UK Health Security Agency

Laboratory surveillance of paediatric bacterial bacteraemia and antimicrobial resistance in England: 2019 to 2023

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Contents

1. Introduction

This is the third edition in a series of health protection reports highlighting trends in laboratory-reported incidence and antimicrobial resistance (AMR) in bacteraemia among England's paediatric population (0 to 17 year olds inclusive). This report covers the years 2019 to 2023. It should be considered supplementary to the English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) report 2023 to 2024 (1). Paediatric data is included in the main ESPAUR report, and further AMR data by age group is provided here. Additional paediatric data from the 2023 point prevalence survey on healthcare associated infections (HCAIs), antimicrobial use (AMU) and antimicrobial stewardship (AMS) in England is published in a supplementary report (2).

This report is based on ESPAUR methodology (1). Resistance rates for certain antimicrobial and organism combinations are not graphically displayed when the number of infection episodes with susceptibility testing is below 20 for that age group. Data reference tables containing bacteraemia incidence and susceptibility data underpinning the Figures and findings in this report are available in the data tables spreadsheet, 'Laboratory surveillance of paediatric BSI and antimicrobial resistance (England) 2019 to 2023: data tables', accompanying this report (each Figure in the report corresponds to a data table of the same name in the spreadsheet).

In the AMR bacteraemia section, AMR rates for specific antimicrobial-organism combinations are described (defined for each organism in Table 3). The included organisms represent some of the most frequently reported causes of bacteraemia across age groups (see 'Accessory data tables 1 to 4' in the spreadsheet). Coagulase-negative *Staphylococcus* (CoNS) and *Micrococcus* spp. remain the most frequently reported organisms detected from blood samples across all age groups and are included in the incidence of bacteraemia section (see Caveats). However, data on the clinical relevance of these organisms is not routinely available.

The age groups used to analyse the incidence of laboratory-reported bacteraemia and antimicrobial susceptibility trends differ slightly, reflecting the low frequency of reports and, therefore, limited susceptibility testing in certain age groups (outlined in Table 2).

New additions to the AMR section in 2023-to-2024 report include:

- a new section comparing meticillin-resistant *Staphylococcus aureus* (MRSA) rates and counts across all paediatric age groups
- re-classification of the paediatric population into more clinically relevant age groupings
- analysis of a broader range of the most commonly isolated organisms in <1 year olds

2. Main points

2.1 Incidence of bacteraemia

Main results:

- reports of bacteraemia in all paediatric age groups increased between 2019 (n=13,973) and 2023 (n=17,663), representing a 25.4% increase in the overall rate for 0 to 17 year olds, rising from 118.5 to 148.6 per 100,000 population
- the rate increase was largely driven by CoNS, which accounted for 40.1% of the overall rate increase in 1 to 4 year olds and 60.6% in <1 year olds between 2019 and 2023. When CoNS and *Micrococcus* spp. isolates were excluded, the overall increase of 25.4% was attenuated to 16.3%
- the highest rate of bacteraemia was observed in <1 year olds (1,258 per 100,000 population in 2023), a 22.3% increase in rate between 2019 and 2023 with half the episodes occurring in infants younger than one month
- *Escherichia coli* remains a common cause of bacteraemia across all age groups, whilst group B *Streptococcus* (GBS) remains the most common cause of bacteraemia in 0 to 3 day olds and *Staphylococcus aureus* in the 5 to 17 year olds (14.1% and 8.1% in 2023, respectively)
- group A *Streptococcus* (GAS) and *Streptococcus pneumoniae* increased as a proportion of overall counts of bacteraemia in >1 year olds between 2019 and 2023 (increasing 93.6% and 31.5%, respectively, however invasive GAS notifications have subsequently declined after a 2022-to-2023 peak, 3)
- bacteraemia counts decreased in most age groups in 2020 (from 4 day olds upwards), likely reflecting the impact of non-pharmaceutical interventions during the COVID-19 pandemic. The decrease was not observed in 0 to 3 day olds

2.2 Antimicrobial resistance

Main results:

- there were no confirmed penicillin-resistant infection episodes of GAS or GBS in children and young people
- penicillin resistance in *S. pneumoniae* remained low (<3%) throughout the period in 4 day to <1 year olds; however, in children one year and over, resistance fluctuated between 1.9% (n=1 per 71 tested in 2023) and 9.4% (n=9 per 96 tested in 2021)
- in 2023, the overall rate of MRSA in children (0 to 17 years) was 8.9% (n=78 per 872 tested), an increase from 5.6% (n=44 per 844 tested) in 2019 and higher than the corresponding rate in the wider English population (6.7%)

- in children aged 4 days to <1 year, the proportion of MRSA doubled between 2019 and 2023 from 5.6% (n=16 per 287 tested) to 11.2% (n=31 per 276 tested) of meticillin-tested *S. aureus* infection episodes
- between 2019 and 2023, *Klebsiella pneumoniae* resistance to most antibiotics included in this report (see Table 3) increased among children across all age groups, with increases most marked in the 4 days to <1 year olds
- in 4 day to <1 year olds, *E. coli* resistance to third-generation cephalosporins nearly doubled from 9.0% (n=39 per 433 tested) in 2019 to 17.9% (n=69 per 385 tested) in 2023
- across all age groups *E. coli* resistance to co-amoxiclav was 36.0% (n=239 per 664 tested) in 2023; this compares to the rate of third-generation cephalosporin resistance of 17.3% (n=126 per 727 tested) in 2023
- in *E. coli* the highest reported co-amoxiclav resistance was in the 1 to 4 year olds at 53.6% (n=45 per 84 tested) in 2023;

2.3 Caveats

- the frequency of bacteraemia in the paediatric population was low; caution should therefore be taken when interpreting incidence and resistance trends due to small sample sizes – resistance rates are not reported where the number tested was <20 samples
- the SARS-CoV-2 (COVID-19) pandemic affected the general case-mix of hospital patients during much of 2020 and 2021; this has likely impacted trends for the 5-year period
- clinical data is not captured in the UKHSA laboratory reporting surveillance system used in this report, and thus the clinical significance of blood culture isolates cannot be determined. This limitation impacts, in particular, isolates from the CoNS, *Micrococcus* spp. and oral streptococci group. As a result, it is not possible to distinguish true infection from blood culture contamination.
- antibiotic susceptibility results reported here have not been confirmed by UKHSA's national reference laboratory

3. Results

3.1 Incidence of bacteraemia

3.1.1 Overall incidence of bacteraemia

The overall reported incidence of bacteraemia in England increased between 2019 and 2023 for 0 to 17 year olds (Figure 1.1), from 118.5 to 148.6 per 100,000 population (a rate increase of 25.4%, n=13,973 in 2019 to 17,663 in 2023). The incidence of bacteraemia was highest in children aged <1 year old (1,285.1 per 100,000 population in 2023; n=7,663), reflecting an 28.5% increase since a five-year low in 2020 (data table Figure 1.1A). In <1 year olds in 2023, half of the bacteraemia episodes occurred in infants under one month, with 19.6% of bacteraemia in <1 year olds occurring in neonates aged 0 to 3 days and 30.4% in 4 day to 1 month olds.

The number of bacteraemia episodes in <1 year olds increased by 22.3% from 2019 to 2023, with stable counts in 0 to 3 day olds but increased by nearly 25% in 4 day to <1 month and 1 month to <1 year olds (data table Figure 1.1A). There were similar increases in the incidence of bacteraemia for 1 to 4 year olds (36.3% increase, 140.4 to 191.4 per 100,000 population) and 5 to 17 year olds (32.4% increase, 45.1 to 59.8 per 100,000 population).

3.1.2 Incidence of bacteraemia by organism in England: coagulase-negative *Staphylococcus* and *Micrococcus* spp.

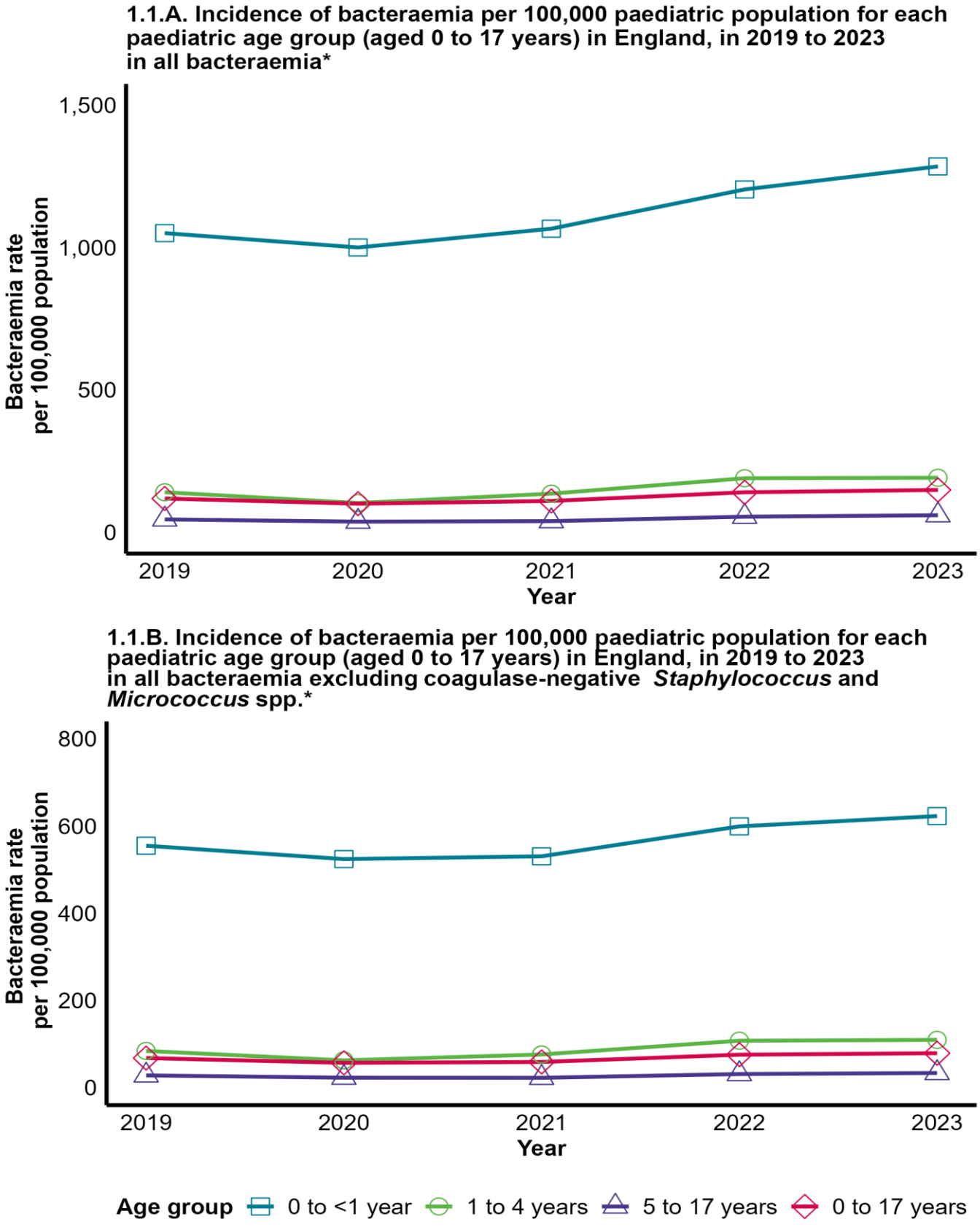
Between 2019 and 2023, approximately two-thirds of the 25.4% incidence rate rise in bacteraemia across the paediatric population was attributable to CoNS and *Micrococcus* spp., and nearly half of all bacteraemia episodes were attributable to CoNS or *Micrococcus* spp. (data tables Accessory 6-8). The highest incidence of CoNS and *Micrococcus* spp. bacteraemia in 2023 was in those aged <1 year old (incidence rate of 662.2 per 100,000 population), where it contributed to 71.0% of the incident rate rise from 2019 to 2023 (data table Accessory 6). Between 2019 and 2023, CoNS and *Micrococcus* spp. bacteraemia contributed to 50.1% and 62.1% of the incidence rate rise in the 1 to 4 year and 5 to 17 year olds, respectively (data tables Accessory 7 and 8). In the <1 year olds, CoNS and *Micrococcus* spp. may be less likely to represent blood culture contamination compared to older age groups, as infants are comparatively more likely to be hospitalised or in intensive care units. This increases their likelihood of having risk factors, such as prosthetic devices, which predispose them to clinically significant bacteraemia. In this age group, when excluding CoNS and *Micrococcus* spp., the incidence of bacteraemia in 2023 was 622.8 per 100,000 population, an increase of 12.3% from 2019 (data table Figure 1.1B).

