
<td>392.4</td>
<td>_____</td>
<td>0.004†</td>
</tr>
</tbody>
</table>

† Statistically significant p-value for trend from 2014 to 2018

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

* Other antibacterials (ATC 3rd level pharmacological subgroup ‘J01X’) include: glycopeptide antibacterials, polymyxin, steroid antibacterials, imidazole derivatives, nitrofuran derivatives, other antibacterials

### Colistin

Usage of colistin in secondary care although small, continued to increase in the last 5 years (from 15.8 to 25.2 DDD per 1,000 admissions, a 59.8% increase), although there was only a 4.3% increase between 2018 and 2019. The increase was observed in usage for both administration routes, with an 77.0% increase for colistin administered by inhalation and a 43.1% increase for parenteral medication.

Over the same period, there was a decrease of colistin usage in multiservice (-15.9%) and small Trusts (-5.6%). Consumption figures for other Trust types have increased, particularly within specialist Trusts where usage reached 208.4 DDDs per 1,000 admissions in 2019.
Carbapenems

There was a significant decrease in carbapenem consumption in 2019, falling to 64.6 DDDs per 1,000 admissions, a 15.3% decrease from 2015 (Table 4.4). Consumption has significantly fallen for most Trust types in the last 5 years, with the exception of multiservice and specialist Trusts.

Piperacillin/tazobactam

There were similar trends across all Trust types for piperacillin/tazobactam prescribing. Following the large reduction (-40.0%) due to the international shortage from 141.5 DDDs per 1,000 admissions in 2015 to 85.0 DDDs per 1,000 admissions in 2017, overall consumption subsequently increased by 14.7% to 97.5 DDDs per 1,000 admissions in 2019. Specialist Trusts’ levels of consumption were nearly back to those seen pre-shortage by 2019 (128.1 DDDs per 1,000 admissions in 2015 vs. 117.7 DDDs per 1,000 admissions in 2019) (Figure 4.4).

As a result of the piperacillin/tazobactam shortage and stewardship schemes, which aim to reduce the use of broad-spectrum antibiotics, increases in usage of antibiotics that can be used as alternatives, such as cephalosporins, quinolones or carbapenems were observed from 2017 onwards.

Ciprofloxacin usage, for example, increased in 2018 but returned to pre-shortage levels in 2019. Usage levels of cephalosporins and quinolones remained similar in 2019, compared to 2018. Although the recently launched cephalosporin/β-lactamase inhibitor combinations ceftolozane/tazobactam and ceftazidime/avibactam, were initially used in small amounts in secondary care, both have shown a steady increase since they were licenced for use in 2016 and 2017 respectively (Table 4.5).
Figure 4.4. Piperacillin/tazobactam consumption in Trusts by Trust type, expressed as DDDS per 1,000 admissions, England, 2015 to 2019

Table 4.5. Quinolone antibacterials and cephalosporins consumption in Trusts, expressed as DDDS per 1,000 admissions, England, 2015 to 2019

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ciprofloxacin</td>
<td>194.2</td>
<td>197.1</td>
<td>195.1</td>
<td>204.4</td>
<td>188.2</td>
</tr>
<tr>
<td>Levofloxacin</td>
<td>40.6</td>
<td>46.7</td>
<td>62.3</td>
<td>75.2</td>
<td>77.0</td>
</tr>
<tr>
<td>Cefuroxime</td>
<td>36.0</td>
<td>35.9</td>
<td>43.2</td>
<td>44.0</td>
<td>43.0</td>
</tr>
<tr>
<td>Cefotaxime</td>
<td>20.4</td>
<td>21.8</td>
<td>22.8</td>
<td>23.9</td>
<td>22.3</td>
</tr>
<tr>
<td>Ceftazidime</td>
<td>13.0</td>
<td>14.7</td>
<td>19.7</td>
<td>18.5</td>
<td>17.8</td>
</tr>
<tr>
<td>Ceftriazone</td>
<td>38.3</td>
<td>42.9</td>
<td>51.4</td>
<td>56.5</td>
<td>55.7</td>
</tr>
<tr>
<td>Ceftazidime/avibactam</td>
<td>-</td>
<td>-</td>
<td>0.1</td>
<td>0.3</td>
<td>0.5</td>
</tr>
<tr>
<td>Ceftolozane/tazobactam</td>
<td>-</td>
<td>0.1</td>
<td>0.2</td>
<td>0.4</td>
<td>0.5</td>
</tr>
</tbody>
</table>

- not authorised for use in the UK

Speciality prescribing

Prescribing in secondary care by speciality groups is reported here. See Annex Chapter 4 for specialities grouping within each group.

In terms of speciality within secondary care, intensive care units (ICUs) had the highest antibiotic usage, with 55.8 DDDS per ICU admission in 2019. There was increased antibiotic prescribing for all specialities between 2015 and 2019, except for geriatrics and general medicine.
The proportions of important antibiotics prescribed by specialist groups has remained similar to last year. For piperacillin/tazobactam and carbapenem prescribing in 2019, ICUs also accounted for the highest usage (6.1% and 5.0% of total DDDs per admission respectively). For colistin, paediatrics had the highest proportion of prescribing (2.8%) (Table 4.6). 

Table 4.6. Proportion of all antibiotic prescribing attributed to piperacillin/tazobactam, carbapenems and colistin in secondary care by speciality, expressed as DDDs per admissions, England, 2019

<table>
<thead>
<tr>
<th>Specialist Group</th>
<th>DDDs per admission</th>
<th>Piperacillin/tazobactam</th>
<th>Carbapenems</th>
<th>Colistin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensive Care Unit</td>
<td>55.6</td>
<td>6.0%</td>
<td>5.0%</td>
<td>0.2%</td>
</tr>
<tr>
<td>AE/Non-specific Out-Patient Department</td>
<td>14.4</td>
<td>0.7%</td>
<td>0.3%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Geriatrics</td>
<td>3.5</td>
<td>3.4%</td>
<td>1.5%</td>
<td>0.0%</td>
</tr>
<tr>
<td>General Medicine</td>
<td>3.3</td>
<td>2.9%</td>
<td>1.7%</td>
<td>1.2%</td>
</tr>
<tr>
<td>General Surgery</td>
<td>3.5</td>
<td>2.2%</td>
<td>1.0%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Specialist Medicine</td>
<td>3.9</td>
<td>2.1%</td>
<td>1.8%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Other</td>
<td>4.4</td>
<td>1.5%</td>
<td>1.1%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Orthopaedics</td>
<td>2.9</td>
<td>1.7%</td>
<td>1.2%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Obstetrics and Gynaecology</td>
<td>2.6</td>
<td>0.6%</td>
<td>0.3%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Paediatrics</td>
<td>2.1</td>
<td>1.5%</td>
<td>1.4%</td>
<td>2.8%</td>
</tr>
<tr>
<td>Specialist Surgery</td>
<td>2.2</td>
<td>1.5%</td>
<td>1.3%</td>
<td>0.4%</td>
</tr>
</tbody>
</table>

Antibiotic consumption surveillance systems

Unintended consequences

Important changes in terms of levels of antibiotic use and the antibiotic groups used in different healthcare settings have been reported by ESPAUR.

In response to concerns raised by the public and healthcare professionals that reduced prescribing could have potential unintended consequences, such as increased incidence of serious infections, PHE is currently undertaking an appraisal of options for monitoring, analysing and disseminating health data for unintended consequences of changes in antibiotic use in England.

Unified Infection Dataset

PHE made a successful bid for AMR Research Capital Funding (National Institute for Health Research AMR Call 2018) to invest in the development of a system - the Unified Infection Dataset (UID) - which will provide linked data on infections, AMR, antimicrobial
prescribing and clinical outcomes. The UID will perform routine and on-demand linkage of data from four core datasets currently held by PHE and will be scalable to accommodate other datasets in future. The UID will assist PHE in executing its health protection functions, including surveillance, epidemiological analyses and generation of public health intelligence.

Four nations

The UK public health agencies are working together to achieve the ambitions set out in the AMR National Action Plan, with the devolved administrations (Northern Ireland, Scotland, and Wales) sharing their national antimicrobial usage data with that from England to enable it to be collated to provide a UK-wide picture.

European – ESAC-Net

The UK submits antibiotic consumption data to the European Surveillance of Antimicrobial Consumption Network (ESAC-Net). ESAC-Net’s annual epidemiological report based on antimicrobial consumption data reported by the UK, EU Member States and 2 EEA countries (Iceland and Norway) is due to be published in November 2020.

Discussion

Total antibiotic consumption in England continued to decrease, falling from 19.4 DDDs per 1,000 inhabitants per day in 2015 to 17.9 DDDs per 1000 inhabitants per day in 2019 – progressing towards the targets to reduce antibiotic use as set out in the National Action Plan.

The largest proportion of antibiotic prescribing in 2019 was in primary care, with GPs accounting for 71.4% of total consumption; the consumption in the GP setting has continued to decrease over the five-year period (-12.2%), alongside reductions seen in NHS dental practices (-19.5%). In contrast, increases were recorded in the other community settings (28.7%), although overall usage is much lower compared to GPs. In secondary care (21.0% of total consumption), prescribing has increased over the past 5 years by 8.8%. The hospital inpatient setting was the main driver behind increases (13.4%) in secondary care.


Between 2015 and 2019, overall consumption of third, fourth and fifth-generation cephalosporins and 'other antibacterials' (see Chapter Annex for definition), such as nitrofurantoin, increased significantly.

For the newly licensed antibiotics ceftazidime/avibactam and ceftolozane/tazobactam consumption in secondary care has gradually increased. Close monitoring of new antibiotics, along with antibiotics in the ‘Watch’ and ‘Reserve’ groups of the WHO’s AWaRe classification of antibiotics, is required to ensure the effectiveness of critical antibiotics.

Therefore, it is important to continue monitoring antibiotic use, its impact on antimicrobial resistance and to promote antimicrobial stewardship within healthcare settings as well as educating the general population on how to correctly use antimicrobials and on the dangers associated with misuse and overuse of antibiotics. PHE have worked closely with key stakeholders, for example NICE, to inform development of clinical treatment guidelines or the Royal College of General Practitioners to develop tools for prescribers to encourage appropriate antibiotic use.

Future actions

To assess usage of antimicrobials and corresponding resistance rates in the context of the COVID-19 pandemic to support the incident response in England and inform antimicrobial stewardship activities at national and local level.

To continue work on appraisal of options of monitoring, analysing and disseminating health data for unintended consequences of changes in antibiotic use in England.

To continue monitoring changes to antibiotic prescribing in relation to policy and guidance changes.

To carry out research exploring the impact of PHE campaigns on dentistry and other community service given the increases in primary care consumption.

5. NHS quality improvement and assurance schemes

Reducing total antibiotic consumption in NHS Trust providers of acute care services

During the financial years 2017/18 and 2018/19 NHS hospital Trusts providing acute care services participated in the NHS Commissioning for Quality and Innovation (CQUIN) scheme to reduce their antibiotic consumption, and this requirement moved into the NHS Standard Contract in financial year 2019/20\(^88\). Within this contract, all NHS Trusts providing acute care are required to reduce their antibiotic consumption by 1% from their own 2018 calendar year baseline value. Performance is reported as the total number of antibiotics as Defined Daily Dose per 1000 hospital admissions (DDD/1000 admissions).

The updated 2019 DDDs as defined by the WHO were used. Anti-tuberculosis, anti-parasitic and topical antibiotics (for example implants) were excluded from the consumption measure, as were antibiotic formulations for which the World Health Organisation (WHO) have not assigned DDDs. Antibiotic consumption data reported as DDDs for all NHS Trusts was provided by Rx-Info each month. Trusts remained able to submit consumption data directly to Public Health England (PHE) if they preferred to do so.

PHE retrieved admissions data from Hospital Episode Statistics (HES) data for each Trust\(^89\), and this was used to report the total antibiotic consumption as DDD/1000 admissions for each Trust. PHE published all Trust consumption data quarterly on PHE Fingertips\(^90\).

Antimicrobial consumption data and Trust performance

Complete data for Quarter 1 to Quarter 4 2019/20 were available for 145 Trusts, of which 43 (30%) met the requirement to deliver a 1% or greater reduction in total antibiotic consumption from their 2018 calendar year baseline value; (median 4% reduction; range 1% to 32% reduction DDD/1000 admissions).

\(^{88}\) https://www.england.nhs.uk/nhs-standard-contract/19-20/
\(^{90}\) https://fingertips.phe.org.uk/profile/amr-local-indicators
Seventy-eight of 145 (54%) Trusts had a 1% or greater increase in total antibiotic consumption (median 4% increase; range 0% to 37% increase DDD/1000 admissions). Overall this resulted in a 2% increase in antibiotic consumption in England from 4567 DDD/1000 admissions in 2018 to 4669 DDD/1000 admissions in financial year (FY) 2019/20. However, when compared to the previous FY, 2019/20 reported an increase of 4% from an England value of 4482 DDD/1000 admissions in FY 2018/19 when the 2017 to 2019 CQUIN scheme delivered improvement.

Reducing antibiotic prescribing in primary care

The NHS Oversight Framework replaced the Clinical Commissioning Group (CCG) Improvement and Assessment Framework (IAF) in 2019/20\(^1\). It is intended as a focal point for joint work, support and dialogue between NHS England and NHS Improvement, clinical commissioners, providers and sustainability and transformation partnerships and integrated care systems.

The NHS Oversight Framework 2019/20 contained the 2 antimicrobial resistance (AMR) related indicators with set targets that have been used in NHS improvement and assurance schemes for CCGs since 2015. The indicators are:

- 107a – reduction in the number of antibiotics prescribed in primary care to be equal to or below value of 0.965 antibacterial items per Specific Therapeutic Group Age-sex Weightings-Related Prescribing Units (STAR-PU) (12 months)
- 107b – number of co-amoxiclav, cephalosporins and quinolones as a percentage of the total number of selected antibacterials prescribed in primary care to be 10% or below

NHS Oversight Framework data sources

NHS England and NHS Improvement, in collaboration with the NHS Business Services Authority report CCG performance for these 2 AMR indicators in order to monitor antibiotic prescribing in primary care and report CCG progress towards the NHS Oversight Framework targets. The NHS Business Services Authority report CCG performance monthly within the NHS antibiotic monitoring dashboard which is published here.

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\(^1\) [https://improvement.nhs.uk/resources/nhs-oversight-framework-201920/](https://improvement.nhs.uk/resources/nhs-oversight-framework-201920/)
**Antimicrobial prescribing in primary care and NHS clinical commissioning group performance**

NHS CCGs have participated in NHS improvement and assurance schemes since 2015 and have delivered sustained reductions in primary care antibiotic prescribing during this time frame. In 2019/20, 96/191 (50%) CCGs met or exceeded the national target to reduce antibacterial items/STAR-PU to at or below 0.965. This is an improvement on FY 2018/19 when 90/191 (47%) CCGs met or exceeded this target. This delivered an England value of antibacterial items/STAR-PU = 0.938, which is a lower value than that reported in the previous 2018/19 financial year.

At the same time, 171/191 (90%) CCGs met or exceeded the national targets to reduce the proportion of co-amoxiclav, cephalosporins and quinolones to ≤10%, an improvement on the 2018/19 financial year where 148/191 (77%) CCGs met or exceeded this target. This has resulted in a 6% reduction of 153,000 prescriptions for broad spectrum antibiotics in primary care during FY 2019/20, which now account for 8.2% of all antibacterial prescription items compared to 8.7% in FY 2018/19.

CCG performance against both targets is reported in the NHS Oversight Framework with CCG performance reported monthly by NHS England92.

**NHS Commissioning for Quality and Innovation (CQUIN) scheme 2019/20**

The NHS England 2019/20 CQUIN scheme included 2 AMR indicators supporting delivery of the delivery of the UK National Action Plan 2019-2024 ambitions to reduce antimicrobial use in humans by 15% by 2024, and halve healthcare associated Gram-negative bloodstream infections93. CQUIN AMR indicator specifications are published by NHS England94 and resources to support their implementation are published by NHS Improvement95. The 2 AMR indicators are:

- **CCG1a** – improving the management of lower urinary tract infections (UTIs) in older people
- **CCG1b** – improving antibiotic prophylaxis in colorectal surgery

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All hospitals who were commissioned to provide acute NHS care in England were eligible to participate in the 2019/20 AMR CQUIN scheme, which required submission of a minimum sample of 100 patient cases meeting the indicator criteria in each of the 4 financial year quarters (Q1-Q4). Where the quarterly total of cases was less than 100, all cases were submitted. Quarterly reporting was submitted to PHE with performance reporting published for each hospital on PHE Fingertips portal.\(^{96}\)

CQUIN scheme achievement was intended to be based on a full FY performance - combined Q1-Q4 data and required case compliance of 60% or greater to receive partial payment, and 90% or greater to receive full payment. However, the scheme rules were amended to accommodate the impact of the COVID-19 pandemic during Q4, and consequently hospitals were not required to submit Q4 data to meet CQUIN achievement; however, Q4 data could continue to be submitted if hospitals wished to do so and would be taken into account. Additional challenges to implementation of CCG1a scheme resulted in a change to compliance based on Q2 and Q3 only, although Trusts could request Q1 data inclusion if required. As a result, all data for Q1-Q4 is reported here, with Q2 and Q3 data reported as scheme compliance for CCG1a, and any 3 quarters data reported as scheme compliance for CCG1b.

**CCG1a: Improving the management of lower UTIs in older people**

This scheme was intended to improve the diagnosis and appropriate use of antibiotics to treat lower UTIs in adults aged 65+ years, in line with National Institute for Health and Care Excellence (NICE) guidance Urinary tract infection (lower): antimicrobial prescribing (NG109)\(^{97}\) and PHE guidance Diagnosis of urinary tract infections.\(^{98}\) CQUIN case compliance required the antibiotic prescription for adults aged 65+ years for the treatment of a lower UTI met all four indicators which are:

- diagnosis of lower UTI based on documented clinical signs or symptoms
- diagnosis excludes use of urine dip stick
- empirical antibiotic prescribed following NICE guidance (NG109) or local guidelines
- urine sample sent to microbiology

109/147 NHS hospital Trusts submitted data for one or more quarters, with 102/147 (69%) submitting data for 2 or more quarters.

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96 https://fingertips.phe.org.uk/profile/amr-local-indicators
97 https://www.nice.org.uk/guidance/ng109
A total of 23,531 cases (a prescription for antibiotic treatment of lower UTI) were submitted during the four quarters of the scheme year, with 9,552 (41%) reported as case compliant. This data is reported for each quarter in table 5.1 which demonstrates significant improvement in case compliance increased each quarter from Q1 to Q4.

The number of Trusts submitting data varies for each quarter, with 97/147 (66%) Trusts submitting data during Q2 and Q3. Twenty-eight of 97 (30%) Trusts with data submitted for these quarters achieved ≥60% case compliance and 2/97 (2%) Trusts achieved ≥90% case compliance.

Table 5.1. 2019/20 CQUIN scheme CCG1a indicator: Lower Urinary Tract Infections in Older People. Case compliance, NHS Trust performance and CQUIN scheme achievement

<table>
<thead>
<tr>
<th></th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q1-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cases audited</td>
<td>6940</td>
<td>7702</td>
<td>7596</td>
<td>1293</td>
<td>23,531</td>
</tr>
<tr>
<td>Number of cases CQUIN compliant</td>
<td>2079</td>
<td>3125</td>
<td>3623</td>
<td>725</td>
<td>9552</td>
</tr>
<tr>
<td>Proportion of cases CQUIN compliant</td>
<td>30%</td>
<td>41%</td>
<td>48%</td>
<td>56%</td>
<td>41%</td>
</tr>
<tr>
<td>Number of acute Trusts submitting data</td>
<td>96</td>
<td>101</td>
<td>101</td>
<td>19</td>
<td>109</td>
</tr>
<tr>
<td>Number of acute Trusts eligible to submit data</td>
<td>147</td>
<td>147</td>
<td>147</td>
<td>147</td>
<td>147</td>
</tr>
<tr>
<td>Proportion of all eligible Trusts submitting data</td>
<td>65%</td>
<td>69%</td>
<td>69%</td>
<td>13%</td>
<td>13%</td>
</tr>
<tr>
<td>Number of Trusts</td>
<td>10/96 (10%)</td>
<td>25/101 (25%)</td>
<td>35/101 (35%)</td>
<td>11/19 (58%)</td>
<td></td>
</tr>
</tbody>
</table>
Eight private organisations who provided NHS care participated in this scheme, however due to the very small case numbers per organisation, this data has been excluded from the report (44 cases in total in Quarters 1-4, all of which were case compliant).

CCG1b: Improving antibiotic prophylaxis in colorectal surgery

This scheme was intended to improve the use of antibiotic prophylaxis regimens to prevent surgical site infections in adults undergoing elective colorectal surgery, in line with NICE guidance Surgical site infections: prevention and treatment (NG125)99. CQUIN case compliance required antibiotics for surgical prophylaxis in elective colorectal surgery were prescribed as a single dose / regimen and in accordance with local antibiotic guidelines.

A total of 16,106 cases (case = a prescription for antibiotic prophylaxis for elective colorectal surgery) were submitted during the four quarters of the scheme year, with 13,134 (82%) reported as case compliant. This data is reported for each quarter in table 5.2 which demonstrates improvement in case compliance increased each quarter from Q1 to Q4.

99 https://www.nice.org.uk/guidance/ng125
The number of Trusts submitting data varied for each quarter. 113/147 NHS hospital Trusts submitted data for one or more quarters, with 100/147 (68%) Trusts submitting at least 3 quarters of data during the scheme. 89/100 (89%) of these Trusts achieved ≥60% case compliance and 35/100 (35%) Trusts achieved ≥90% case compliance.

Table 5.2. 2019/20 CQUIN scheme CCG1b: Improving Antibiotic Prophylaxis in Colorectal Surgery. Case compliance, NHS Trust performance and CQUIN scheme achievement

<table>
<thead>
<tr>
<th></th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q1-4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of cases audited</strong></td>
<td>5000</td>
<td>4868</td>
<td>5004</td>
<td>1234</td>
<td>16,106</td>
</tr>
<tr>
<td><strong>Number of cases CQUIN compliant</strong></td>
<td>3766</td>
<td>3966</td>
<td>4289</td>
<td>1113</td>
<td>13,134</td>
</tr>
<tr>
<td><strong>Proportion of cases CQUIN compliant</strong></td>
<td>75%</td>
<td>82%</td>
<td>86%</td>
<td>90%</td>
<td>82%</td>
</tr>
<tr>
<td><strong>Number of acute Trusts submitting data</strong></td>
<td>105</td>
<td>108</td>
<td>105</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td><strong>Number of acute Trusts eligible to submit data</strong></td>
<td>147</td>
<td>147</td>
<td>147</td>
<td>147</td>
<td></td>
</tr>
<tr>
<td><strong>Proportion of all eligible Trusts</strong></td>
<td>71%</td>
<td>74%</td>
<td>71%</td>
<td>16%</td>
<td></td>
</tr>
<tr>
<td><strong>Number of Trusts achieving ≥60% case compliance</strong></td>
<td>81/105 (77%)</td>
<td>95/108 (88%)</td>
<td>97/105 (92%)</td>
<td>23/23 (100%)</td>
<td></td>
</tr>
<tr>
<td>participating Trusts</td>
<td>Number of Trusts achieving ≥90% case compliance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------------------------------------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td></td>
<td>31/105 (30%)</td>
<td>47/108 (44%)</td>
<td>60/105 (56%)</td>
<td>16/23 (70%)</td>
<td></td>
</tr>
<tr>
<td>Number of Trusts submitting data for 3 or 4 quarters</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Trusts submitting data for 3 or 4 quarters achieving ≥60% CQUIN case compliance</td>
<td>89/100 (89%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Trusts submitting data for 3 or 4 quarters achieving ≥90% CQUIN case compliance</td>
<td>35/100 (89%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Five private organisations who provided NHS care participated in this scheme, however due to zero case numbers this data has been excluded from the report (0 cases in total in Quarters 1-4).
6. Antimicrobial stewardship

‘Tackling Antimicrobial Resistance 2019 to 2024: the UK’s 5-year national action plan’\(^{100}\) states that the sub-optimal use of antimicrobials in human medicine is one of the main drivers of antimicrobial resistance (AMR). It has a target to reduce UK antimicrobial use in humans by 15% by 2024. Part of this action plan is to strengthen stewardship programmes to ensure antimicrobials are only used when appropriate. This chapter outlines key antimicrobial stewardship (AMS) interventions delivered during 2019/20:

- Primary care
  - TARGET (Treat Antibiotics Responsibly, Guidance Education and Tools)
  - Self-Reported AMS in Primary Care
  - Preventing and managing urinary tract infection (UTI): Enhancing the role of community pharmacists
  - Newly developed audits including uncomplicated UTI, catheter-associated UTI and UTI in over 65-year olds
  - Development of the TARGET Treating your Infection - Self-Care leaflet
- Update of NICE/PHE Management of Common Infections (MOCI) reference tools
- Assessment of UK healthcare workers’ knowledge, attitudes and behaviour on antibiotics to influence antimicrobial stewardship
- Behavioural insights interventions on AMS
  - Social norms feedback letters to General Practice
- Dental Practice
  - Antimicrobial prescribing in private dental practice
  - Dental subgroup of ESPAUR

Primary care

The PHE Primary Care Interventions Unit led on a number of programme and projects including the TARGET antibiotics programme, the analysis of responses to the self-report on AMS practices by General Practice, development of a self-care infection leaflet and audits and worked with community pharmacy to enhance the role of the community pharmacist in preventing and treating UTIs.