In almost all age groups the incidence (and count) of bacteraemia increased between 2019 and 2023, although this increase was attenuated when CoNS and *Micrococcus* spp. were excluded. (Figure 1.1B). The exception to this increasing trend was in the 0 to 3 day olds, where the

number of bacteraemia cases decreased by 9.3% (n=842 to 764) during the same period when CoNS and *Micrococcus* spp. were removed (data table Figure 1.1B).

The reason for the increased isolation of these organisms, along with their clinical significance, requires further consideration at both the local and national levels. This includes a review of local blood culture collection techniques and the national blood culture pathway improvement programme which aims to enhance accuracy and efficiency of blood culture testing.

Figure 1.1 Incidence of bacteraemia per 100,000 paediatric population for each paediatric age group (aged 0 to 17 years) in England: 2019 to 2023* in (A) all bacteraemia (B) all bacteraemia excluding coagulase-negative *Staphylococcus* and *Micrococcus* spp.



*Note the figures have different y-axis scales

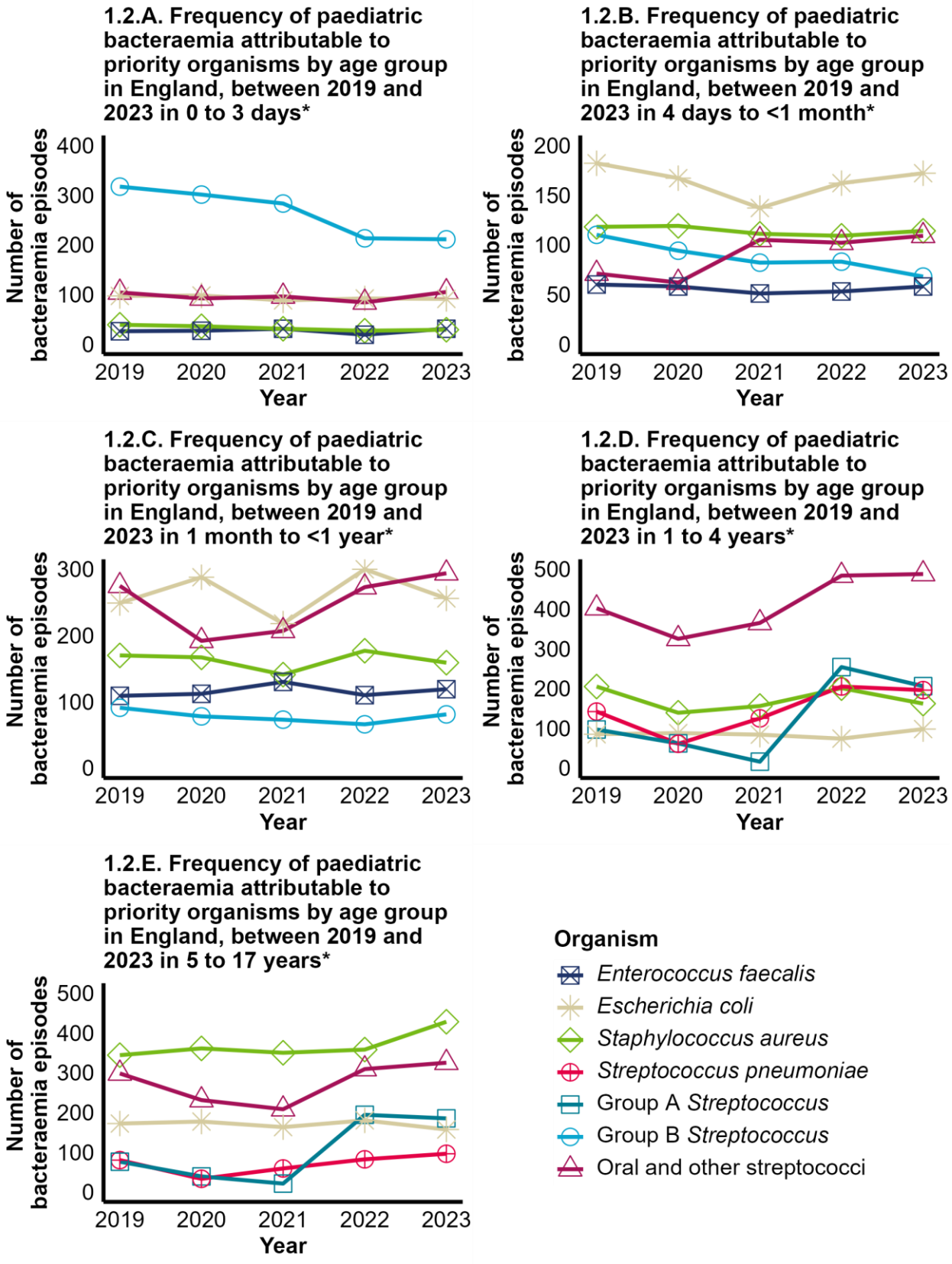
3.1.2 Incidence of bacteraemia by organism in England: priority organisms

Priority organisms are those of public health significance in the paediatric population for AMR and most commonly isolated from blood cultures, excluding CoNS and *Micrococcus* spp., as listed in the Methods section. Priority organisms contributed to between 27-33% of bacteraemia reported in each age group (data tables Accessory 1-5).

The 5 most commonly isolated priority organisms by age group in 2023 were (Figure 1.2):

- 0 to 3 days old:
  - GBS (n=211)
  - oral and other streptococci (n=105, *Streptococcus* spp. in the *S. anginosus*, *S. bovis*, *S. mitis*, *S. mutans*, *S. salivarius*, and *S. sanguinis* groups)
  - *E. coli* (n=91)
  - *Enterococcus faecalis* (n=31)
  - *S. aureus* (n=29)
- 4 days to <1 months old:
  - *E. coli* (n=172)
  - *S. aureus* (n=114)
  - oral and other streptococci (n=109)
  - GBS (n=68)
  - *E. faecalis* (n=58)
- 1 month to <1 year old:
  - oral and other streptococci (n=294)
  - *E. coli* (n=256)
  - *S. aureus* (n=159)
  - *E. faecalis* (n=119)
  - GBS (n=81)
- 1 to 4 years old:
  - oral and other streptococci (n=488)
  - GAS (n=206),
  - *S. pneumoniae* (n=196)
  - *S. aureus* (n=162)
  - *E. coli* (n=98)
- 5 to 17 years old:
  - *S. aureus* (n=428)
  - oral and other streptococci (n=325)
  - GAS (n=185)
  - *E. coli* (n=157)
  - *S. pneumoniae* (n=96)

Figure 1.2. Frequency of paediatric bacteraemia attributable to priority organisms by age group in England, between 2019 and 2023* in (A) 0 to 3 days, (B) 4 days to <1month, (C) 1 month to <1 year, (D) 1 to 4 years, and (E) 5 to 17 years



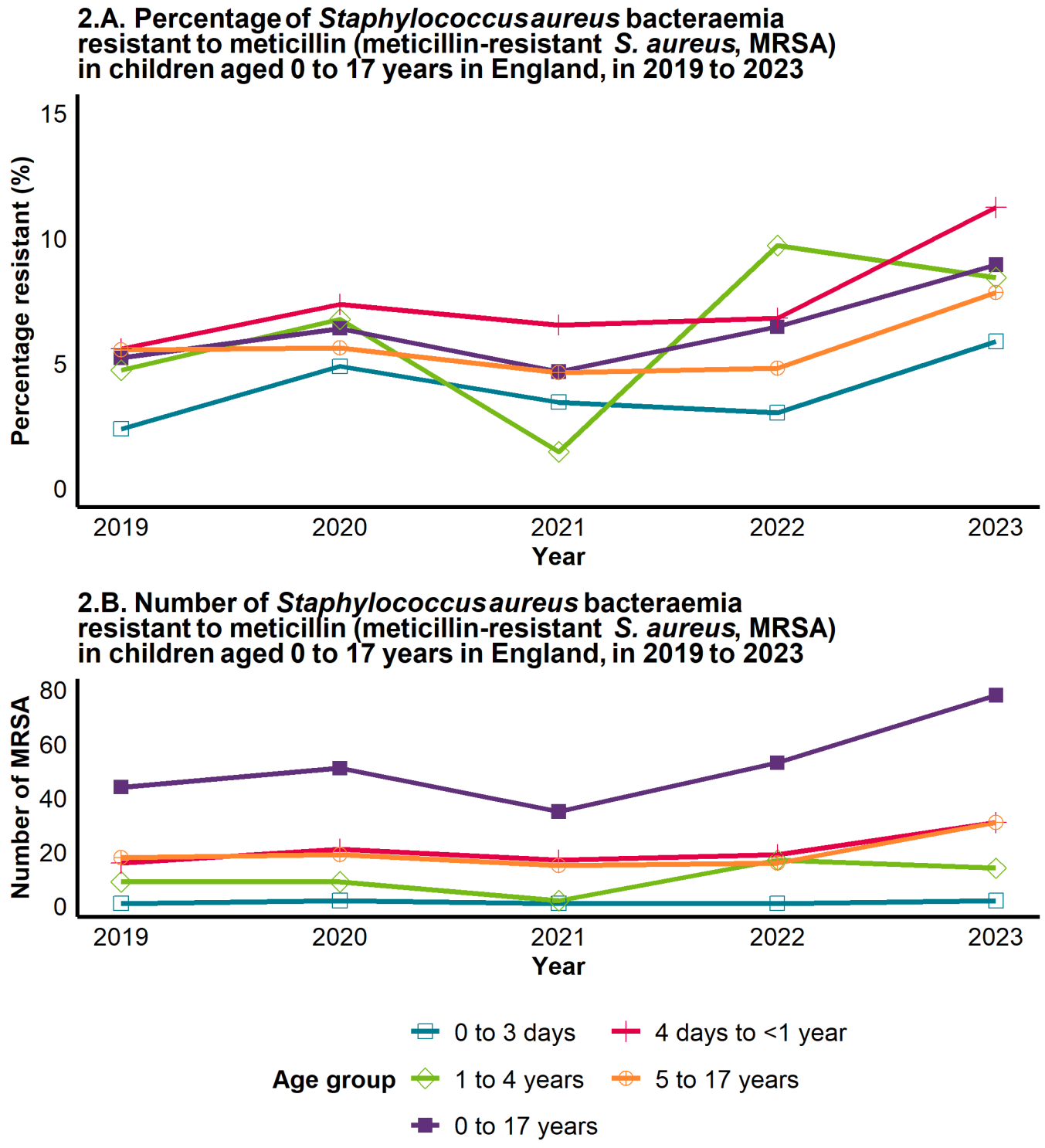
*Note the figures have different y-axis scales

3.2 Meticillin-resistant *Staphylococcus aureus* (MRSA)

There was a higher proportion of meticillin-resistant *S. aureus* (MRSA) in children compared to the wider population (8.9% in paediatrics compared to 6.7% in the wider population in 2023, p<0.05) (1) (data table Figure 2). Across all paediatric age groups, *S. aureus* resistance to meticillin (MRSA) increased between 2019 and 2023 (5.2%, n=44 per 844 *S. aureus* tested to 8.9%, n=78 per 872 *S. aureus* tested, respectively) (Figure 2). In all age groups other than 1 to 4 year olds, the proportion of *S. aureus* that were MRSA increased from 2022 and peaked in 2023; in 1 to 4 year olds the peak was seen in 2022 with a slight drop reported in 2023. In 2023 the age group with the highest proportion of MRSA was neonates and infants aged 4 days to <1 year old (11.2%). This age group also had the largest increase over the five years, doubling from 2019 (5.6%).