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TARGET (Treat Antibiotics Responsibly, Guidance Education and Tools)

The TARGET antibiotics toolkit\(^\text{101}\) is a suite of AMS resources designed to be used by the whole primary care team within a GP practice or out of hours setting. The toolkit is hosted on the Royal College of General Practitioners website and remains the most accessed section of their website throughout 2019/20. Monthly website views (Figure 6.1) show peaks in use during the winter months (seasonal flu period) or following promotional activities.

The ‘Leaflets for Patients’ section was the most popular section of the TARGET Toolkit website with 52,715 visits. The ‘UTI Resource Suite’ the second most visited section with 24,437 visits; both sections show a 3.5-fold increase in visits compared to the previous year. Further details from the study is available in the Annex for Chapter 6.

**Figure 6.1. TARGET Toolkit website: monthly total views between April 2019 and March 2020. Data points represent total numbers of website views per month. Promotional activities and release of new resources are indicated by coloured lines**

Self-reported antimicrobial stewardship practices in primary care

The self-assessment tool (SAT) is a 16-question self-report of antimicrobial stewardship practices in primary care, available in the TARGET Antibiotics Toolkit\textsuperscript{102,103} and the e-module Antibiotic Resistance in Primary Care.\textsuperscript{104} This study analysed responses to the SAT (July 2016 to September 2019) (n=2,373) and compared them to previous SAT data (November 2014 to June 2016) (n=1,415).

Clinicians reported engaging in positive AMS practices including using antibiotic guidance to inform treatment decisions (98%, no change), discussing antibiotic prescribing within the practice (73%, increase 6%), using patient-facing resources (94%, increase 23%), conducting antibiotic audits in the last 2 years (98%, increase 53%), keeping written records and action plans (81%, increase 19%), using back-up prescribing (99%, increase 5%) and using clinical coding (80%, increase 5%).

Areas for improvement include:

- developing strategies to avoid patients reconsulting to obtain antibiotics (45%, increase 12%)
- undertaking antibiotic-related learning (37%, increase 8%)
- ensuring all temporary prescribers have access to antibiotic guidance (55%, decrease 8%)
- having easily available patient information leaflets in consultations (31%; not comparable with previous data)

The findings offer a unique insight into the self-reported AMS behaviours in primary care and suggestions for ways to optimise AMS. It is reassuring to see that in the last 3 years, attention to AMS activities has not waned, and in many areas, has increased.

Further details from the study is available in the Annex - Chapter 6.


\textsuperscript{103} www.rcgp.org.uk/targetantibiotics

\textsuperscript{104} https://elearning.rcgp.org.uk/course/info.php?popup=0&id=167
TARGET Newly developed UTI audits

The PHE TARGET team, with input from local GPs, has developed 3 new UTI primary care audits accessible via the TARGET website which are:

- uncomplicated UTI
- catheter-associated UTI
- UTI in over 65-year olds

Each audit assesses the diagnosis and management of suspected UTI against the PHE diagnostic guidelines and the NICE/PHE antibiotic treatment guidelines. They are available to download in both Microsoft Word and Excel (includes calculating cells) formats, to suit user preferences. It encourages audit participants to develop an action plan based on the audit results, a template for which is provided on the final page of each audit.

TARGET Treating your infection – self-care leaflet

An important part of the AMR Action Plan is to raise public awareness to encourage self-care when ill. The PHE TARGET team have developed a Self-care patient information leaflet to empower patients and carers to be able to self-care when suffering from a common infection such as colds, flu and winter vomiting bugs. The leaflet has been designed with input from patients and health care professionals and is suitable for use in primary care settings. The leaflet includes information on:

- types, symptoms and durations of common infections
- ways to make yourself feel better / self-care actions
- safety netting / signs of serious illness
- where to get help
- ways to prevent the spread of infections

Preventing and managing UTI: enhancing the role of community pharmacists

Community pharmacists play a vital role in AMS as highlighted by the Department of Health 5-year National Action Plan. A national survey in 2014 of 2,424 females living in the UK showed that 13% of women first contacted a pharmacist for advice on their UTI; since then national and local campaigns around “seeking your pharmacist’s advice” have been promoted.

In 2019 Imperial College London in collaboration with PHE trialled the TARGET Treating Your Infection patient information leaflets for both uncomplicated UTI and UTI in the elderly in the community pharmacy setting to identify opportunities to enhance the role of community pharmacists specifically in the management of patients with suspected or confirmed UTI.

Findings from the 38 pharmacists and 51 service users allowed triangulating responses about the patient journey which were:

- 25% (13/51) of service users with urinary symptoms had sought help first from a pharmacist
- pharmacists were confident in giving advice about UTI and 65% (n=33/51) of the service users were comfortable discussing their urinary symptoms in private settings with pharmacists
- pharmacists felt that that they could be the first professional contact for service users with suspected UTI but pointed out the need for additional funding and staff to do so, the lack of a specific pathway to refer patients, and the importance of increasing the prescribing role of pharmacists
- community pharmacists have a key role in supporting the control of AMR by educating service users about viral and bacterial infections and promoting a healthy lifestyle
- pharmacists felt that both TARGET UTI leaflets could be combined for use in the pharmacy setting

This study demonstrates how future strategies to enhance the role of community pharmacists with integrated working between general practices and community pharmacy may optimise the management of service users with suspected UTI. The current reconfiguration of primary care in England with primary care networks, integrated care systems and the new community pharmacy contract could provide a real opportunity for collaborative working.

**NICE/PHE management of common infections guidelines and associated quick reference tools**

NICE continued to work with 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. In 2019/20 there were 6 APGs published on impetigo, leg ulcer infection, diabetic foot infection, cellulitis, pneumonia (community-acquired), and pneumonia (hospital-acquired), with more topics in development. PHE and NICE also produce a joint Summary of Antimicrobial Prescribing guidance which is updated when new APGs are published or based on user feedback.

The UTI diagnostic flowcharts quick reference tools published in 2018 obtained NICE endorsement and aligned with the Catheter Associated UTI antimicrobial prescribing guidance continue to be widely used in primary care. Between April 2019 and March 2020, the tools had 24,606 unique page views and were downloaded over 20,000 times. They were updated in September 2019 with further updates expected in 2020 and a full review 2021.

**Assessment of UK healthcare workers’ knowledge, attitudes and behaviour on antibiotics to influence antimicrobial stewardship**

In 2019, the ECDC following a competitive open process commissioned PHE to run the first multi-country, multi-professional study on the knowledge, attitudes and behaviours of healthcare workers regarding antibiotics, antibiotic use and AMR across 30 European Union (EU) and European Economic Area (EEA) countries.

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The COM-B model\textsuperscript{110} was used as a framework, for developing the survey. The findings from the UK data call attention to the barriers to prudent antibiotic use and provides evidence for guiding policy and intervention development targeted at healthcare workers.

The full methods and results for the EU/EEA data have been published\textsuperscript{111} and the UK results will be submitted for peer review.

**Key UK findings**

In the UK, 2,404 participants responded to the survey, equating to 13.1\% of the EU/EEA total and the largest proportion of respondents among all 30 countries involved.

Similar to EU, most UK participants were female 77\% (n=1863), with 21\% (n=510) identifying as male and 1\% (n=31) preferring not to state their sex. UK respondents were mostly aged between 36-55 years 59\% (n=1428), 23\% (n=561) were under 36 years and 17\% (n=397) over 55 years.

The highest response rates were seen in nursing professionals (nurses, nursing assistants and midwives, 42\% (n= 962) of total), followed by pharmacists 23\% (n=523) and medical doctors 18\% (n=427). In contrast, the EU/EEA received the highest response rates from medical doctors 42\% (n=7351), followed by nursing professionals 27\% (n=4772) and pharmacists 19\% (n=3258).

UK healthcare workers correctly answered that antibiotics are not effective against viruses 97\% (n=2332), they have associated side effects 97\% (n=2332) and unnecessary use makes antibiotics ineffective 97\% (n=2332). Fewer proportion correctly answered the following statements ‘healthy people can carry antibiotic resistant bacteria’ 90\% (n=2163) ‘Every person treated with antibiotics is at an increased risk of antibiotic resistant infection’ 80\% (n=1922) and ‘Antibiotic resistant bacteria can spread from person to person 78\% (n=1874). The largest discrepancy in scores was observed for the latter statement, where the UK respondents achieved the lowest score for correct answer 78\% (n=1874) out of all the questions and the EU/EEA total came to 87\% (n=15965) correct answers.

\textsuperscript{110}https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3096582/
Medical doctors had the highest % of respondents answering all 7 questions correctly 80% (n=342) followed by pharmacists 74% (n=387), dentists 68% (n=15) and nurses 52% (n=461).

In the UK, 80% (n=1826) of healthcare workers agreed that guidelines on managing infections were easily accessible, in comparison to 75% (n=10726) of EU/EEA respondents.

In addition, 68% (n=1546) (UK) and 67% (n=9580) (EU/EEA) of healthcare workers felt they had easy access to the materials needed to give advice on prudent antibiotic use and antibiotic resistance.

Only 62% (n=1412) of UK respondents agreed that they have good opportunities to provide advice on antibiotic use, in comparison to 72% (n=10293) of EU/EEA participants.

Further analysis of the access to guidelines and resources data in community and hospital settings is underway.

Of the 699 respondents (59%) that prescribe, dispense or administer antibiotics at least once a week, only 21% (n=221) gave out resources on antibiotic use at least once in the previous week leading up to the survey (Figure 6.2). A higher proportion 61% (n=643) of respondents gave out advice on the prudent use of antibiotics at least once in the previous week. In the EU/EEA, slightly fewer respondents gave out resources 17% (n=2430) and advice 55% (n=7862) at least once a week.

The top 3 barriers to providing advice or resources in the UK (n=1671) were lack of resources 19%, insufficient time 11% and the patient being uninterested in the information 7% (Table 6.1). In contrast, 8% of healthcare workers answered that they were able to give out advice or resources as needed and 9% answered that they did not give out resources or advice as the patient did not require the information.
Figure 6.2. Behaviour and practice of those that frequently prescribed, dispensed or administered antibiotics

![Bar chart showing the frequency of giving out resources or advice on prudent antibiotic use or management of infections to individuals.](image)

- **UK (n=1054)**
  - At least once a week: 6%
  - Rarely: 17%
  - Never: 13%
  - Do not remember: 21%

- **EU/EEA (n=14294)**
  - At least once a week: 55%
  - Rarely: 51%
  - Never: 13%
  - Do not remember: 17%

- **UK (n=1054)**
  - How often did you give out advice related to prudent antibiotic use or management of infections to an individual during the last one week?
  - At least once a week: 4%
  - Rarely: 23%
  - Never: 61%
  - Do not remember: 12%

- **EU/EEA (n=14294)**
  - How often did you give out advice related to prudent antibiotic use or management of infections to an individual during the last one week?
  - At least once a week: 20%
  - Rarely: 11%
  - Never: 55%
  - Do not remember: 2%
Table 6.1. The barriers to providing advice or resources on prudent antibiotic use or management of infections

<table>
<thead>
<tr>
<th>Why were you not able to provide advice or resources as often as you prescribed OR administered OR dispensed antibiotics?</th>
<th>Proportion chosen option (% of total selection) in the UK (n = 1671)</th>
<th>Proportion of chosen option (% of total selection) in the EU/EEA (n= 13226)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not applicable</td>
<td>44</td>
<td>23</td>
</tr>
<tr>
<td>No resources available</td>
<td>19</td>
<td>18</td>
</tr>
<tr>
<td>Insufficient time</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>Patient does not require information</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>I was able to give out advice or resources as needed</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Patient uninterested in information</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>I was not sure what advice to provide</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Difficulty getting patient to understand diagnosis</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Language barriers</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Behavourial insights projects on AMS

A number of AMS interventions led by the PHE Behavioural Insights team focused on using social norms and feedback to support improving AMS practice.

Social norms feedback letters to general practice

The feedback letter from the Chief Medical Officer (CMO) to GPs at practices whose antibiotic prescribing was in the top 20% of prescribers was continued for another year. These were sent in September 2019. This year, 3 different letters were sent for comparison and analysis. They were:

- the standard annual letter to GPs whose practices were in the top 20% of prescribers
- the standard letter with an additional case study of an individual patient who carries a resistant strain of bacteria
• a letter informing them that the practice was above the new antibiotic prescribing threshold

Preliminary results suggest that the new letters did not perform any better than the standard letter.

Letters were also developed and trialled for additional groups this year. They were:

• GP practices which are over the new threshold (but not in top 20% of prescribers) – letters were developed that were text only and letters that had text and graph; these will be compared to a control condition of no letter
• GPs whose practices were just under the new threshold to inform them of this compared to a control of no letter

Preliminary results suggest that the letters sent to additional groups were not effective and it is difficult to be certain why the new letter was not effective. However, there are at least 2 important differences from the standard letter which was shown to be effective in previous years.