Counts of MRSA were highest in 4 days to <1 year and 5 to 17 year olds which increased from 2022 to 2023 (Figure 2b). The number of MRSA episodes in 0 to 3 year olds has remained stable over the five-year period. Further interpretation of resistance to antibiotic agents among MRSA infection episodes was not conducted due to the low (<20) annual number of infection episodes (data tables for Figures 4, 8, 13, 18).

Figure 2. (A) Percentage and (B) counts of *S. aureus* bacteraemia resistant to meticillin (meticillin-resistant *S. aureus,* MRSA) in children aged 0 to 17 years in England, 2019 to 2023



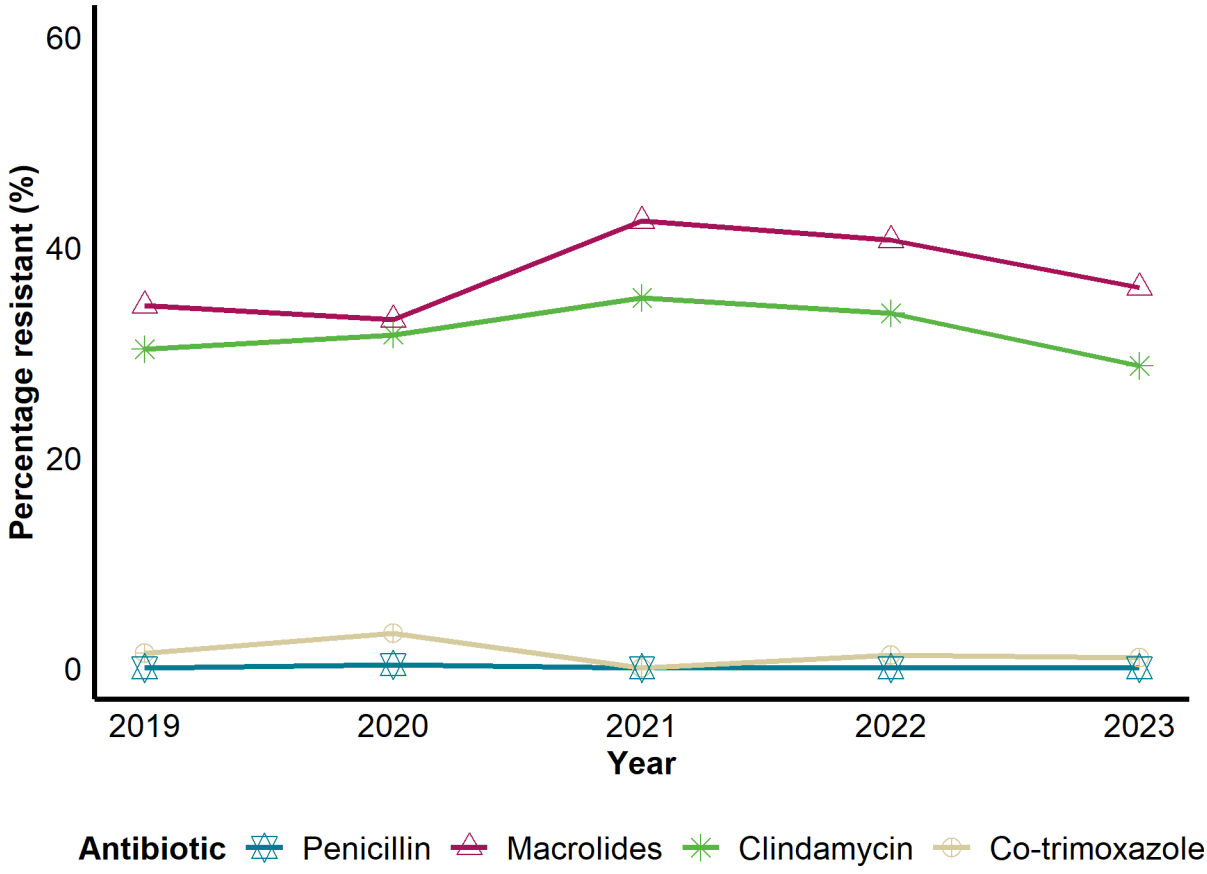
3.3 Antimicrobial resistance in bacteraemia cases

3.3.1 Neonates (0 to 3 day olds)

Gram-positive bacteraemia

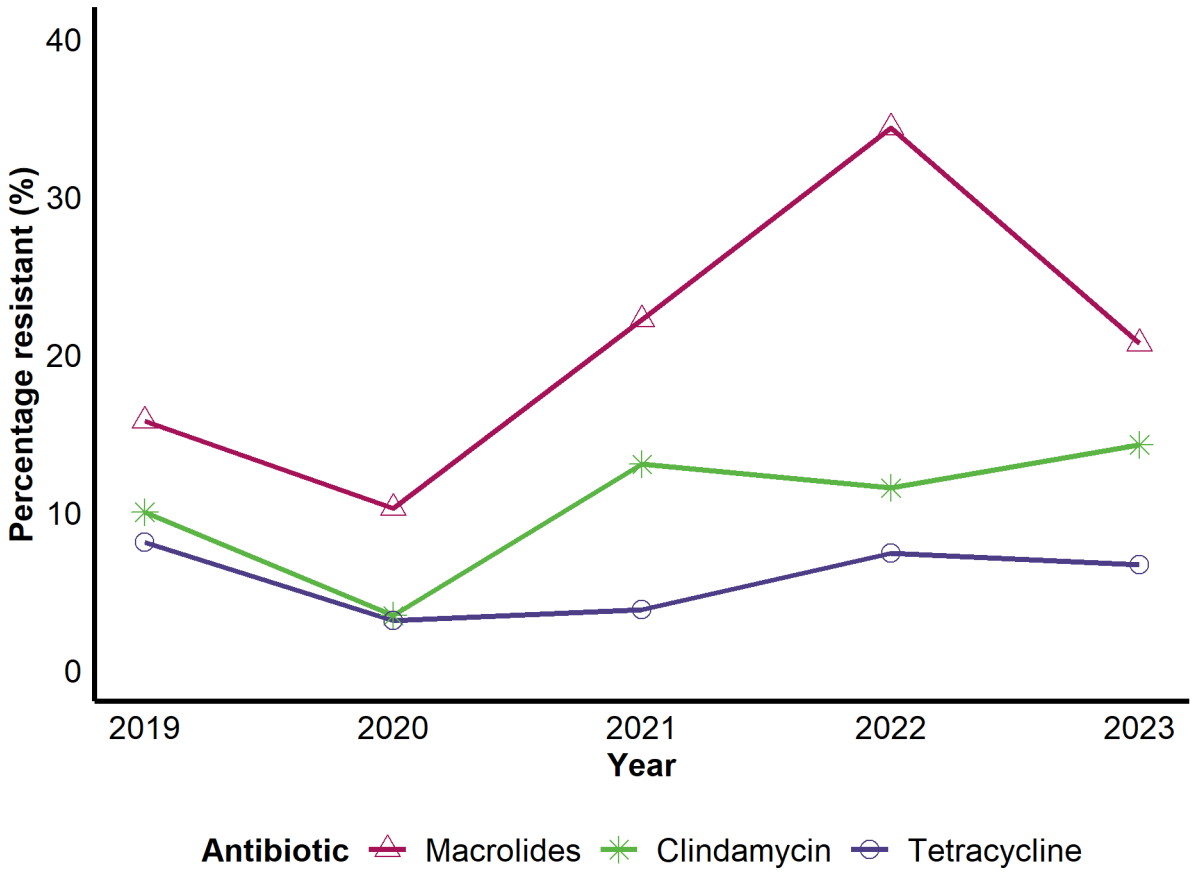
In neonates, one GBS infection episode was reported as resistant to penicillin between 2019 and 2023 (out of 1,326 infection episodes) (data table Figure 3) but this was not confirmed by the AMRHAI reference laboratory. Only one resistant isolate has been confirmed in adults for the reporting period (4). Any GBS isolate reported as penicillin-resistant should be referred to AMRHAI for confirmation (9, 10). Resistance to macrolides and clindamycin remained stable at 36.2% (n=72 per 199 tested) and 28.8% (n=44 per 153 tested), respectively, in 2023 (Figure 3). GBS resistance to co-trimoxazole remained <4% during the five-year period.

Figure 3. AMR of group B *Streptococcus* for children aged 0 to 3 days in England, 2019 to 2023



Meticillin-susceptible *S. aureus* (MSSA) resistance to macrolides ranged from 10.3% (n=4 per 39 tested) in 2020 to 34.4% (n=11 per 32 tested) in 2022, before decreasing to 20.7% (n=6 per 29 tested) in 2023 (Figure 4). Resistance to clindamycin and co-trimoxazole in MSSA remained <15% (Figure 4).

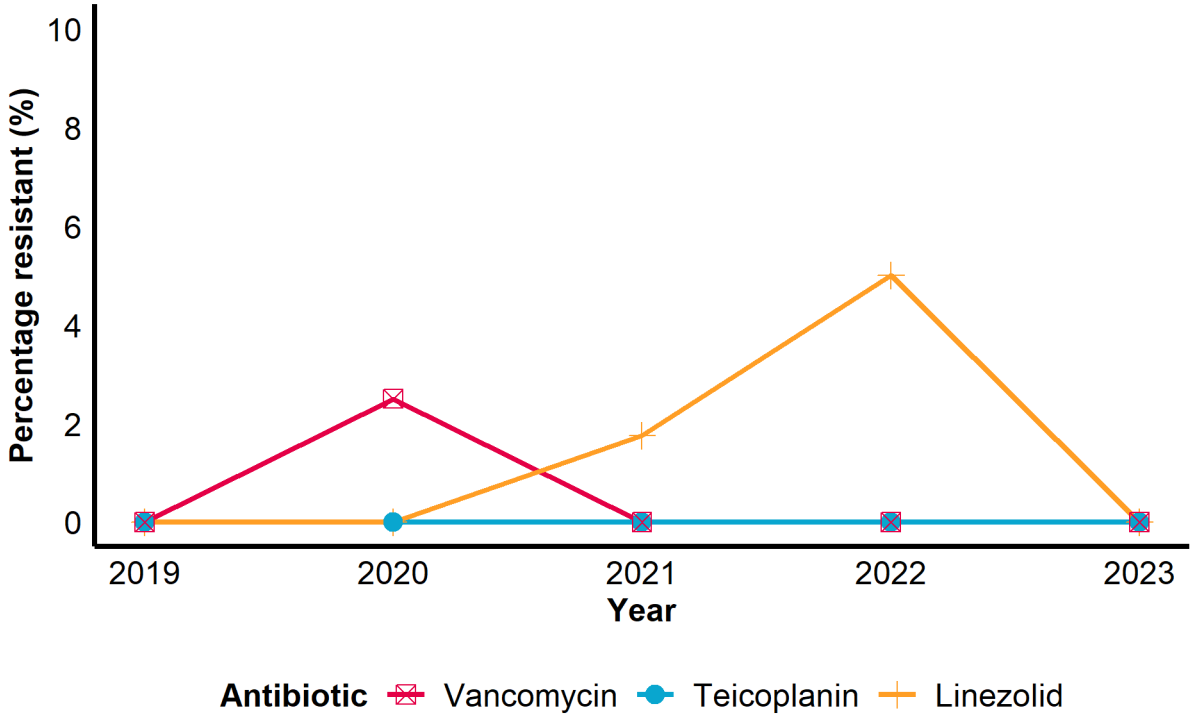
Figure 4. AMR of meticillin-susceptible *S. aureus* (MSSA)* bacteraemia for children aged 0 to 3 days in England, 2019 to 2023



*Resistance to co-trimoxazole, not displayed for MSSA, due to low (≤20) number of bacteraemia with reported susceptibility testing results (see Methods).