First, there was a difference in the content. There are 3 ingredients of the standard letter that should cause it to be effective; they are:

• the social norms message (you are in the top 20% of prescribers)
• the CMO as a messenger
• action planning (the simple actions the GPs can take)

The new letters had a message about missing the new prescribing target instead of a social norms message, so it might be that the social norms aspect is very important.

Second, the new letter was sent to a different target group: GPs whose prescribing was over or close to the new target, but who were not in the 20% of prescribers. There may be factors that make this group less likely to reduce their prescribing.

The trial will be fully analysed in 2020/21.

Dental prescribing

Dental practice is an important contributor to antibiotic prescribing in England and NHS dentists in primary care prescribe approximately 10% of antibiotics dispensed in UK
community pharmacies\textsuperscript{112} to manage oral and dental infections.\textsuperscript{113} Developing our knowledge of their prescribing behaviour and developing interventions is an important aspect to tackling inappropriate use of antimicrobials in England. Current information on NHS dental prescribing is available from the PHE prescribing dashboard\textsuperscript{114} using data from the NHS Business Services Authority.

Antimicrobial prescribing in private dental practice

There are no routinely collected data on private dental prescribing, but their practice contributes to the totality of antimicrobial prescribing in England. This survey aimed to explore the volume of antibiotic prescribing by private dental practitioners in a defined geographical region and to inform what contribution antibiotic prescribing by private dental practitioners may have on the totality of dental antibiotic prescribing in England.

A previous pilot survey on private practitioners\textsuperscript{115} found the majority of respondents prescribed the appropriate antibiotic at the correct dose, frequency and duration. Overall, they prescribed or dispensed fewer than 6 courses of antibiotics each month with just less than half not auditing their prescribing. The sample size of the pilot was small (n=53) and was drawn from one private organization (Simply health formerly DENPLAN Ltd). The authors suggested a definitive larger study of private dental practitioners antibiotic prescribing would be of value in determining their contribution to reducing the development of AMR.

Thames Valley private dental practices were chosen as a convenient sample due to the demographics and number of private dental practices. It is an affluent area with pockets of deprivation in each local authority area. It includes the counties of Berkshire, Buckinghamshire and Oxfordshire and serves a population of just over 2 million.\textsuperscript{116}

There are in the region of 330 NHS dental contracts and 150 private practices.\textsuperscript{117}

A short postal survey was developed recognising some of the elements of the antimicrobial prescribing self-audit tool produced by the Faculty of General Dental

\begin{thebibliography}{99}
\bibitem{112} Paula Elouafkaoui, Linda Young, Rumana Newlands, Eilidh M.Duncan, Andrew Elders, Jan E. Clarkson, Craig R. Ramsay: An Audit and Feedback Intervention for Reducing Antibiotic Prescribing in General Dental Practice: The RAPiD Cluster Randomised Controlled Trial, Translation Research in a Dental Setting (TRiaDS) Research Methodology Group \url{https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5004857/pdf/pmed.1002115.pdf}
\bibitem{113} \url{https://www.fgdp.org.uk/antimicrobial-prescribing-standards/prescribing-antimicrobials}
\bibitem{114} \url{https://www.gov.uk/government/publications/dental-prescribing-dashboard-2018}
\bibitem{116} Public Health England, Oral health needs assessment Thames Valley
\bibitem{117} Dental services: \url{https://shapeatlas.net/}
\end{thebibliography}
Practices (UK) and the British Dental Association. The surveys were sent to 149 private dental practice addresses in Thames Valley. The response rate was 30.2% (n=45).

The survey invited practices to log all antimicrobial prescriptions prescribed in their practice during the last 2 weeks of February 2020. Practices were asked to return surveys no later than 31 March 2020. Data points were:

- number of surgeries (to indicate practice size)
- the drug prescribed
- whether this was for an adult or child
- whether it was a private or NHS prescription
- whether they dispensed the prescription

The total number of antimicrobial prescriptions issued were 302, all of which were for antibiotics, and all but one were private prescriptions. The majority of the prescriptions (293) were for adults and 261 were dispensed in the practice and (Table 6.2).

Table 6.2. Number of prescriptions for adult dispensed in the practices

<table>
<thead>
<tr>
<th>Prescription details</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Antimicrobial prescribed</strong></td>
<td></td>
</tr>
<tr>
<td>Antibiotic</td>
<td>302 (100.0%)</td>
</tr>
<tr>
<td>Antiviral</td>
<td>0 (0.0%)</td>
</tr>
<tr>
<td>Antifungal</td>
<td>0 (0.0%)</td>
</tr>
<tr>
<td><strong>Patient</strong></td>
<td></td>
</tr>
<tr>
<td>Adult</td>
<td>293 (97.0%)</td>
</tr>
<tr>
<td>Child</td>
<td>0 (0.0%)</td>
</tr>
<tr>
<td>Not provided</td>
<td>9 (3.0%)</td>
</tr>
<tr>
<td><strong>Type of prescription</strong></td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>301 (99.7%)</td>
</tr>
<tr>
<td>NHS</td>
<td>1 (0.3%)</td>
</tr>
<tr>
<td><strong>Dispensed at the practice</strong></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>261 (86.4%)</td>
</tr>
<tr>
<td>No</td>
<td>39 (12.9%)</td>
</tr>
<tr>
<td>Not provided</td>
<td>2 (0.7%)</td>
</tr>
</tbody>
</table>

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118 https://www.fgdp.org.uk/antimicrobial-prescribing
119 Number of surgeries, this is the number of dental treatment rooms in the practice
Antibiotic prescribing activity by proportion of antibiotic type was compared to that reported in the dental prescribing dashboard. This is based on data from the NHSBSA’s Information Services Database and excludes private prescriptions\textsuperscript{120}. The percentage of antibiotic prescribing in this survey to that reported in the dental prescribing dashboard is similar to that of NHS prescribing across England and in Thames Valley (Table 6.3).

### Table 6.3. Proportion of antibiotics prescribed by type in the survey sample compared to NHS antibiotic prescribing by type in Thames Valley and England in 2019\textsuperscript{125,121}

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Survey sample N (%)</th>
<th>Thames Valley NHS antibiotic prescribing (%)</th>
<th>England NHS antibiotic prescribing (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amoxicillin</td>
<td>225 (74.5%)</td>
<td>66.8%</td>
<td>66.0%</td>
</tr>
<tr>
<td>Metronidazole</td>
<td>64 (21.2%)</td>
<td>27.1%</td>
<td>28.6%</td>
</tr>
<tr>
<td>Erythromycin</td>
<td>7 (2.3%)</td>
<td>3.6%</td>
<td>3.3%</td>
</tr>
<tr>
<td>Clindamycin</td>
<td>1 (0.3%)</td>
<td>0.6%</td>
<td>0.5%</td>
</tr>
<tr>
<td>Other</td>
<td>5 (1.7%)</td>
<td>1.9%</td>
<td>1.6%</td>
</tr>
<tr>
<td>Total</td>
<td>302 (100.0%)</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

In the last national adult dental health survey, respondents were asked about the type of dental service that they had used for their last completed course of treatment and using private dental care was reported by 27 per cent\textsuperscript{122}. This suggests that the volume of dental prescribing currently measured in England is likely to be an underestimate by at least 25%.

This sample of private practices adds to our knowledge of the volume of prescribing in private practice.

\textsuperscript{120} https://www.gov.uk/government/publications/dental-prescribing-dashboard-2018

\textsuperscript{121} https://www.gov.uk/government/publications/dental-prescribing-dashboard-2018

Future work

Actions that will be progressed for the various AMS projects during 2019/20

Review the impact of COVID-19 on AMS in both primary and secondary care. Consider plans to extend AMS interventions, such as the role out of ARK (Antibiotic Review Kit) and develop interventions across pharmacy settings.

Support development of strategies to avoid patients reconsulting to obtain antibiotics. Support development of resources to undertake antibiotic-related learning in primary care, that are accessible in the workplace.

Develop a TARGET UTI leaflet for community pharmacy.

Update and complete full review of the NICE/PHE quick reference tool.

Further analysis of the data from the Assessment of UK healthcare workers’ knowledge, attitudes and behaviour on antibiotics to influence antimicrobial stewardship will be undertaken to understand responses by professional groups and settings.

There will be a workshop with key stakeholders across all devolved administrations will take place in June 2020 to discuss the survey data, draw useful conclusions and make recommendations for how to act upon the findings.

Recommendations resulting from this survey will align with and be guided by the Behaviour Change Wheel. These recommendations will aid the development of targeted interventions by healthcare profession and sector, guide policy making, inform public awareness campaigns and spark the creation of practices, tools and behaviours that will assist in reducing the AMR burden, prevent infections and protect antibiotics.

Modelled on the annual letter to primary care PHE Behavioural Insights Team (PHEBI) have developed a feedback letter on prescribing in secondary care. The letter informs CEOs of their prescribing and how that compared to the annual target prescribing. It lists simple actions that could be taken in order to ensure they achieve the target. The letters have been delayed due to the covid-19 outbreak and will be continued as part of 2020 work.

Building Rapid Interventions to reduce antibiotic resistTance (BRIT) team at the University of Manchester was commissioned to develop a strategy for regular individual feedback to GPs on antibiotic prescribing. They are developing a trial which will take place in 2020 to compare practice-level versus individual-level feedback to GPs on antibiotic prescribing.
The audit of prescribing in private dental practice shows prescribing of antibiotics in this sector. We will continue working to improve prescribing of antibiotics in private and NHS dental practices across England and improve awareness of AMR.

Investigate the impact on antimicrobial prescribing following the cessation of routine dental care and the set-up of urgent dental care systems during COVID-19.
7. Professional education, training and public engagement

Training, education and public engagement are vital to ensure the ongoing success of antimicrobial stewardship (AMS) and as such, have been highlighted in both the UK 20-year vision for antimicrobial resistance (AMR)\(^ {123}\) and the UK 5-year National Action Plan (NAP) for antimicrobial resistance 2019 to 2024\(^ {124}\) to minimise infection, provide safe and effective care to patients and engage with the public.

This chapter provides an outline of a number of professional education and training, and community engagement initiatives carried out in England during 2019/2020, to help meet these ambitions.

PHE professional education and training: e-learning

TARGET Future Learn Module evaluation

The TARGET (Treat Antibiotics Responsibly, Guidance Education and Tools) 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 the Future Learn platform.\(^ {125}\) The course, based on the TARGET webinars,\(^ {126}\) contains 6 weekly one-hour modules aimed at primary care healthcare professionals involved in the treatment of common infections. Each weekly module comprises varying numbers of steps.

- Week 1: Introduction to Antimicrobial Resistance in Primary Care
- Week 2: Prescribing in Urinary Tract Infections
- Week 3: Assessing the Need for Antibiotics
- Week 4: Managing Patient Expectations and Back up/Delayed Prescribing
- Week 5: Antibiotics for Children
- Week 6: Common Practice Approach

The course ran in September 2019 and again in February 2020. Whilst 2,117 individuals enrolled in the course, 703 (33.2%) actively participated. Most users were between 18

\(^{123}\) https://www.gov.uk/government/publications/uk-20-year-vision-for-antimicrobial-resistance
\(^{125}\) https://www.futurelearn.com/courses/target-antibiotics
\(^{126}\) http://www.target-webinars.com/
and 45 years old. The course was generally very well-received as indicated by end of course survey results; a total of 96.7% stated that the course exceeded or met their expectations, with participants finding it informative and appreciating the resources. The course will continue to run throughout 2020/21 with rolling registration.

Community pharmacy AMR training webinar

Previous studies have highlighted that community pharmacy, care home, and out-of-hours staff receive less stewardship training relative to other groups for example GPs. To help bridge this gap, the PHE East of England Centre in collaboration with Health Education England (HEE) ran a training webinar for community pharmacy aligned with the “Keep Antibiotics Working” public awareness campaign. The aim of the webinar was to build on the knowledge of participants (all pharmacy staff) to increase:

- understanding of AMR and why it is important
- knowledge of what pharmacy teams can do to help stop the spread of AMR
- effective recognition of clients with self-limiting infections
- confidence in giving advice about self-care and when not to take antibiotics
- ability to share key campaign messages with patients who are dispensed antibiotics, and preparedness of the pharmacy to make the most of the campaign

Six hundred and twenty-six pharmacy team members from across England registered for the webinar and included pharmacists or pharmacist managers (66%), pharmacy technicians and dispensers (8%), pre-registration pharmacists (3%), and others including public health advisers and nurse prescribers (15%). Registrations were from London (26%); East of England and South East (12% each); North West and West Midlands (10%); East Midlands and South West (7%); North West (5%). Most registered participants had not previously participated in an AMS project (61% n=381), highlighting the dearth of AMS activities tailored to this group.