Between 2019 and 2023, *E. faecalis* resistance to vancomycin and linezolid was ≤5%, and no episodes of resistance to teicoplanin were reported during this period (Figure 5).

Figure 5. AMR of *Enterococcus faecalis* bacteraemia for children aged 0 to 3 days in England, 2019 to 2023

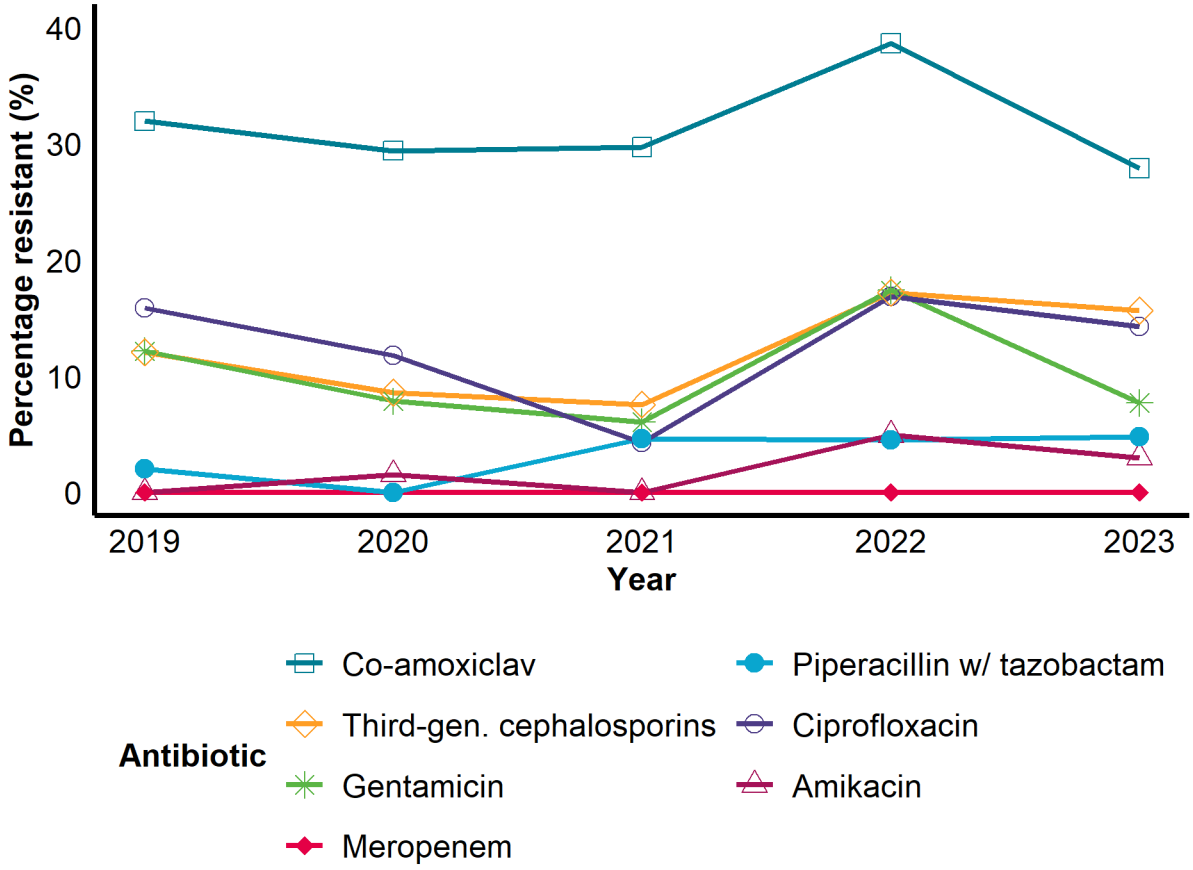


Gram-negative bacteraemia

E. coli resistance to co-amoxiclav fluctuated with a maximum of 38.6% (n=34 per 88 tested) in 2022 and a minimum of 27.9% (n=24 per 86 tested) in 2023 (Figure 6). *E. coli* resistance to third-generation cephalosporins ranged from 7.6% (n=9 per 119 tested) in 2021 to 17.2% (n=16 per 93 tested) in 2022, and was 15.6% (n=15 per 96 tested) in 2023 (Figure 6). Ciprofloxacin resistance fluctuated over the period between a minimum of 4.3% (n=5 per 116 tested) in 2021 and a maximum of 16.9% (n=15 per 89 tested) in 2022, with reported resistance at 14.3% (n=13 per 91 tested) in 2023. Gentamicin resistance fluctuated between 6.0% (n=7 per 116 tested) in 2021 and 17.4% (n=16 per 92 tested) in 2022, and was 7.7% (n=7 per 91 tested) in 2023. Amikacin resistance remained stable at <5%. Meropenem resistance was not reported in this age group between 2019 and 2023 (Figure 6).

A change in EUCAST breakpoints for Enterobacterales and piperacillin with tazobactam complicates trend interpretation (see Methods; see Box 2.3 in ESPAUR, 1), however in 0 to 3 day olds, *E. coli* resistance to piperacillin with tazobactam remained <5% over the period (4.8%, n=4 per 84 tested in 2023) (Figure 6).

Figure 6. AMR of *Escherichia coli* bacteraemia for children aged 0 to 3 days in England, 2019 to 2023



3.3.2 Neonates and infants (4 day to <1 year olds)

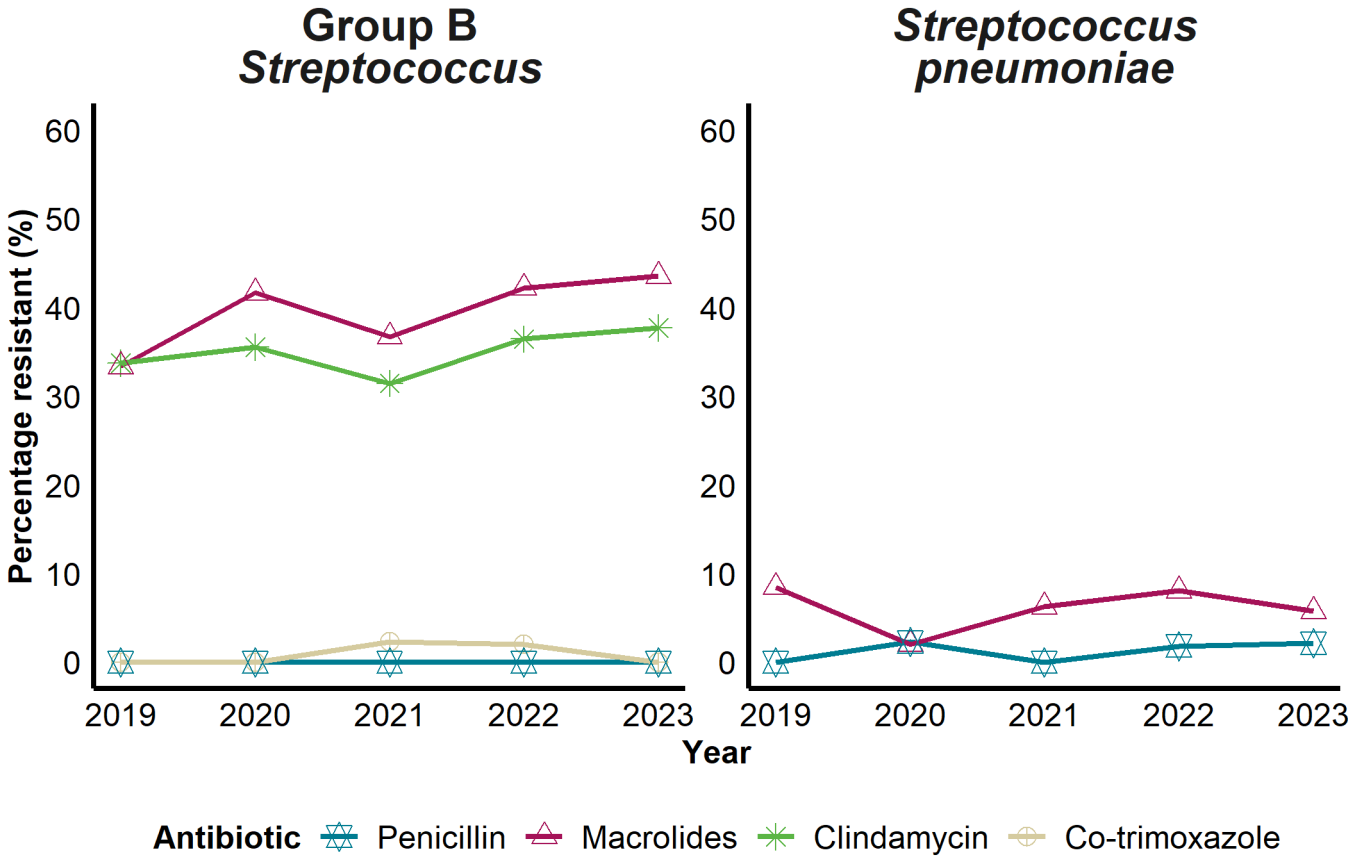
Gram-positive bacteraemia

In 4 day to <1 year olds, between 2019 and 2023, no GBS infection episodes resistant to penicillin were reported (Figure 7). Macrolide resistance increased from 33.3% (n=70 per 210 tested) in 2019 to 43.5% (n=64 per 147 tested) in 2023, while clindamycin resistance rose from 33.7% (n=56 per 166 tested) in 2019 to 37.7% (n=46 per 122 tested). Resistance to co-trimoxazole remained <3% over the five-year period (Figure 7).

Trends and demographics of GAS are discussed in more detail in the seasonal and annual reports (3, 5, 6). The number of GAS infection episodes with susceptibility testing was low (<20) in 2020 and 2021; however, no episodes of GAS resistant to penicillin were reported between 2019 and 2023 (data table Figure 7). GAS resistance to macrolides and clindamycin remained <8%.

Between 2019 and 2023, *Streptococcus pneumoniae* resistance to penicillin remained <3% (Figure 7). No third-generation cephalosporin-resistant infection episodes were reported during the five-year period (data table Figure 7). Resistance to macrolides fluctuated between 2.0% (n=1 per 49 tested) in 2020 and 8.5% (n=6 per 71 tested) in 2019 and was 5.8% (n=3 per 52 tested) in 2023 (Figure 7). Co-trimoxazole resistance increased from 14.3% (n=5 per 35 tested) in 2019 to 24.0% (n=6 per 25 tested) in 2023 (data table Figure 7).

Figure 7. AMR of *Streptococcus* spp.* bacteraemia for children aged 4 days to <1 year in England, 2019 to 2023



*Resistance not displayed for GAS, due to low (≤20) numbers of reported bacteraemia episodes [2020 and 2021] (see Methods). Resistance to clindamycin and co-trimoxazole was not displayed for *S. pneumoniae* due to low (<20) number of bacteraemia with reported susceptibility testing results (see Methods).

MSSA resistance to macrolides increased over the 2019 to 2023 period from 15.9% (n=42 per 264 tested) in 2019 to 21.5% (n=50 per 233 tested) in 2023 (Figure 8). Clindamycin resistance remained stable over the same period, at 15.7% (n=30 per 191 tested) in 2023. In reports of MSSA, resistance to co-trimoxazole was <2% over the five-year period.

Between 2019 and 2023, *E. faecalis* resistance to vancomycin, teicoplanin, and linezolid was <4% (Figure 9).

E. faecium resistance to teicoplanin ranged from 2.7% (n=1 per 37 tested) in 2021 to 13.8% (n=4 per 29 tested) in 2022 and was 6.1% (n=2 per 33 tested) in 2023 (Figure 9). Vancomycin resistance ranged from 2.4% (n=1 per 41 tested) in 2021 to 10.3% (n=3 per 29 tested) in 2019 and was 5.9% (n=2 per 34 tested) in 2023. Linezolid resistance was <5%.

Figure 8. AMR of meticillin-susceptible *S. aureus* (MSSA) bacteraemia for children aged 4 days to <1 year in England, 2019 to 2023

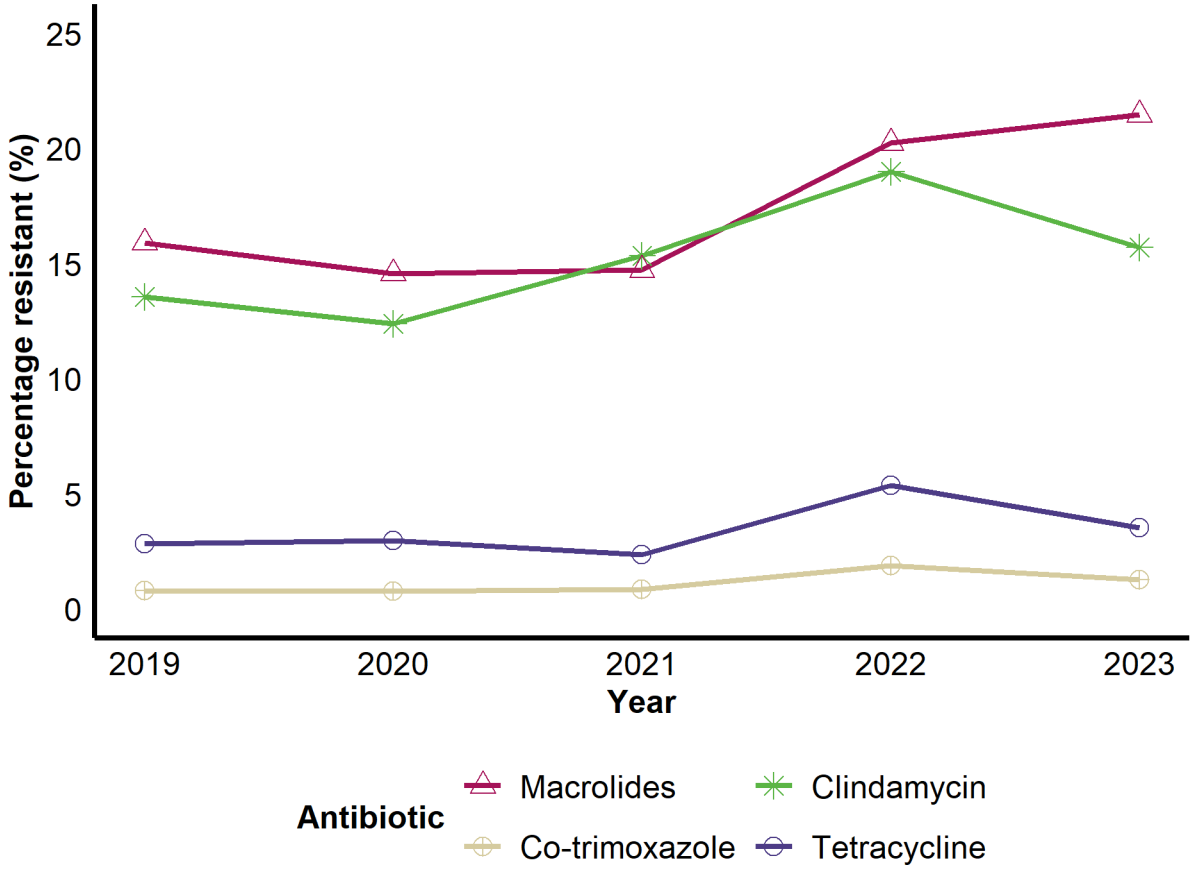
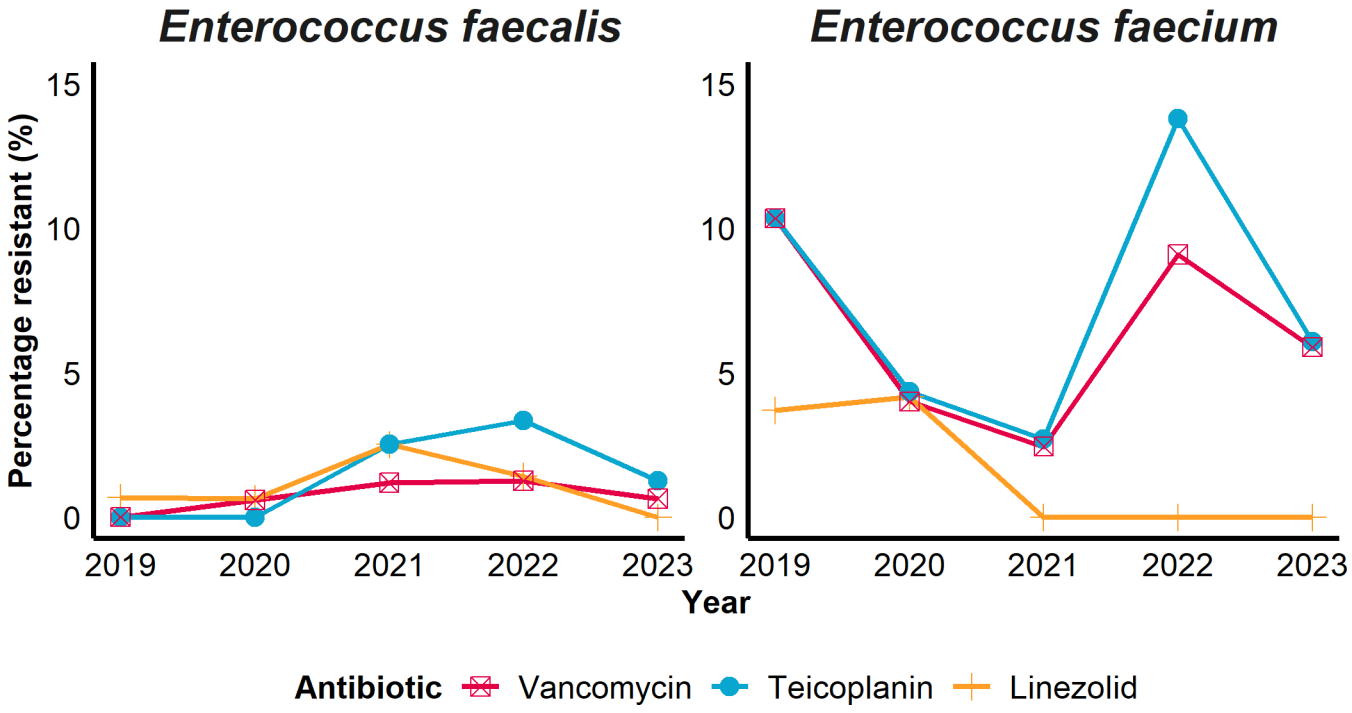


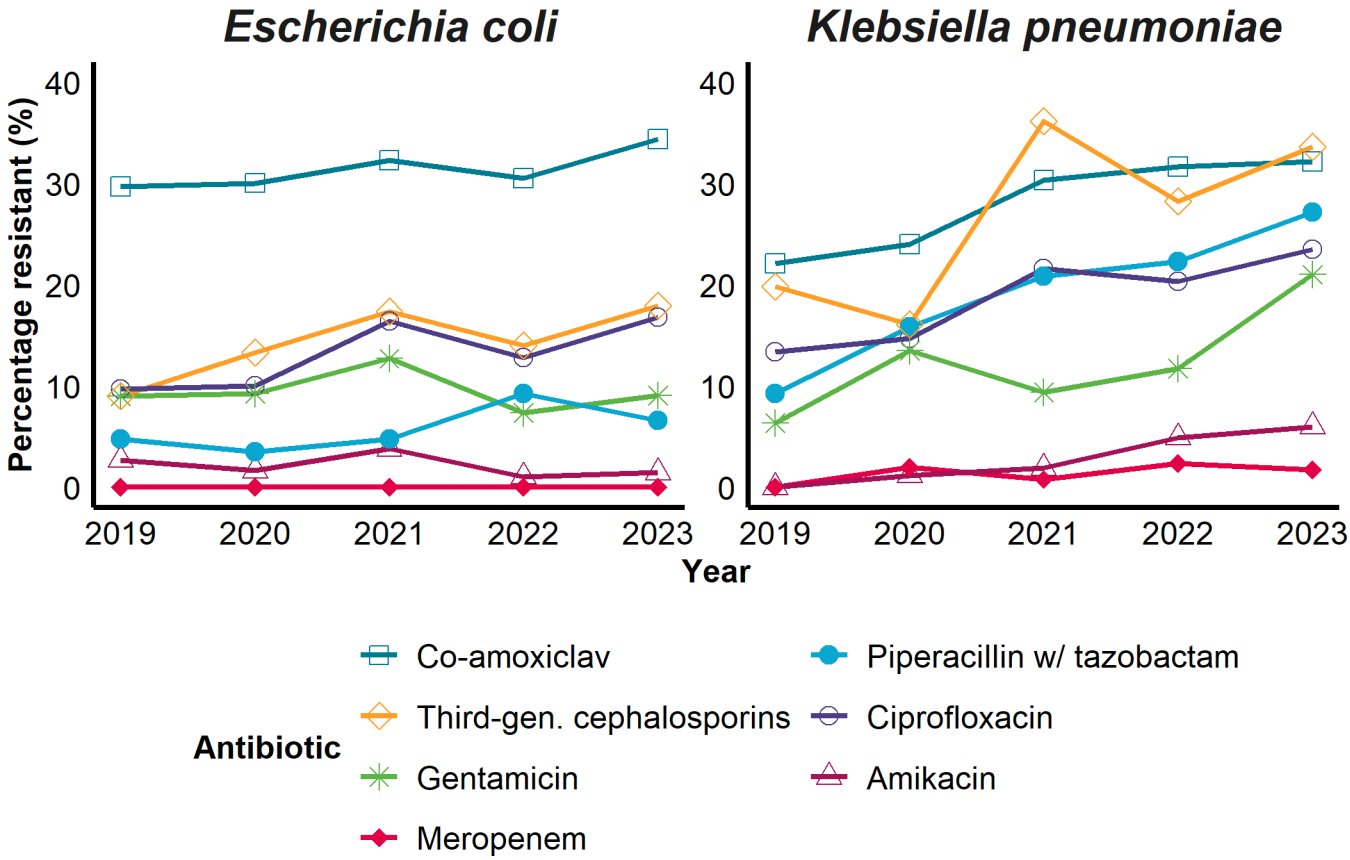
Figure 9. AMR of *Enterococcus* spp. bacteraemia for children aged 4 days to <1 year in England, 2019 to 2023



Gram-negative bacteraemia

E. coli resistance to co-amoxiclav, third-generation cephalosporins and ciprofloxacin increased over the five-year period (Figure 10). Resistance to co-amoxiclav increased from 29.7% (n=120 per 404 tested) in 2019 to 34.4% (n=119 per 346 tested) in 2023. Third-generation cephalosporin resistance increased from 9.0% (n=39 per 433 tested) in 2019 to 17.9% (n=69 per 385 tested) in 2023. Resistance to ciprofloxacin increased from 9.7% (n=40 per 412 tested) in 2019 to 16.8% (n=60 per 357 tested) in 2023. Resistance to gentamicin ranged between 7.4% (n=31 per 421 tested) in 2022 and 12.7% (n=58 per 456 tested) in 2021, and was 9.1% (n=33 per 364 tested) in 2023. Resistance to amikacin remained <4%. Between 2019 and 2023, no episodes of *E. coli* resistant to meropenem were reported (Figure 10).