Pre-webinar AMS knowledge was assessed via questionnaire during the registration process (Table 7.1). The statements “Antibiotic-resistant bacteria can spread from person to person” and “Every person treated with antibiotics is at an increased risk of antibiotic resistant infection” were correctly assessed as true by only 74% and 77% of the respondents, the lowest proportion of the 7 questions. This is similar to the findings of the ECDC Survey on Antibiotic Use across 30 EU/EEA member states.127

Table 7.1. Pre-webinar knowledge test questions and percentage of correct and incorrect answers

<table>
<thead>
<tr>
<th>Key knowledge question (n)</th>
<th>Correct answer</th>
<th>Correct (%)</th>
<th>Incorrect (%)</th>
<th>Unsure (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antibiotics are effective against viruses (n=578)</td>
<td>FALSE</td>
<td>96.5</td>
<td>2.3</td>
<td>1.2</td>
</tr>
<tr>
<td>Antibiotics are effective against cold and flu (n=575)</td>
<td>FALSE</td>
<td>95.3</td>
<td>2.3</td>
<td>2.4</td>
</tr>
<tr>
<td>Taking antibiotics has associated side effects or risks such as diarrhoea, colitis, allergies (n=579)</td>
<td>TRUE</td>
<td>95.9</td>
<td>1.6</td>
<td>2.6</td>
</tr>
<tr>
<td>Unnecessary use of antibiotics makes them become ineffective (n=579)</td>
<td>TRUE</td>
<td>95.2</td>
<td>3.8</td>
<td>1</td>
</tr>
<tr>
<td>Healthy people can carry antibiotic resistant bacteria (n=579)</td>
<td>TRUE</td>
<td>88.4</td>
<td>2.6</td>
<td>9</td>
</tr>
<tr>
<td>Antibiotic-resistant bacteria can spread from person to person (n=579)</td>
<td>TRUE</td>
<td>73.9</td>
<td>17.1</td>
<td>9</td>
</tr>
<tr>
<td>Every person treated with antibiotics is at an increased risk of antibiotic-resistant infection (n=579)</td>
<td>TRUE</td>
<td>76.7</td>
<td>12.8</td>
<td>10.5</td>
</tr>
</tbody>
</table>

Participants were also asked about their awareness and use of national AMS resources and guidelines (Figure 7.1). Most registrants (81%) were aware of, or have used, National Institute for Health and Care Excellence (NICE) guidelines, while only 55% of the registrants had seen the Keep Antibiotics Working (KAW) advert.
Following the webinar, feedback was sought from participants; some quotes are highlighted in box 7.1:

Box 7.1 Feedback quotes from community pharmacy webinar

**Resources available:**

“There were some downloadable leaflets in campaign leaflets I had not noticed that are great for conversations and increasing the public awareness of overuse of antibiotics however for pharmacies to print this for all conversations will be prohibitive.”

**Self-limiting illness duration and Self-care advice:**

“I gained some good advice on how to talk to patients/carers about self-care.”

“Ability to give better patient advice re. self-care etc. reinforced and expanded by the webinar and the tools provided for example the Target Leaflet.”

**AMR and communicating:**

“Realising the resistance problem is much worse currently with much larger predicted problems than I was aware of.”

“I feel I am more able to explain to a patient the connection between antibiotics and resistance to antibiotics.”
In conclusion, utilising existing relationships with stakeholders was crucial, allowing the team to identify the most effective means of communication (that is dissemination via Local Pharmaceutical Committees and AMR regional Pharmacy Advisor) and preferred webinar delivery time to optimise uptake. The collaboration between regional and national functions and directorates was also effective; having shared objectives (for example education on AMR and facilitating the campaign) and communication enabled a wider range of expertise and resources to be shared than if completed by national or regional team alone. Developing the webinar to coincide with the mandatory national campaign, led to good participation. It is recommended that the AMR webinar is held annually to coincide with national campaigns.

e-Bug health educator training

e-Bug, in collaboration with the BSAC, have developed an e-learning course,\(^{128}\) on the Future Learn platform, for those who teach children and young people. The course aims to improve knowledge and confidence to teach this group about microbes, preventing the spread of infection and antibiotic use in an engaging and age-appropriate way. The course included 3 two-hour sessions which were:

- Session 1 – Microbes, hand and respiratory hygiene
- Session 2 – Food hygiene and oral hygiene
- Session 3 – Antibiotics and self-care

The first run of the course was from 13 Jan 2020 to 15 March 2020 with 400 individuals enrolled in the course and 258 participants completing at least one of the 3 sessions. Of the 40 users who filled out the end of course survey, 98% said the course met or exceeded their expectations (55% exceeded).

PHE professional education and training: workshops

TARGET Train the Trainer

The TARGET Train the Trainer (TtT) programme aims to train those working in the primary care sector to deliver the TARGET AMS workshop and to become accredited TARGET trainers. To become an accredited TARGET trainer, individuals must:

- attend the TtT workshop
- deliver the AMS workshop within 6 months of receiving the training
- complete relevant documents which will be reviewed for accreditation

\(^{128}\) https://www.futurelearn.com/courses/e-bug-health-educator-training
The AMS workshop aims to:

- highlight the need for optimising antibiotic prescribing by presenting evidence of the link between antibiotic prescribing and resistance in GP patients
- demonstrate how reducing antimicrobial prescribing can not only reduce antibiotic resistance, but also patients’ future expectations for an antibiotic and any further consultations

Four TtT Workshops, attended by 58 participants, were held between September 2019 and February 2020 across England. Three further workshops were scheduled in March 2020 but were postponed due to COVID-19. TtT workshop attendees went on to deliver a further 11 AMS workshops between November 2019 and March 2020, with 171 attendees (Figure 7.2). Other TtT workshop attendees had planned to run workshops but were forced to postpone due to the COVID-19 pandemic.

Figure 7.2. Location and attendance of TARGET Train the Trainer Workshops and further cascade of the AMS workshops by attendees

Workshop evaluation showed that both the TtT and the cascaded AMS workshops were well-received (Figure 7.3).
Respondents were asked to give feedback on different workshop components and indicate if they were useful; they would use them personally; and they would use them in their practice. Antibiotic guidance was considered the most useful component by both workshop attendees, with 71.4% stating that it was useful (Figure 7.4).

Attendees highlighted that the workshop was a useful opportunity to interact and debate and would have liked even more time to explore and discuss certain aspects as they
valued the opportunity to learn from others. Many respondents liked the use of local prescribing data and evidence from studies, however some had difficulty understanding these elements of the workshops and would have preferred more time to understand this. AMS workshop attendees stated that they would have liked clinical scenarios in other age groups (specifically children) and other case studies (four respondents mentioned wound care), and more opportunity for debate. Some trainers noted that there was too much information to be delivered in a 1-hour time slot and struggled to do so.

Moving forward the training materials will be condensed to allow more time for open discussion and debate. Delivering live virtual training will also be examined; this will not only save costs but also allow more frequent training delivery to a wider audience.

e-Bug Train the Trainer model with local authorities and networks

The e-Bug Train the Trainer programme aims to train educators/teachers, local authority representatives, and community members who work with children (for example Science, Technology, Education and Maths ambassadors) how to use, and get the most out of, the e-Bug toolkit. Training sessions are hosted by a local authority or network.

Between 1 April 2019 and 31 March 2020, the programme was delivered to 143 individuals across the UK. Local authorities in Gloucestershire, Walsall and Wiltshire have cascaded the training to 42 other educators in their areas. 98% of the 49 participants who evaluated the training rated the workshop as “good” (41%) or “excellent” (57%); 95% were “likely” (30%) or “very likely” (65%) to recommend the workshop to others. Feedback included “an excellent training session and I am now ready to teach the children all about hand hygiene”.

PHE professional education and training: conferences

Healthcare students AMR conference

The third National Student AMR Conference was held on 16 November 2019 in Aston University, Birmingham and encouraged students to ‘Be part of the change – Help Keep Antibiotics Working’. The conference had lectures and workshops focusing on a One Health Approach covering both animal and human health. Speakers originated from Dentistry, Medicine, Nursing, Pharmacy, Veterinary and other Healthcare Sciences disciplines. One hundred and ninety-five students from across the specialities attended.

Six students who submitted abstracts were chosen to present 5-minute Flash talks; topics covered included diagnostic testing, prescribing behaviour and microbiology. All
conference presentations are available via the Antibiotic Guardian (AG) website.\textsuperscript{129} Ninety-six post conference questionnaires were completed by students from 23 universities. Pharmacy, Medicine and Biomedical sciences were the top 3 courses represented in the survey.

Students considered AMR to be a more or as important a challenge in the world today as climate change (89.53%, n=86), obesity (95.35%, n=86), food security (93.02%, n=86), and gender inequality (96.51%, n=86).

Post conference knowledge results (Figure 7.5) for the statement “Every person treated with antibiotics is at an increased risk of antibiotic resistant infection” was correctly answered by only 75% of the respondents, the lowest proportion of the knowledge questions directly related to AMR. For questions on environmental and animal health factors and infection prevention and control (IPC) (Figure 7.5), only 43% of respondents correctly identified that it is illegal in the EU to use antibiotics to stimulate growth of farm animals; highlighting a need for greater awareness in the important work in AMR by the animal health sector. Almost all students (97%) correctly identified that poor IPC practices cause the spread of AMR.

\textsuperscript{129}https://antibioticguardian.com/Meetings/third-national-students-amr-conference/
Figure 7.5. Post conference responses to Knowledge Assessment showing percentage correct responses

Most students knew that most antibiotics were prescribed in primary care (68.3% n=82) and had heard the term 'antibiotic stewardship' or 'antimicrobial stewardship' (81.4% n=86). In relation to IPC, 82.6% (n=86) of students were aware that best way to clean your hands to stop the spread of bacteria is to “Wash thoroughly with soap and water” compared to “using a hand sanitising gel/foam” (17.4%, n=86).

Eighty-eight percent (n=84) of students agreed or strongly agreed that they would like more education on the appropriate use of antimicrobials. The students were also asked if they had teaching on prudent antibiotic use (55.8%, n=86) or management of infections (diagnosis and antibiotic treatment) (65.1%, n=86) and if any of their examination questions included questions on prudent antibiotic use (30.2%, n=86) or management of infections (diagnosis and antibiotic treatment) (48.8%, n=86).

Overall conference feedback was positive with evaluation findings highlighting the importance of supplementing university teaching with conferences such as these.
Antibiotic Guardian shared learning event and awards

The fourth AG shared learning event and awards took place on 27 June 2019 to acknowledge, celebrate and share learning of work of healthcare professionals across UK and abroad in tackling antimicrobial resistance. Keynote speech was delivered by honorary guest and Chief Veterinary Officer for the UK, Christine Middlemiss.

The evening event was attended by colleagues in healthcare organisations across England, Scotland, Wales, Europe, Africa & Asia. The poster presentations for the winners, and those highly commended for each category, from this and previous years are available on the AG website.130,131

These shared learning events provide PHE and other national organisations a robust selection of case studies of work ongoing to tackle AMR that have been peer reviewed through the judging process. Several projects which started locally and have won or been highly commended at the AG awards have gone on to become national projects and/or feature in the UK AMR national action/implementation plan.

Projects and case studies were submitted in the categories of Animal Health, Agriculture & Food Supply, Children & Family, Community Communications, Diagnostics, Infection Prevention and Control, Innovation, Prescribing & Stewardship, Research, Student of the Year and the Das Pillay Memorial AMS Award.

Other professional education and training

Health Education England: intervention development

The DHSC Research & Development committee through the National Institute for Health Research132 has awarded funding to explore behavioural science in education and training strategy around AMS. The research piece has been awarded as a joint bid to University College London and the University of Manchester.

The existing HEE AMR training guide133 has been adapted into an interactive online toolkit that is available on e-Learning for Healthcare (eLfH). HEE worked with PHE

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131 https://antibioticguardian.com/shared-learning/
Primary Care and Interventions Unit, to develop an eLearning module on AMR for Community Pharmacists.¹³⁴

de-learning module for community pharmacists

This free e-learning session addresses the impact of AMR and the hugely important role community pharmacy staff can play to Keep Antibiotics Working. The e-learning was designed to help the whole community pharmacy team:

- understand the connection between antibiotic use and AMR
- identify their role in optimising antibiotic use in the general population who visit their pharmacy
- use the Antibiotic Checklist (a checklist completed by patient and pharmacy staff to follow the antibiotic prescription journey and assess patient knowledge on antibiotic use) to personalise patient advice when dispensing antibiotics
- improve their self-care/safety-netting advice using the TARGET Treating Your Infection leaflets¹³⁵
- be aware of the global impact of AMR

Between February and April 2020, the e-learning was accessed 212 times, and 58 participants had taken and passed the self-assessment questions at the end of the e-module. Participants rated the content 4.5/5.

The e-learning will be further evaluated as part of package of resources to support community pharmacy staff in their AMS role. This e-LfH module was developed by PHE in partnership with the BSAC, the Royal Pharmaceutical Society (RPS), the University of Leeds, the University of Nottingham, the University of Reading and the design company, the Letter G.

Health Education England: innovation fund

In 2019/20 HEE awarded funding for the second consecutive year to organisations, that aimed to encourage and support initiatives that will contribute to workforce development through education and training, particularly around behaviour change with evidence of outcomes.