Figure 10. AMR trends of *Escherichia coli* and *Klebsiella pneumoniae* bacteraemia in children aged 4 days to <1 year in England, 2019 to 2023



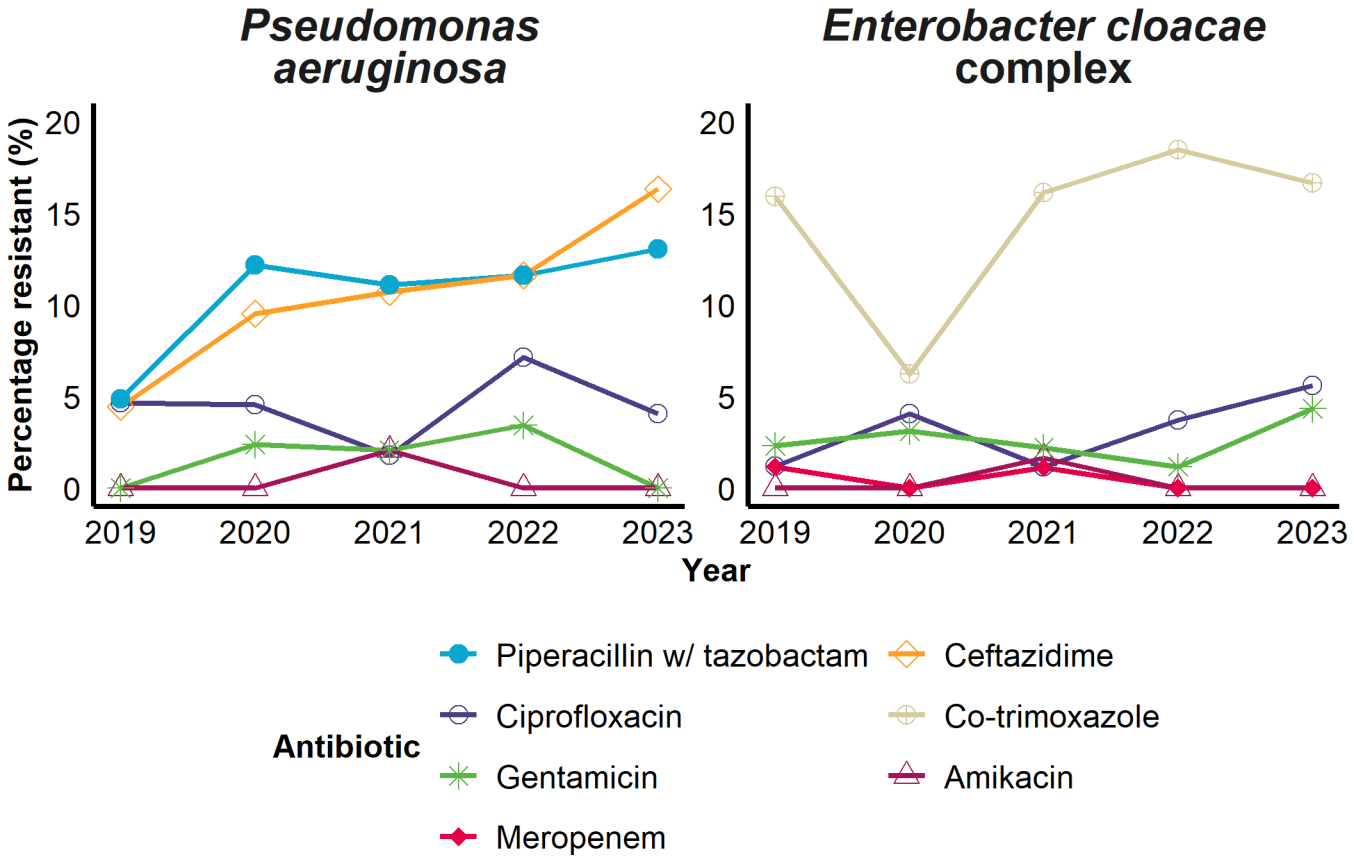
Between 2019 and 2023, *K. pneumoniae* resistance to almost all included antibiotics increased, similar to trends across the wider English population (1) (Figure 10). Resistance to co-amoxiclav increased with approximately one-third of all tested infection episodes being resistant to the agent in 2023, from 22.1% (n=23 per 104 tested) in 2019 to 32.2% (n=37 per 115 tested) in 2023. Resistance to third-generation cephalosporins increased by 13.8 percentage points, from 19.8% (n=23 per 116 tested) in 2019 to 33.6% (n=41 per 122 tested) in 2023. Resistance to ciprofloxacin increased from 13.4% (n=15 per 112 tested) in 2019 to 23.5% (n=28 per 119 tested) in 2023. Resistance to gentamicin increased by over three-fold over the five-year period from 6.4% (n=7 per 110 tested) in 2019 to 21.0% (n=25 per 119 tested) in 2023 (Figure 10). Resistance to amikacin increased from 0.0% (n=0 per 85 tested) in 2019 to 6.0% (n=6 per 100

tested) in 2023. The only specified antibiotic where resistance did not increase was meropenem, which fluctuated between 0.0% (n=0 per 110 tested) in 2019 to 2.4% (n=3 per 127 tested) in 2022 and was 1.7% (n=2 per 116 tested) in 2023 (Figure 10).

A change in EUCAST breakpoints for Enterobacterales and piperacillin with tazobactam complicates trend interpretation for this agent (see Methods). In 4 days to <1 year olds, *E. coli* resistance to piperacillin with tazobactam remained <10% (6.6%, n=22 per 332 tested in 2023) throughout the period (Figure 10). However, a large increase was reported in *K. pneumoniae* resistance, rising from 9.3% (n=10 per 108 tested) in 2019 to 27.2% (n=31 per 114 tested) in 2023; it is likely that part of this increase in resistance is attributable to the change in breakpoints, as discussed in ESPAUR (1).

Between 2019 and 2023, *P. aeruginosa* resistance to piperacillin with tazobactam and ceftazidime increased; from 4.9% (n=2 per 41 tested) in 2019 to 13.0% (n=6 per 46 tested) in 2023 for piperacillin with tazobactam, and from 4.4% (n=2 per 45 tested) in 2019 to 18.0% (n=9 per 50 tested) in 2023 for ceftazidime (Figure 11). Resistance to ciprofloxacin remained <8% and resistance to gentamicin and amikacin remained <4% throughout the five-year period. Reported resistance to meropenem increased from 0.0% in 2019 to 32.3% in 2023, although these figures are influenced by the low overall number of infection episodes (n=0 resistant infection episodes per 22 tested for meropenem out of a total of 46 episodes in 2019; n=10 resistant infection episodes per 31 tested for meropenem out of a total of 53 episodes) (data table Figure 11).

Figure 11. AMR of *Pseudomonas aeruginosa and *Enterobacter cloacae* complex bacteraemia for children aged 4 days to <1 year in England, 2019 to 2023**



*Resistance to meropenem not displayed for *P. aeruginosa* due to low (<20) number of bacteraemia with reported susceptibility testing results (see Methods).

Enterobacter cloacae complex resistance to ciprofloxacin, gentamicin, amikacin, and meropenem remained stable and <6% between 2019 and 2023 (Figure 11). Resistance to co-trimoxazole fluctuated between 6.2% (n=4 per 64 tested) in 2020 and 18.5% (n=12 per 65 tested) in 2022, and was 16.7% (n=12 per 72 tested) in 2023, caveated by the low overall numbers tested.

3.3.3 Infants and children (1 to 4 year olds)

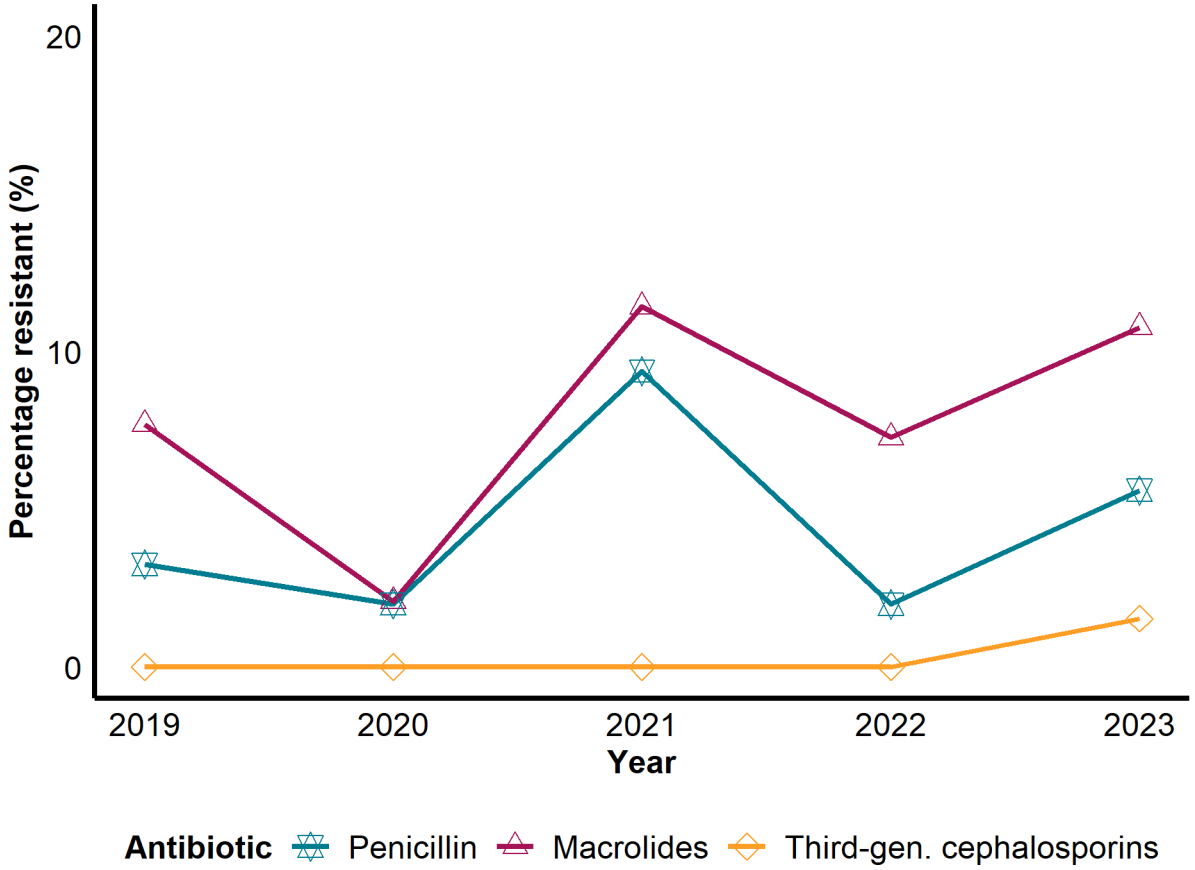
Gram-positive bacteraemia

Between 2019 and 2023, resistance to penicillin in GAS was not reported in 1 to 4 year olds (data table Figure 12). Resistance to macrolides, clindamycin and co-trimoxazole was <5% from 2019 to 2023; however, the number of episodes with susceptibility testing were low. Trends and demographics of GAS are discussed in more detail in the seasonal and annual reports (3, 5, 6).

S. pneumoniae resistance to penicillin remained <10% but fluctuated annually (Figure 12). Resistance to macrolides ranged from 2.1% (n=1 per 48 tested, in 2020) to 11.4% (n=12 per 105 tested, in 2021), while co-trimoxazole resistance varied between 10.3% (n=6 per 58 tested,

in 2022) and 19.5% (n=8 per 41 tested, in 2019). Clindamycin resistance increased from 2.4% (n=1 per 41 tested) in 2019 to 6.5% (n=3 per 46 tested) in 2023 (data table Figure 12).

Figure 12. AMR trends for *Streptococcus pneumoniae bacteraemia for children aged 1 to 4 years in England, 2019 to 2023**



* Resistance to clindamycin, and co-trimoxazole not displayed for *S. pneumoniae*, due to low (<20) number of bacteraemia with reported susceptibility testing results (see Methods).

MSSA resistance to macrolides decreased by 6.2 percentage points from 23.6% (n=42 per 178 tested) in 2019 to 17.4% (n=25 per 144 tested) in 2023 (Figure 13). Clindamycin resistance fluctuated over the five-year period between 12.2% (n=14 per 115 tested) in 2021 and 20.9% (n=31 per 148 tested) in 2019. In reports of MSSA, resistance to co-trimoxazole was <7% (data table Figure 13).

Among 1 to 4 year olds, the number of resistant *E. faecalis* episodes to teicoplanin, vancomycin, and linezolid remained <4% between 2019 and 2023 (Figure 14).