AMR Innovation fund 2019/20 awarded 2 contracts for delivery which were:

- advancing Quality Alliance (AQuA) developed case studies based on quality improvement methodology to train staff around the government ambition to reduce Gram-negative blood stream infections
- University of Manchester developed training focussed on behavioural changes in relation to AMR and rollout a train the trainer package in a local setting

HEE also funded the rollout of a previous Innovation fund project, where the RPS ran pharmacist AMS training across England. The 18/19 pilot training programme supported key pharmacists within NHS Trusts/Sustainability and Transformation Partnerships to develop the skills and behaviours to become effective antimicrobial stewardship clinicians, leaders and mentors. The key findings are presented below.

**Antimicrobial stewardship training for pharmacists**

During 2018/19, the RPS developed and delivered an expert-led, structured AMS training programme for pharmacists practising in patient-facing roles. This programme, the first of its kind in England, was commissioned by the HEE AMR Innovation Fund and delivered in collaboration with PHE and the UK Clinical Pharmacy Association Pharmacy Infection Network.

The training programme was approximately 100-days in duration, supported by a curriculum, and included self-directed learning; one face-to-face training day; identification and implementation of a quality improvement (QI) project; moderated peer discussions; an end of training professional discussion and portfolio-based assessment. Up to 30 funded places were made available to post-Foundation pharmacists practising in primary or secondary care in London and the South East.

Figure 7.6 details the progression of learners enrolled into the programme with 18 learners completing the end of training assessment, and 17 of these meeting the assessment outcomes. Learners were assessed on whether their portfolios and discussion responses demonstrated Advanced Pharmacy Framework competencies (clusters 1 and 2).

A total of 19 improvement projects addressing key areas on AMR were undertaken by students (Table 7.2). Data were collected in 68% of projects and potential improvement identified in 84% of these.
Table 7.2. Improvement Projects undertaken, addressing key areas of AMS

<table>
<thead>
<tr>
<th>Health care sector</th>
<th>Projects (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary care</td>
<td>6</td>
</tr>
<tr>
<td>Secondary care</td>
<td>13</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project intervention</th>
<th>Projects (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audit and feedback</td>
<td>5</td>
</tr>
<tr>
<td>Education</td>
<td>4</td>
</tr>
<tr>
<td>Changes in processes</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interim project findings</th>
<th>Projects (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improvement in outcome measures</td>
<td>5</td>
</tr>
<tr>
<td>Improvement in process measures</td>
<td>6</td>
</tr>
<tr>
<td>No change to status quo</td>
<td>2</td>
</tr>
<tr>
<td>Results not yet available</td>
<td>6</td>
</tr>
</tbody>
</table>

Learner knowledge was evaluated through a quiz and a self-assessment questionnaire pre- and post-training. The group mean score for the knowledge quiz improved from 64% pre-training to 84% post-training. Learner self-assessment of their knowledge across key topic areas also improved, as illustrated by Figure 7.7.
The RPS AMS training programme demonstrated acquisition of knowledge and skills as well as application of learning in the workplace. Examples of ongoing impact have been identified from learner feedback. Lessons from the full evaluation of this programme have informed future training, including another HEE funded cohort across all regions of England in 2020.

For further information on HEE’s innovation fund projects please visit
www.hee.nhs.uk/our-work/population-health/infection-management/innovation-fund

137 https://www.rpharms.com/blog/details/reducing-antibiotic-prescribing-through-system-leadership
Further details on HEE’s AMR activities can be found at www.hee.nhs.uk/our-work/antimicrobial-resistance and https://www.e-lfh.org.uk/programmes/antimicrobial-resistance-and-infections/

NICE: Management of Common Infections workshop

On the 22 October 2019 a joint workshop by NICE and PHE was held to discuss Management of Common Infections (MOCI) Implementation. Fifty-seven delegates from CCGs, NHS Trusts and National Organisations attended the workshop which aimed to support implementation of joint NICE and PHE antibiotic prescribing guidance tools and evidence-based antimicrobial prescribing information for all care settings.

The event covered the AMR Strategy and MOCI, the use of the Antimicrobial prescribing guidelines in practice with case studies and had a breakout discussion to discuss attendee’s perspective on the guidelines. Valuable feedback was received on all these topics to help guide future implementation.

There was a request for NICE to:

- improve communication with the primary care sector when updating prescribing guidelines
- release updates together, instead of one every month, for ease of local implementation and management
- ensure the guidance is easily accessible on prescribing systems

Other requests included more training for prescribers, collaboration and alignment of educational interventions between national bodies (PHE/HEE/NICE/BSAC) to ensure consistent messages for front line clinicians and the public.

The Regional Medicines Optimisation Committees (RMOC) was mentioned as an untapped lever as they combine knowledge of localities while, at the same time, working as a national system; and are therefore best-placed to offer both the breadth and depth that effective implementation of NICE guidance requires.

Delegates were asked in a post-event survey about key actions they have taken, or will take, since the workshop. These included:

- plans to work with care homes on waaw participating and reviewing treatment of rti and uti in this setting
- one delegate communicating and collaborating with another out-of-hours service they met at the workshop
- insuring improved implementation of current work including reminding practices to enable easy access to the guidance on all PCs
- focussing their efforts on the top 5 practices which are above the 10% target for broad-spectrum antibiotics with a particular focus on UTIs
- national plans to update guidance for CQC inspectors and the MOCI guidelines implementation into training for medicines team and GP inspectors
- developing an educational tool linked to NICE guidance

Engagement activities

Keep Antibiotics Working: three-year summary

The ground-breaking ‘Keep Antibiotics Working’ campaign is a critical behaviour change initiative to alert the general public to the issue of AMR, with the aim of reducing patient pressure on GPs to prescribe.

The campaign has now run nationally for 3 consecutive years (Autumn 2017, 2018 and 2019), following a successful pilot in the North West. Targeted advertising on TV, radio, outdoor, press, digital platforms, social media, alongside PR and extensive partner support from health care professionals, the NHS and local authorities, continues to change the narrative on AMR from not only the future risk to humanity, but also the immediate risk to the individual.

The start of the 2019 campaign was successfully announced in PR, with good coverage in a number of national and regional news programmes and support from notable influencers such as Dr Ranj Singh and Dr Zoe Williams.

PHE continued to work in close partnership with the NHS and engaged all GP practices in England. During the campaign period posters and leaflets were distributed to a range of partners including local authorities, health care centres and Housing Associations. In addition, specially designed self-care prescription pads were sent to healthcare professionals, providing a tangible evidence-based intervention to satisfy patient concerns and help alleviate pressure on clinicians to prescribe.

Public awareness is high, with 83% of our audience agreeing that “Taking antibiotics when you don’t need them, puts you and your family at risk of antibiotic resistant infections”. Attitudinal shifts continue to be seen among the general public with 78% of the audience reporting that they were unlikely to ask for antibiotics if they’d been told they were not needed.

2019’s campaign was the third year of our three-year strategy, and in 2020 we will be conducting a three-year review of the campaign to understand the impact on public understanding and attitudes to antibiotics as well as the impact on antibiotic prescribing, which will inform our future strategy for addressing the issue through marketing.
World Antibiotic Awareness Week (WAAW) and European Antibiotic Awareness Day (EAAD), 2019

WAAW and EAAD continued to provide an excellent opportunity to engage with healthcare workers and the public on tackling antimicrobial resistance. Although there were restrictions to national organisation promotion during the week, senior NHS and health system leaders published a letter\(^{138}\) to colleagues in CCGs and Trusts asking for their help in promoting WAAW on 21 October 2019.

Healthcare professional toolkit

A new WAAW and EAAD toolkit\(^{139}\) was developed and uploaded to the .GOV website on 7 October 2019. The toolkit provided guidance to support the NHS, local authorities and others to actively lead WAAW and EAAD activities and to encourage responsible use of antibiotics.

Twitter activity

An international twitter storm was organised by the US Centers for Disease Control and Prevention (CDC), the WHO and the European Centre for Disease Prevention and Control (ECDC). PHE adapted resources and hashtags for use in England. The twitter storm encouraged users to use the hashtags #AntibioticGuardian, #AntibioticResistance, #KeepAntibioticsWorking and #EAAD. #AntibioticResistance was the most used hashtag, tweeted 30,347 times, by 18,873 participants during the period 18-25 November 2019. Recommended hashtags (#AntibioticGuardian, #AntibioticResistance, #KeepAntibioticsWorking, and #EAAD) combined, were used 53,500 times during the period 18 to 25 November 2019.

TARGET/RCGP campaign

On the build up to WAAW the RCGP’s Clinical Innovation and Research Centre (CIRC) and PHE ran the TARGET Antibiotics communications campaign to support GPs and practice teams to reduce inappropriate antibiotic prescribing and to inspire more GPs to reduce antibiotic prescribing and promote continuous professional development. The campaign incorporated a range of communication tools, including 5 weekly clinical news articles and twitter messaging, and a restructured TARGET toolkit\(^{140}\) website.

\(^{139}\) https://www.gov.uk/government/publications/european-antibiotic-awareness-day-resources-toolkit-for-healthcare-professionals-in-england
\(^{140}\) www.rcgp.org.uk/TARGETantibiotics
The TARGET Antibiotics Toolkit was accessed 29,546 times by 18,331 unique visitors over the eight-week course of the campaign; 11,900 resources were downloaded during this time with the leaflets to share with patients section being the most accessed (19,331 clicks).

Five clinical news articles, each written by an expert in the field, discussed various aspects on AMR and AMS, highlighting a particular topic and useful tools for prescribers around that topic.

**Table 7.3: Access to the clinical news articles during the campaign**

<table>
<thead>
<tr>
<th>Clinical news article</th>
<th>Page views</th>
<th>Unique page views</th>
<th>Avg time on page</th>
</tr>
</thead>
<tbody>
<tr>
<td>What more can GPs do to reduce the risk of antimicrobial resistance?</td>
<td>208</td>
<td>168</td>
<td>00:08:16</td>
</tr>
<tr>
<td>Do I prescribe too many antibiotics? What's appropriate?</td>
<td>349</td>
<td>303</td>
<td>00:11:00</td>
</tr>
<tr>
<td>Scoring systems and audit to improve antimicrobial prescribing decisions in primary care</td>
<td>179</td>
<td>146</td>
<td>00:06:28</td>
</tr>
<tr>
<td>Antibiotics: Managing common infections</td>
<td>253</td>
<td>196</td>
<td>00:07:26</td>
</tr>
<tr>
<td>Tips for prescribing antibiotics to children</td>
<td>1,716</td>
<td>1,341</td>
<td>00:05:33</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,705</strong></td>
<td><strong>2,154</strong></td>
<td><strong>00:07:45</strong></td>
</tr>
</tbody>
</table>

The social media arm of the campaign had regular and consistent messaging across Twitter, Facebook and LinkedIn. Tweets had 44,042 impressions and 502 tweet engagements (shares, likes, clicks). Content on LinkedIn received 1,383 impressions. Whilst the campaign was an extremely successful engagement tool at raising awareness of AMR, further research is required to identify if this engagement facilitated appropriate antibiotic prescribing.

**e-Bug – educating young people**

e-Bug is a free educational resource, operated by PHE, for classroom and home use, making learning about micro-organisms, the spread, prevention and treatment of infection fun and accessible for all teachers, parents/carers and students. All activities and lesson plans have been designed to national policy and strategy and
implementation of the national curriculum. The e-Bug website is currently available in 25 different languages; Ukraine and Kosovo partnered the e-Bug programme in 2019.

**e-Bug**[^e-Bug141] – use and access of the e-Bug website

Between April 2019-March 2020, the e-Bug website received almost 1.5 million visits, the highest figure to record. Visits from UK users have increased by over 5 times, compared to the same period the previous year (Table 7.4). The greatest increase was observed in February and March 2020 (Figure 7.8), with the activities on hand and respiratory hygiene being most viewed (Table 7.5). This coincides with the release of the government’s Coronavirus (COVID-19): guidance for educational settings[^COVID-19] which recommends use of e-Bug resources to teach about hygiene.