E. faecium resistance to vancomycin fluctuated between a minimum of 10.2% (n=5 per 49 tested) in 2019 to a maximum of 20.0% (n=6 per 30 tested) in 2020. Similarly, resistance to teicoplanin ranged from a minimum of 10.9% (n=5 per 46 tested) in 2023 to a maximum of 19.0% (n=8 per 42 tested) in 2021 (Figure 14). Resistance to linezolid was <5%.

Figure 13. AMR of meticillin-susceptible *S. aureus* (MSSA) bacteraemia for children aged 1 to 4 years in England, 2019 to 2023

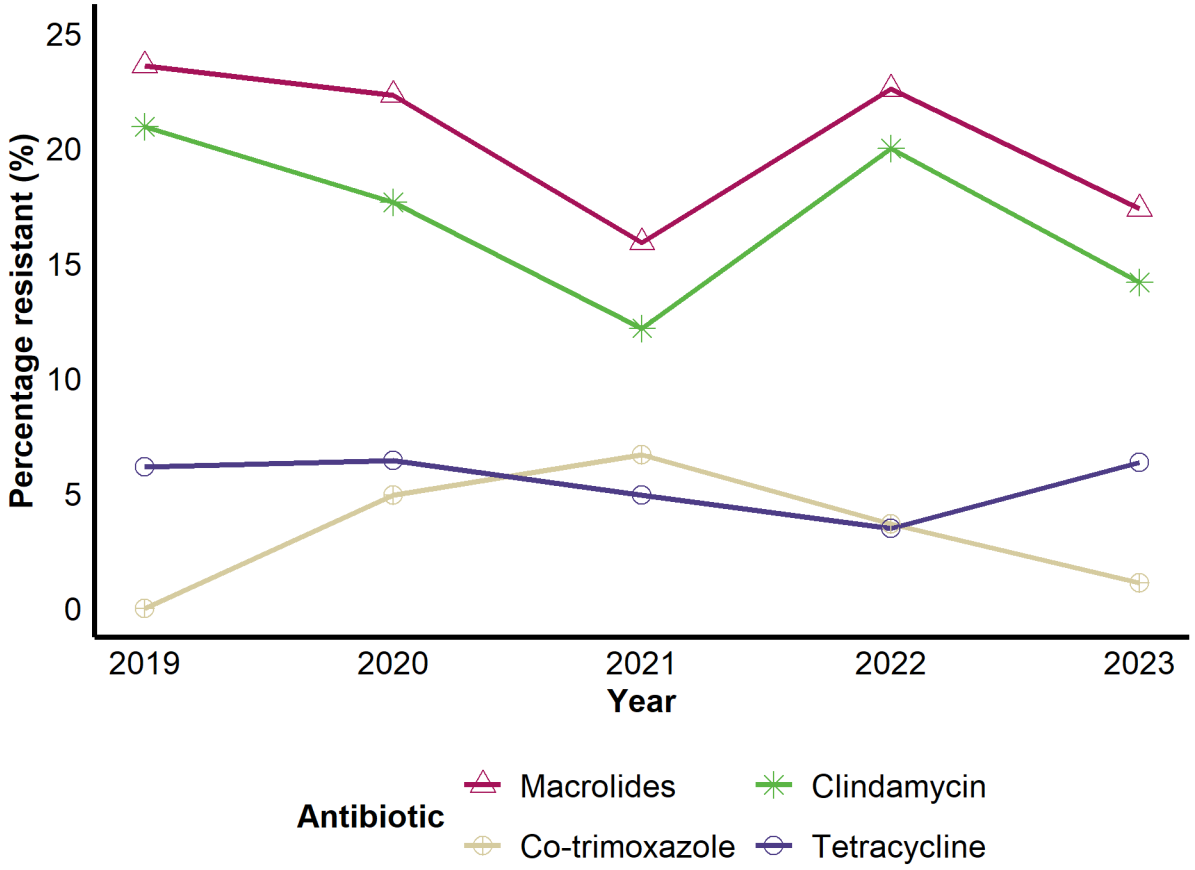
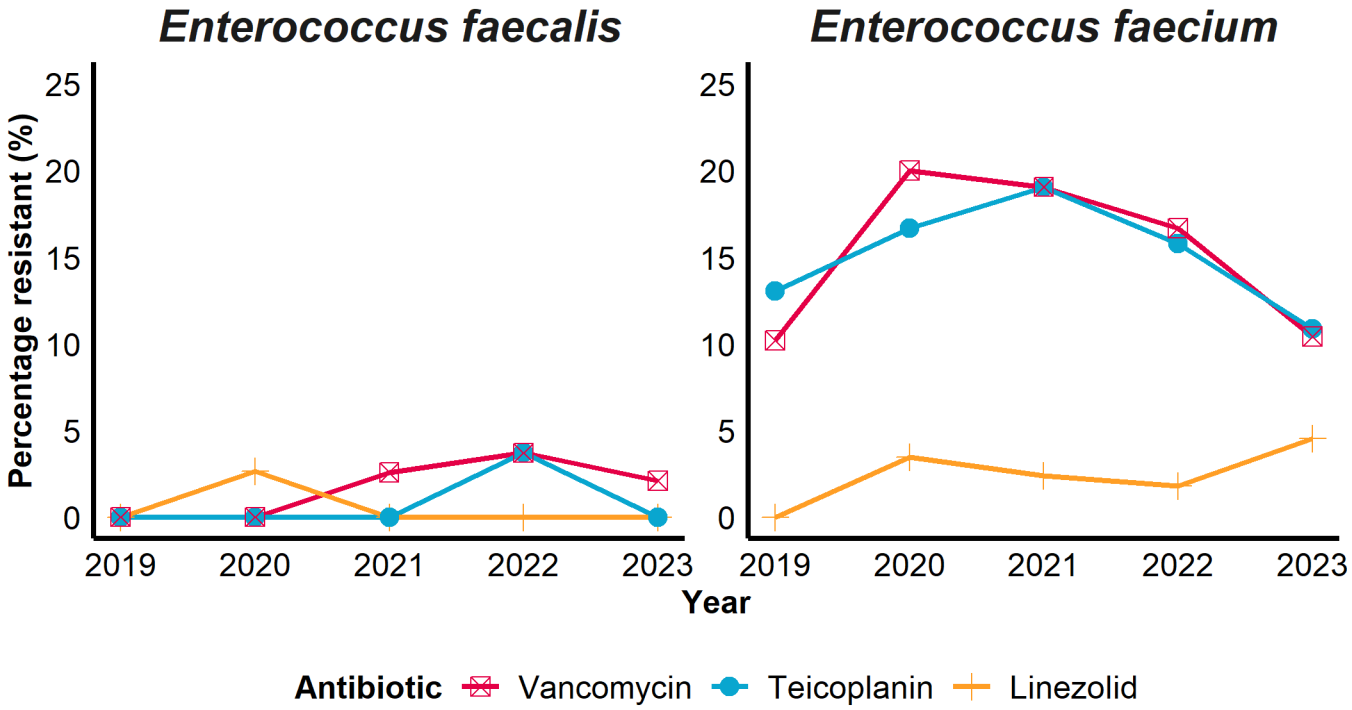


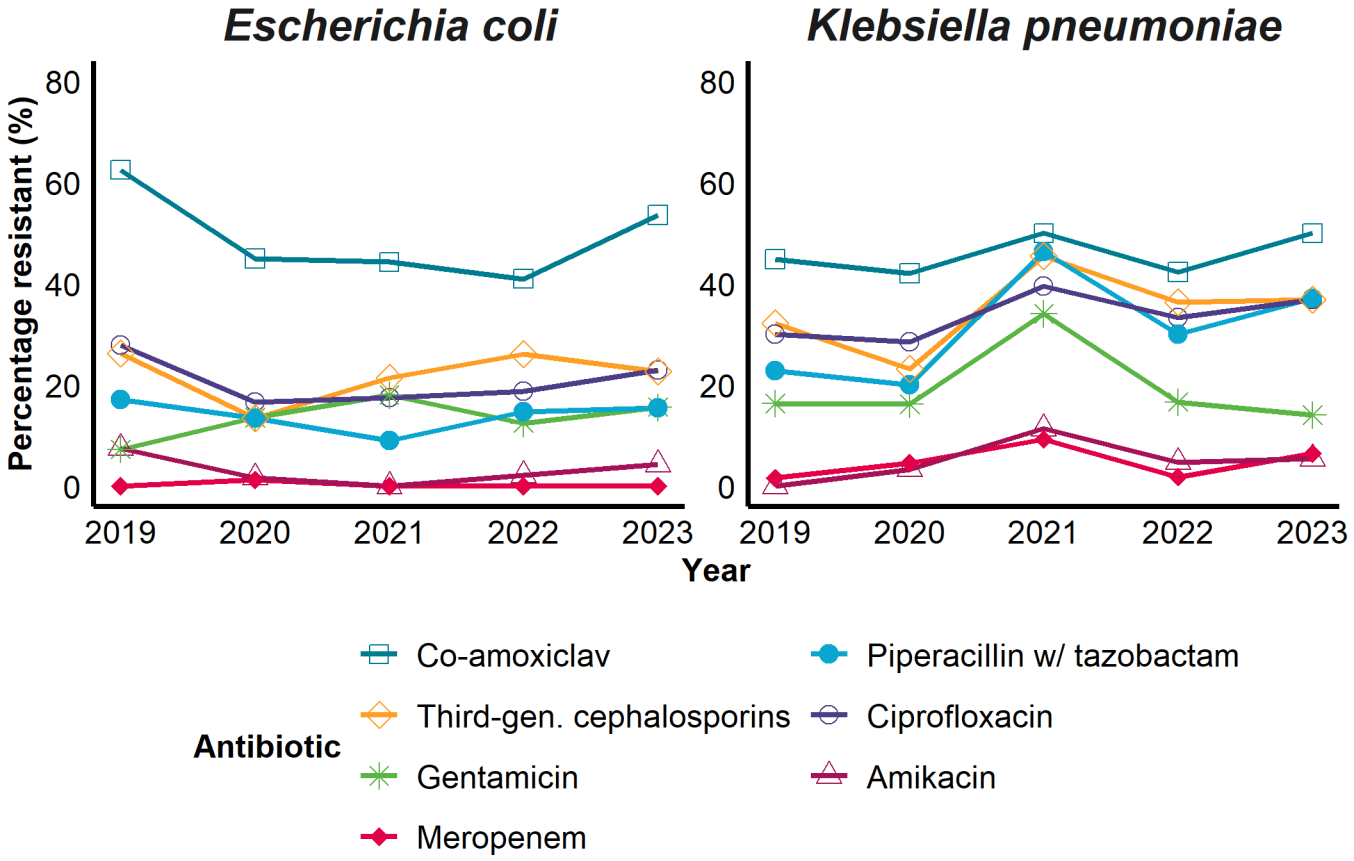
Figure 14. AMR of *Enterococcus* spp.* bacteraemia for children aged 1 to 4 years in England, 2019 to 2023



Gram-negative bacteraemia

E. coli resistance to co-amoxiclav ranged from a minimum of 41.0% (n=25 per 61 tested) in 2022 and a maximum of 62.5% (n=50 per 80 tested) in 2019 and was 53.6% (n=45 per 84 tested) in 2023 (Figure 15). Ciprofloxacin resistance ranged from 16.7% (n=13 per 78 tested) in 2020 to 27.8% (n=22 per 79 tested) in 2019 and was 22.9% (n=19 per 83 tested) in 2023. Third-generation cephalosporin resistance was stable, and at 22.7% (n=20 per 88 tested) in 2023. Resistance to gentamicin more than doubled from 7.3% (n=6 per 82 tested) in 2019 to 15.7% (n=13 per 83 tested) in 2023. *E. coli* resistance to amikacin was <8% over the period. Resistance to meropenem was low, with only one infection episode reported resistant over the period (data table Figure 15).