**Table 7.4. Top countries accessing the e-Bug website 1 April 2019 to 31 March 2020 compared with 1 April 2018 to 31 March 2019**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>United Kingdom</td>
<td>22,736</td>
<td>130,328</td>
<td>56.21%</td>
</tr>
<tr>
<td>France</td>
<td>11,785</td>
<td>18,981</td>
<td>8.19%</td>
</tr>
<tr>
<td>United States</td>
<td>6,626</td>
<td>9,863</td>
<td>4.25%</td>
</tr>
<tr>
<td>Spain</td>
<td>8,484</td>
<td>8,784</td>
<td>3.79%</td>
</tr>
<tr>
<td>Greece</td>
<td>3,799</td>
<td>4,172</td>
<td>1.80%</td>
</tr>
<tr>
<td>Italy</td>
<td>2,340</td>
<td>4,066</td>
<td>1.75%</td>
</tr>
<tr>
<td>Denmark</td>
<td>2,952</td>
<td>3,236</td>
<td>1.40%</td>
</tr>
<tr>
<td>Belgium</td>
<td>2,668</td>
<td>3,154</td>
<td>1.36%</td>
</tr>
<tr>
<td>Romania</td>
<td>1,898</td>
<td>2,366</td>
<td>1.02%</td>
</tr>
<tr>
<td>Australia</td>
<td>1,730</td>
<td>1,367</td>
<td>1.02%</td>
</tr>
</tbody>
</table>

[^e-Bug141]: www.e-Bug.eu
Figure 7.8. Number of UK users accessing the e-Bug website each month between 1 April 2019 and 31 March 2020

Table 7.5. Top English e-Bug pages accessed 1 April 2019 to 31 March 2020

<table>
<thead>
<tr>
<th>Pages</th>
<th>Page Views 18/19</th>
<th>Page Views 19/20</th>
</tr>
</thead>
<tbody>
<tr>
<td>e-Bug Homepage England</td>
<td>67,457</td>
<td>99,887</td>
</tr>
<tr>
<td>KS1 Horrid Hands</td>
<td>1,242</td>
<td>75,277</td>
</tr>
<tr>
<td>KS2 Hand Hygiene</td>
<td>3,634</td>
<td>42,431</td>
</tr>
<tr>
<td>Junior Games Homepage (England)</td>
<td>26,163</td>
<td>37,371</td>
</tr>
<tr>
<td>Junior Student Homepage</td>
<td>20,667</td>
<td>32,073</td>
</tr>
<tr>
<td>KS1 Super Sneezes</td>
<td>1,163</td>
<td>29,900</td>
</tr>
<tr>
<td>KS2 e-bug Lessons Homepage</td>
<td>13,308</td>
<td>25,391</td>
</tr>
<tr>
<td>KS2 Respiratory Hygiene</td>
<td>1,146</td>
<td>21,151</td>
</tr>
<tr>
<td>KS3 Hand Hygiene</td>
<td>849</td>
<td>18,548</td>
</tr>
<tr>
<td>KS3 Respiratory Hygiene</td>
<td>275</td>
<td>12,177</td>
</tr>
</tbody>
</table>

e-Bug: A randomised controlled trial to evaluate the impact of the e-Bug toolkit

The e-Bug team worked with South Gloucestershire Local Authority (LA) to conduct a feasibility study looking at the impact of e-Bug Train the Trainer on student knowledge of microbes, hand/respiratory hygiene and antibiotic use/self-care. The study included 8 primary schools that received training at different times over the implementation period (September 2019 to February 2020). Student learning, soap use and absenteeism was assessed. Data were collected by the local authority and the work in each school will
contribute to their rating as part of the Healthy Schools Scheme. The results of this feasibility study will be analysed and published in 2020/21.

Findings and feedback from LAs have contributed to the development of a new Train the Trainer toolkit. This resource will be piloted in 2020/21 as a core part of the workshop and will provide participants with a comprehensive step-by-step guide to running a workshop that also includes modifiable slide decks, administrative resources, and evaluation tools. This toolkit will support participants to cascade this e-Bug training in their catchment areas. An online evaluation tool has been developed and will help understand the impact and coverage of the training over 2020/21.

**e-Bug: Antibiotic Guardian youth badge**

The Antibiotic Guardian (AG) youth programme was designed by e-Bug in collaboration with AG and Girlguiding and Scout leaders/commissioners. The programme was piloted with a total of 232 children and 14 youth group leaders. Leaders fed back that the topic was important and fit well with existing group themes. Children reported high enjoyment and self-reported intentions to improve behaviour around hand and respiratory hygiene.

The three-stage programme brought together new and existing e-Bug activities that are designed to be engaging and interactive, and include topics such as: microbes; hand, respiratory and food hygiene; antimicrobials and AMR. Learning is then consolidated through creation of a poster or other demonstration of knowledge gained during the programme. Participants are finally encouraged to make a pledge to be an ‘Antibiotic Guardian’ via the AG website, whereby they select a behaviour change they intend to adopt and share this with friends and family.

In line with the official programmes run by Girlguiding and Scouts, the AG youth programme offers a commemorative badge in recognition of successful completion. To receive badges, a preliminary feedback survey must be completed online, offering data on what activities are being used and how useable the resource is. Ideally the resource will be evaluated in the future to study the impact on behaviour change.

The programme for community groups was intended to be launched during British Science Week in March 2020; however due to the escalating situation caused by COVID-19, this was not possible. The decision was later made that the programme provides an invaluable resource to teach children about correct hand and respiratory hygiene and should be available during the COVID-19 pandemic. Following this, the programme was promoted as a resource for home-schooling, with easy to execute activities relating to infection prevention and control.
Qualitative investigation into adolescents’ views of the microbiome and antibiotics

The human microbiome is the ecosystem of microorganisms living in the human body. There is emerging knowledge on how antibiotics and diet affect this ecosystem and the development of antibiotic resistance; the microbiome represents a potential area of intervention to reduce AMR. Awareness of the detrimental effects of antibiotics on the microbiome may influence the public’s behaviour and attitudes.

To investigate if and how the microbiome may influence adolescents’ attitudes and behaviours towards antibiotics and lifestyle choices, a qualitative focus group study with adolescents (aged 14 to 18) and teachers in English schools and colleges was undertaken. Findings were aligned to the Theoretical Domains Framework.

Microbiome knowledge varied between adolescents. Most were aware of ‘good microbes’ in the body but did not understand their role and many confused them with enzymes and immune cells. Older adolescents who were studying a science subject, had more advanced knowledge of antibiotics and displayed intentions to use antibiotics appropriately. Adolescents believed that a diet rich in fibre and probiotics would be beneficial for their microbiome but reported lacking the capability and opportunity to change behaviour, due to lack of time and control over lifestyle.

Teachers with a science or biology background reported better knowledge and teaching confidence than those without this background. All educators felt that the topic was important for adolescents to understand, but reported barriers to teaching the topic, including lack of time and the topic not being in the national curriculum. All teachers felt educational resources, based on the newest research and knowledge, were needed.

Recommendations from the study which will support the UK AMR national action plan are:

- include information on how students can protect their microbiome in the national curriculum to facilitate improved diet and antibiotic use
- develop educational resources, including background information for teachers, to motivate students and increase their knowledge, skills and opportunity to improve diet and appropriate antibiotic use

Antibiotic Guardian

PHE launched the pledge-based 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.
From initiation in 2014 to the end of 2019, there have been 75,289 pledges on the main AG webpage. During 2019, the campaign website has been visited 82,992 times, this resulted in 9,289 pledges from 146 countries. AGs from more than 70% of countries made a pledge in 2019. The number of pledges each year has been 12,315 in 2014, 15,002 in 2015, 15,140 in 2016 and 15,170 in 2017 and 8,373 in 2018. Pledge translations are available in Dutch, French, German, Russian and Turkish.

In November 2019, in collaboration with Africa CDC, the Africa AG page was launched including tailored pledges for Africa content. It is available for all African Union member states to use in their national campaigns. The total number of AG pledges on the African site is 185 (7 November to 31 December 2019), with representation from 17 countries. Of these 47% are healthcare professionals, 16% members of the public and 36% students and educators.

The Australia page was also launched in 2019 in collaboration with Agriculture Victoria. The total number of AG pledges on the Australian page is 78, (30 April to 31 December 2019). Of these 62% are healthcare professionals, 22% members of the public and 15% students and educators.

**Antibiotic Guardian: school ambassadors programme**

A pilot programme to develop AG school ambassadors was developed during 2019 ahead of WAAW. PHE staff members and pharmacy professionals were invited to become ambassadors by attending a training webinar.

A total of 76 ambassadors were recruited including 46 PHE and 30 non-PHE healthcare professionals across a range of professions including public health specialists, scientists, project managers, nurses, paramedics, pharmacists, technicians, dispensers and store managers. Ambassadors had the option of either making a presentation to a group of children at a school or community group, or to provide the school with material for the school newsletter. A toolkit (based on e-Bug materials) was provided to all ambassadors. Following the presentation, children were asked to design posters to illustrate what they had learned and the importance of keeping antibiotics working.

**Children feedback**

Ambassadors collected feedback from the children, through a written survey, or a show of hands. Responses to these surveys showed that of 73 children, 93% claimed that they had fun participating in sessions, and 84% reported learning something new. The survey also found that of 35 children, 92% reported that they would relay information they had learned to their family.

**Ambassador feedback**

A survey was sent to all ambassadors seeking insight on their experiences with the AG school ambassador programme. Of the 76 staff who initially signed up to be
ambassadors, 45% (34/76) completed the survey; 32% (24/76) confirmed they participated in the programme by either delivering a session to a group of children; 13% (10/76) respondents did not participate. Of the 24 respondents who participated in the programme, 62% (13/24) delivered a session to a group of children, while 30% (7/24) provided a section for their school newsletter (the remaining participants selected ‘other’). All 24 respondents either agreed or strongly agreed that the children they presented to understood at least some of the concepts covered in their presentation. Similarly, all either agreed or strongly agreed that they would be likely to run the programme again or recommend to another colleague.

Suggestions received from ambassadors via the survey were to circulate the learning material further in advance of the sessions to give them a better opportunity to familiarise themselves with the content and provide further support to those who were not confident presenting to groups. Of 24 respondents, 79% stated that being a part of this programme had helped them either personally, professionally, or both.

School feedback: Most participants involved primary schools (11), with 2 secondary schools, 3 community groups, and the remaining being a mix of both, or not applicable. The pilot programme reached approximately 1,900 children. An additional survey was sent to schools that participated in the programme, although response rates were not high (3 school representatives of the 27 that registered on the AG website), feedback received from teachers was overwhelmingly positive, commenting that children were highly engaged and enthusiastic about the content.

One of the key barriers expressed by ambassadors, was that it was sometimes difficult to gain schools’ engagement. Some volunteers were unable to present at schools they approached due to lack of engagement and communication; this issue will need to be addressed for future programmes. Another barrier was the short time frame in which ambassadors were expected to deliver their sessions, that is WAAW. Feedback was received expressing that the week of 18 to 25 November was a busy time of year for some ambassadors and schools, and that flexibility of dates may have led to greater uptake of the programme.

When considering whether to develop this pilot into an ongoing body of work, a key consideration would be the barriers as expressed by ambassadors as discussed above. COVID-19 social distancing measures would also be a consideration for any similar programme in the future.
Future activities

Modify TARGET training resources based on COVID-19 pandemic to include making patient information leaflets suitable for the online consult.

Develop clinical scenarios for the TARGET AMS workshop on prescribing in children and skin infections.

Develop and run virtual TARGET workshops in light of COVID-19 restrictions.

Continue to roll out the Antibiotic Prescribing in Primary Care e-learning on the Future Learn platform.

Carry out full evaluation of the HEE webinar and antibiotic checklist in the pharmacy setting.

Work with NICE to implement actions from MOCI event.

Consider developing the student conference as an online conference or series of webinars to improve access for students across England. Discuss feasibility of this with students and educators.

Continue to contribute to the RPS/HEE AMR training programme.

Continue to increase engagement of healthcare professionals in tackling AMR during WAAW, EAAD and through the Antibiotic Guardian campaign and TARGET programme, taking into consideration analysis of the UK results from the European Healthcare workers survey.

Continue to increase public engagement through the e-Bug programme and pilot the e-Bug train the trainer course.

Host the fifth Antibiotic Guardian shared learning and awards.

Develop the Antibiotic Guardian Ambassadors as a virtual programme.
8. Stakeholder engagement

British Society for Antimicrobial Chemotherapy (BSAC)

The BSAC represents one of the world’s most influential networks of infection specialists (including, but not limited to, infectious disease physicians, microbiologists, pharmacists, researchers, and nurses).

BSAC provides high-quality open access support which takes many forms: free membership, workshops, conferences, and research publications via our ‘Journal of Antimicrobial Chemotherapy’, and the online open access education and research journal, ‘JAC-Antimicrobial Resistance’.

In addition, BSAC deliver:

1.1 The longest-running Resistance Surveillance programme in Europe, offering a biobank of more than 60,000 isolates to the UK’s research community.

1.2 A national susceptibility testing programme, actively supporting harmonisation of methodologies with the EUropean Committee for Antimicrobial Susceptibility Testing (EUCAST).

1.3 The Outpatient Parenteral Antimicrobial Therapy (OPAT) programme, which aims to bring care closer to home for patients.

1.4 An open access virtual learning platform, which includes:

- massive open online courses on Antimicrobial Stewardship (AMS), accessed by tens of thousands of learners from 135 countries, with translations in Mandarin, Russian, Spanish, Brazilian Portuguese – and a bespoke course for the African continent
- e-learning courses on Gram-negative infections, rapid diagnostics, wound management, and vaccines – among many others
- AMS fora for Middle East and North Africa, nursing, pharmacy technicians, Commonwealth pharmacists
- an e-book on AMS ‘From Principles to Practice’

1.5 Publication of evidence-based guidelines and good practice recommendations.
1.6  Informing and influencing via our All-Party Parliamentary Group on Antibiotics, meetings with representatives from UK Government departments and the NHS, education for schools through The Mould that Changed the World, and campaign partnerships through Stop Superbugs.

In addition, BSAC responded to the COVID-19 pandemic by reinventing our grants programme, establishing an information hub and commissioning opinion pieces from frontline scientists and healthcare professionals.

www.bsac.org.uk  @BSACandJAC

Care Quality Commission

The Care Quality Commission (CQC) makes sure health and social care services provide people with safe, effective, compassionate, high-quality care and encourages care services to improve. CQC regulate against the Health and Social Care Act 2008\textsuperscript{143}.

CQC has been included in workstreams relating to antimicrobial resistance (AMR) by NHS England, the National Institute for Health and Care Excellence (NICE) and Public Health England (PHE) where we have been able to advise groups on CQC’s regulatory and improvement remit. This work has also enabled the appropriate development of CQC’s inspection tools to support the UK 5-year action plan for antimicrobial resistance 2019 to 2024\textsuperscript{144}.

Internally, CQC have focussed on upskilling the inspection workforce with e-learning packages for hospital, primary care and adult social care inspectors. CQC’s medicines optimisation team have been trained in the use of PHE data sources to support inspectors to make judgements about the prescribing and use of antimicrobials.

CQC produced its annual State of Care | Care Quality Commission report and, along with other reviews and reports, a report on the provision of dental care in care homes Smiling matters: oral health care in care homes | Care Quality Commission This report highlighted concerns over availability of suitable and timely care which could have implications for appropriate antimicrobial prescribing in these settings.

\textsuperscript{143} https://www.legislation.gov.uk/ukpga/2008/14/pdfs/ukpga_20080014_en.pdf
Faculty of General Dental Practice UK

The Faculty of General Dental Practice UK (FGDP(UK)) has continued to emphasise the importance of appropriate antimicrobial prescribing in dentistry, and to raise awareness of antimicrobial resistance (AMR) and of the need for AMS to reduce drug-resistant infections.

Over the last year, FGDP(UK) has continued to promote use of the dental AMS toolkit by its members and the wider profession, in particular the updated Antimicrobial Prescribing Self-Audit Tool. It has also continued to raise awareness of AMR and dental AMS through its dedicated Antimicrobial Prescribing webpage, which co-hosts the toolkit, articulates the scale, nature and relevance of the problem of AMR to dentistry, and provides links to the leading text on antibiotic prescribing in dentistry, FGDP(UK)'s Antimicrobial Prescribing for General Dental Practitioners145.

‘Antimicrobial Prescribing for General Dental Practitioners’ continues to be made available to dentists in hard copy and freely on the FGDP(UK) website, where it has been viewed over 150,000 times since 2015. Work has continued with the Faculty of Dental Surgery to extend its scope to include secondary care prescribing, and an updated document will be published later this year.

FGDP(UK) organised a press and social media campaign around World Antibiotic Awareness Week and European Antibiotics Awareness Day 2019, which promoted prescribing in line with dental guidelines and encouraged take-up of the British Association of Oral Surgeons’ Antimicrobial Stewardship e-Learning Modules146.

The seventh annual dental collaboration of its kind, it was supported by the Association of Clinical Oral Microbiologists, the Association of Dental Hospitals, the British Association of Oral Surgeons, and the dental sub-group of the Scottish Antimicrobial Prescribing Group. The French Society of Oral Surgeons (Société Francaise de Chirurgie Orale) also engaged, helping to emphasise the shared international nature of the goal. The initiative was widely covered in dental media.

The Faculty also collaborated with the British Dental Association and the other UK organisations above to urge dentists to participate in a national survey of antibiotic prescribing.

145 https://www.fgdp.org.uk/guidance-standards/antimicrobial-prescribing-gdps
146 http://www.baos.org.uk/elearning/
FGDP(UK)’s AMR Lead, Dr Nick Palmer - a leading authority on dental antibiotic prescribing and author of the Faculty’s guidelines – represented the Faculty at meetings of the ESPAUR Dental Sub-group and ESPAUR Oversight group, and is an adviser to NICE on antimicrobial prescribing in dentistry.

FGDP(UK) has also been guiding dentists on appropriate antimicrobial prescribing throughout the COVID-19 pandemic. The Faculty’s online advice was signposted in NHS England’s COVID-19 guidance and Standard Operating Procedure.

The National Institute for Health and Care Excellence (NICE)

NICE continues to work with 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 is producing these guidelines which are jointly badged by both NICE and PHE. In 2019/20 there were 6 APGs published on pneumonia (hospital-acquired), pneumonia (community-acquired), cellulitis, diabetic foot infection, leg ulcer infection, impetigo, with more topics in development.

The format of APG content comprises a visual summary of the recommendations, the guideline, the associated evidence review and a summary document that includes content from all APGs alongside PHE’s guidance for primary care. Some guidelines also include decision aids to inform shared decision making, such as cystitis – taking an antibiotic. NICE will continue to engage both at a national and regional level with key external stakeholders including PHE, NHS England/Improvement, Health Education England (HEE) and the CQC to support the wider implementation of the APGs.

To support the appropriate use and stewardship of new antimicrobials at the point of launch, NICE is also developing evidence summaries for antimicrobial prescribing. Topics published in 2019 were on meropenem with vaborbactam (Vaborem) and ceftolozane with tazobactam (Zerbaxa) for treating hospital-acquired pneumonia, including ventilator-associated pneumonia.

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 Antimicrobial stewardship: 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. The NICE guideline on Antimicrobial
stewardship: systems and processes for effective antimicrobial medicine use (NG15) was reviewed for update in January 2018. Based on a review of current policy and evidence since publication, and the views of topic experts and stakeholders the guideline was considered current and accurate.

NICE continue to collaborate with colleagues in NHS England and Improvement along with DHSC on a develop and test project looking at novel value assessment and reimbursement of new antimicrobials offering high potential to address unmet need. This project explores the value of enhanced Technology Appraisal of 2 new antimicrobials to inform a novel reimbursement model that would delink volume of prescribing from payment to the pharmaceutical company.

The project launched in July 2019 and the team have recently finished a period of market engagement with stakeholders, sharing the draft documents on the selection process and criteria, evaluation framework and commercial negotiation framework, and will be inviting submissions from industry to participate in the project via the official journal of the EU by early June 2020. The 2 products for the evaluation will be selected in 2020, undergo the evaluation in 2021, with a negotiated contract expected to be completed in first quarter of 2022.

NICE also produce Medtech Innovation Briefings (MIBs) on new medical devices and diagnostics. These briefings help to avoid the need for organisations to produce similar information locally, saving staff time and resources. MIBs can be quickly developed (in around 15 weeks) on most technologies and provide factual information for organisations to consider. Other NICE outputs (such as NICE guidelines, diagnostics guidance, or Technology Appraisals) are reserved for technologies that have the potential to deliver substantial benefits, have a high potential to address an unmet need, or where an evaluation of the clinical and cost effectiveness of the technology is beneficial to the NHS. This could be for antimicrobials that have a new mode of action that is less susceptible to development of resistance or for innovative technologies that optimise antibiotic prescribing, for example. Guidance is often supported by adoption tools to encourage the uptake of technologies that are recommended by NICE. NICE’s Diagnostics Assessment Programme produces guidance on the use of innovative diagnostic technologies, including those that are relevant to the AMR strategy. Guidance has been published on: Rapid tests for Group A Streptococcal infections in people with a sore throat; Procalcitonin testing for diagnosing and monitoring sepsis; Tests for rapidly identifying bloodstream bacteria and fungi; and Integrated multiplex PCR tests for identifying gastrointestinal pathogens in people with suspected gastroenteritis.

The Diagnostics Assessment Programme also represents NICE on the UK AMR Diagnostics Collaborative which brings together key partners across the NHS, industry and academia to deliver the UK’s diagnostic ambitions for AMR.
Public Health Agency (Northern Ireland)

The Public Health Agency (Northern Ireland) continues to support efforts to reduce MRSA bloodstream infections, *Clostridium difficile* infections, Gram-negative bacteraemias and antibiotic consumption through the work of the Regional Healthcare associated Infections and AMS Improvement Board and the Health Protection department. Highlights during 2019 include: public engagement activities including continuation of a social and mass media campaign, hosting information stands at large local public events, delivery of e-bug training workshops to primary school teachers, engagement with youth groups and coordinated efforts in undergraduate and postgraduate training around infection prevention and control (IPC)/AMR/AMS; work on changing prescribing behaviour including development of a community pharmacy pilot for C-reactive protein CRP point-of-care-testing, continued delivery of workshops using the TARGET resources, GP practice visits, repeat of an intervention letter from the Chief Medical Officer in NI and a collaborative pilot project to improve urinary tract infection (UTI) AMS in nursing homes. Work in secondary care has included delivery of an IPC study-day for secondary care staff and further development of a Trust-facing surveillance system enabling real-time analysis of Gram-negative bacteraemias and monthly updates to ward-level antibiotic consumption data.

Public Health Wales

The Healthcare Associated Infection, Antimicrobial Resistance and Prescribing Programme (HARP) team, Public Health Wales, provides professional support to the NHS in Wales to reduce the burden of healthcare associated infections and antibiotic resistance 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, antimicrobial stewardship and infection prevention and control. The HARP team supports and advises the Wales AMR & HCAI Steering Group, chaired by the CMO Wales as well as the AMR and HCAI Delivery Boards set up to deliver the UK AMR strategy in Wales.

A number of reports are published by the HARP team, including annual antimicrobial prescribing in primary care, secondary care, resistance in both primary and secondary care, and the annual welsh antimicrobial point prevalence study. For HCAI surveillance, the HARP team provide a monthly dashboard of HCAI, as well as a quarterly dashboard of surgical site infections. Wales data is also provided to the UK AMR delivery board and ECDC.

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 antimicrobial resistance reference laboratory.
(Specialist Antimicrobial Chemotherapy Unit), which provides molecular confirmation of antimicrobial resistance, 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, drivers of carbapenem use, every 5 years. Each year the Welsh HBs participate in the European Antibiotic Awareness Day, supported by materials and communications from PHW and WG.

More information, including all our published reports, are available at: https://phw.nhs.wales/services-and-teams/harp/

Royal Pharmaceutical Society

We are committed to continue supporting the UK National Action Plan and 20-year vision, and the global strategy for AMR. Our Chief Executive, President, Executive Team, National Boards and Expert Groups support this vital work by highlighting the important contribution that pharmacy and pharmaceutical sciences can make to AMR.

During 2019, we developed and delivered a new expert-led AMS Training Programme for pharmacists practising in patient-facing roles. Commissioned by the HEE AMR Innovation Fund, this programme was the first of its kind in England and was delivered in collaboration with PHE and the UKCPA Pharmacy Infection Network. As part of World Antibiotic Awareness Week 2019, we worked with PHE to develop and deliver the Antibiotic Guardian School Ambassadors’ pilot. Further information about these projects can be found in the ESPAUR report.

Our Boards and Antimicrobial Expert Advisory Group continue working closely together to respond to consultations on AMS and management of infections and contribute to national and global AMR campaigns. We continue working alongside other national groups to support engagement and confidence in optimising the use of antimicrobials and encourage all pharmacists to become Antibiotic Guardians. For further information please visit https://www.rpharms.com/about-us/who-we-are/expert-advisors/antimicrobial-expert-advisory-group.

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, SONAAR 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.
These data are used by organisations such as the Scottish Antimicrobial Prescribing Group (SAPG) to inform antimicrobial prescribing policy and develop initiatives for antimicrobial stewardship and the Scottish Microbiology and Virology Network (SMVN) to support the development of testing strategies for NHS diagnostic laboratories in Scotland.

The SONAAR 2020 report will be published in November 2020 and will be available online.
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Chapter 1: Introduction
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Chapter 2: Antimicrobial resistance
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Chapter 4: Antibiotic consumption
Amelia Andrews, Angela Falola, Berit Muller-Pebody, Simon Collin, Susan Hopkins

Chapter 5: NHS quality improvement and assurance schemes
Emma Budd, Elizabeth Beech, Diane Ashiru-Oredope, Susan Hopkins

Chapter 6: Antimicrobial stewardship
Diane Ashiru-Oredope, Ella Casale, Emily Cooper, Alicia Demirjian, Natalie Gold, Aoife Hendrick, Leah Jones, Donna Lecky, Blathnaid Mahon, Anna Sallis, Sally Weston-Price, Sandra White.

Chapter 7: Professional education & training and public engagement

Chapter 8: Stakeholder engagement
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About Public Health England

Public Health England exists to protect and improve the nation’s health and wellbeing, and reduce health inequalities. We do this through world-leading science, research, knowledge and intelligence, advocacy, partnerships and the delivery of specialist public health services. We are an executive agency of the Department of Health and Social Care, and a distinct delivery organisation with operational autonomy. We provide government, local government, the NHS, Parliament, industry and the public with evidence-based professional, scientific and delivery expertise and support.

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