Figure 15. AMR of *Escherichia coli* and *Klebsiella pneumoniae* bacteraemia for children aged 1 to 4 years in England, 2019 to 2023

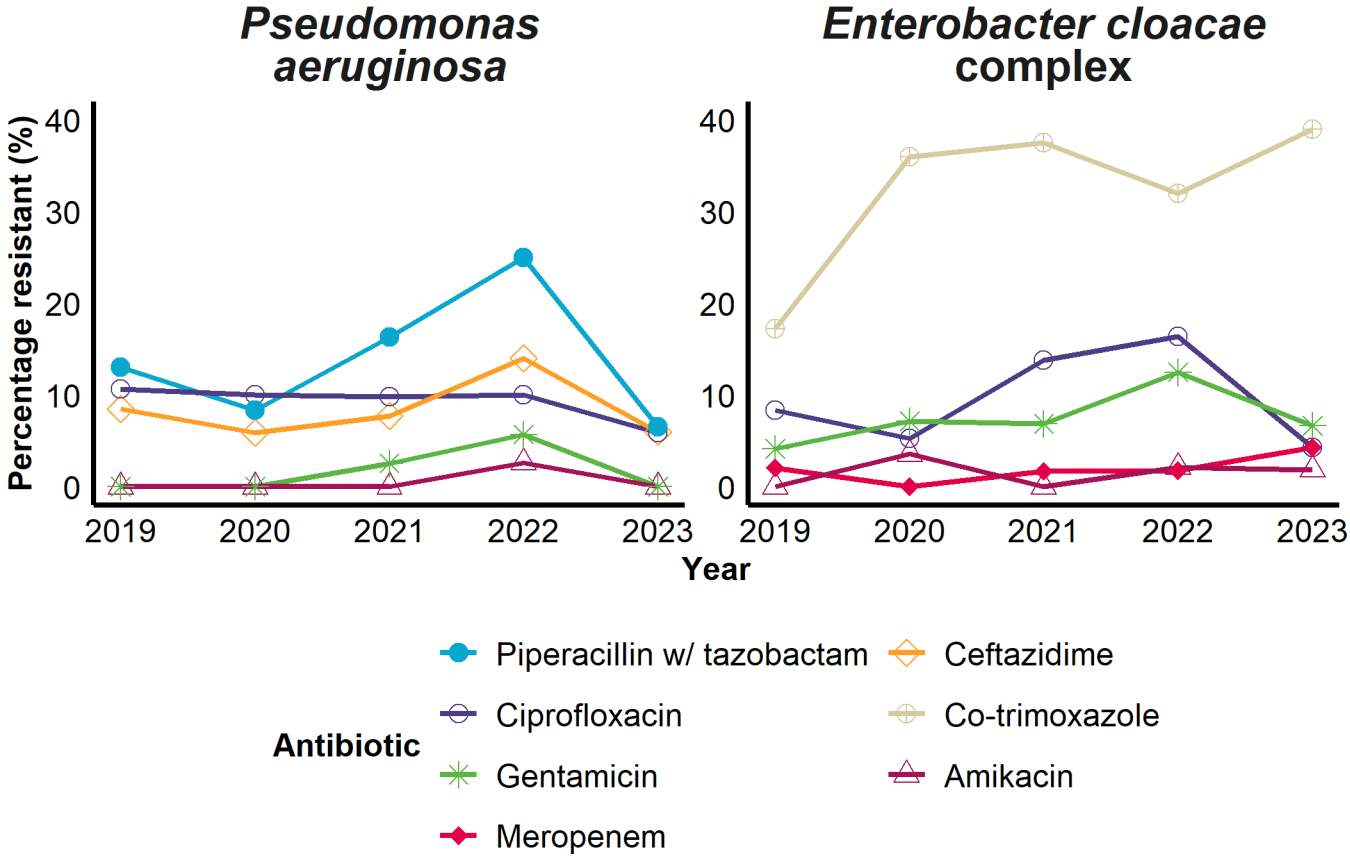


K. pneumoniae resistance to all included antibiotics increased in 2021 and decreased in 2022, and then most subsequently increased again in 2023 (Figure 15). Resistance to third-generation cephalosporins and amikacin remained stable from 2022 to 2023, while gentamicin decreased by 2 percentage points during the same period. In 2023, resistance to co-amoxiclav was 50.0% (n=31 of 62 tested) (Figure 15), while resistance to ciprofloxacin was 36.8% (n=42 of 57 tested). Resistance to meropenem fluctuated between 1.6% (n=1 per 61 tested) in 2019 and 9.3% (n=4 per 43 tested) in 2021 and was 6.5% (n=4 per 62 tested) in 2023.

A change in ESPAUR breakpoints for Enterobacterales and piperacillin with tazobactam complicates trend interpretation (see Methods). In 1 to 4 year olds, *E. coli* resistance to piperacillin with tazobactam decreased from 17.1% (n=13 per 76 tested) in 2019 to 9.0% (n=7 per 78 tested) in 2021, before subsequently increasing in 2022 and 2023, and was 15.5% (n =13 per 84 tested) in 2023 (Figure 15). In *K. pneumoniae*, piperacillin with tazobactam resistance increased from 22.8% (n=13 per 57 tested) in 2019 to 37.1% (n=23 per 62 tested) in 2023; it is likely that part of this increase in resistance is attributable to the change in breakpoints as discussed in ESPAUR (1).

P. aeruginosa resistance to piperacillin with tazobactam ranged from 6.5% (n=3 per 46 tested) in 2023 to 25.0% (n=12 per 48 tested) in 2022 (Figure 16). Resistance to ceftazidime ranged from a minimum of 5.9% (n=3 per 51 tested) in 2020 to a maximum of 14.0% (n=7 per 50 tested) in 2022, with resistance at 6.0% (n=3 per 50 tested) in 2023. Ciprofloxacin remained stable at around 10% before decreasing to 5.9% (n=3 per 51 tested) in 2023. Resistance to aminoglycosides was <6% during this period. Reported meropenem resistance fluctuated between a maximum of 36.0% (n=9 resistant infection episodes per 25 tested for meropenem out of a total of 52 episodes) in 2021 and a minimum of 14.8% (n=4 resistant infection episodes per 27 tested for meropenem out of a total of 51 episodes) in 2023 (data table Figure 16).

Figure 16. AMR of *Pseudomonas aeruginosa and *Enterobacter cloacae* complex bacteraemia for children aged 1 to 4 years in England, 2019 to 2023**



* Resistance to meropenem not displayed for *P. aeruginosa* due to low (<20) number of bacteraemia with reported susceptibility testing results (see Methods).

Enterobacter cloacae complex resistance to ciprofloxacin increased from 8.3% (n=4 per 48 tested) in 2019 to 16.4% (n=9 per 55 tested) in 2022 before decreasing to 4.3% (n=3 per 70 tested) in 2023 (Figure 16). Resistance to gentamicin increased from 4.2% (n=2 per 48 tested) in 2019 to 12.5% (n=7 per 56 tested) in 2022 before decreasing to 6.7% (n=5 per 75 tested) in 2023. Amikacin and meropenem resistance were <5%. Co-trimoxazole resistance increased from 17.2% (n=5 per 29 tested) in 2019 to 39.0% (n=23 per 59 tested) in 2023.

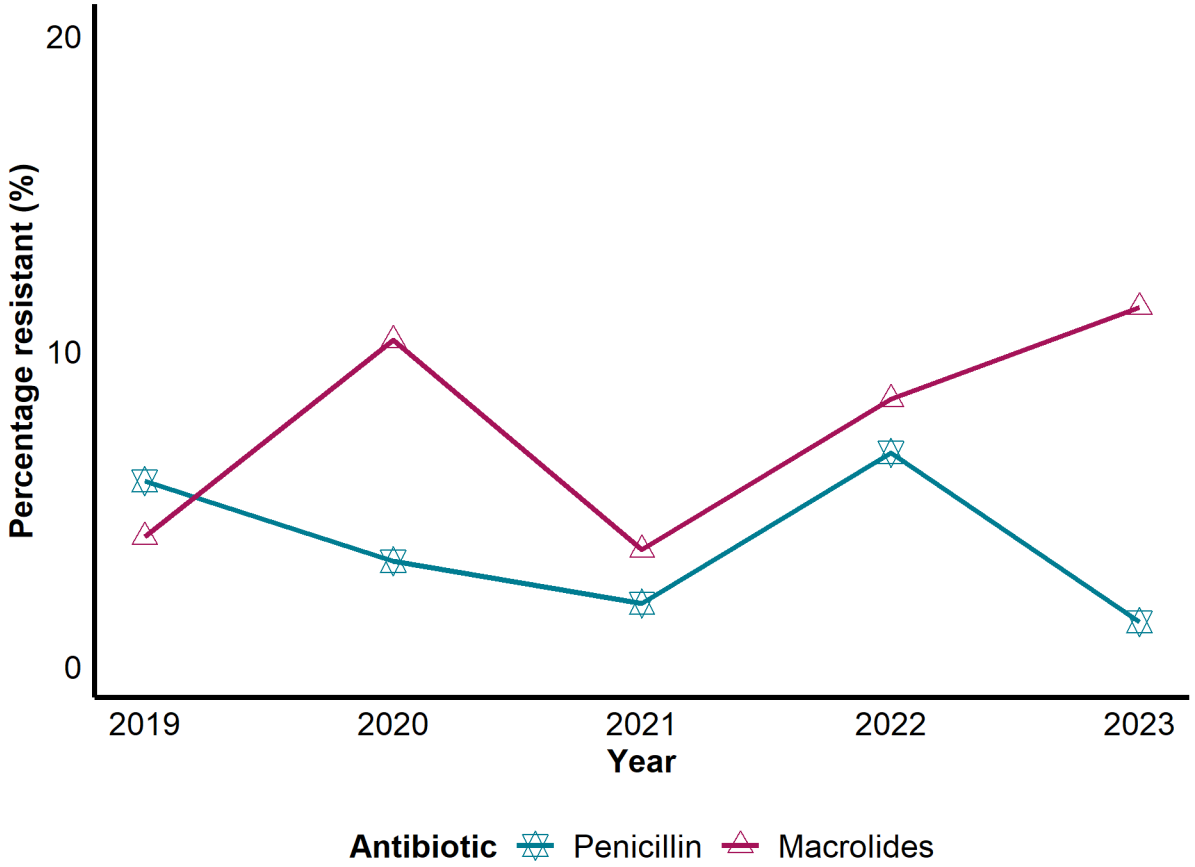
3.3.4 Children (5 to 17 years)

Gram-positive bacteraemia

GAS remained universally susceptible to penicillin in this age group. Resistance to macrolides and clindamycin remained <7% between 2019 and 2023 (data table Figure 17). Fewer than 10 infection episodes resistant to co-trimoxazole were reported between 2019 and 2023, with most of these occurring in 2022, however, co-trimoxazole susceptibility testing was low (<20) in 2019 to 2021 (data table Figure 17). Trends and demographics of GAS are discussed in more detail in the seasonal and annual reports (3, 5, 6).

S. pneumoniae resistance to penicillin was <7% between 2019 and 2023 (Figure 17). Macrolide resistance fluctuated between a minimum of 3.7% (n=2 per 54 tested) in 2021 and a maximum of 11.4% (n=9 per 79 tested) in 2023. Clindamycin resistance remained low, however testing was low (<20) before 2022. Between 2019 and 2023, co-trimoxazole resistance increased from 9.5% (n=2 per 21 tested) in 2019 to 20.0% (n=7 per 35 tested) in 2023, with a peak of 25.0% (n=7 per 28 tested) in 2022. When tested, *S. pneumoniae* demonstrated susceptibility to third-generation cephalosporins (data table Figure 17).

Figure 17. AMR of *Streptococcus pneumoniae bacteraemia for children aged 5 to 17 years in England, 2019 to 2023**



*Resistance to clindamycin, co-trimoxazole, and third-generation cephalosporins not displayed for *S. pneumoniae*, due to low (<20) number of bacteraemia episodes with reported susceptibility testing results (see Methods).

MSSA resistance to macrolides fluctuated over the 2019 to 2023 period, from a minimum of 11.8% (n=36 per 304 tested) in 2021 to a maximum of 20.5% (n=63 per 308 tested) in 2022 (Figure 18). Clindamycin resistance fluctuated between 10.0% (n=26 per 261 tested) in 2021 and 15.7% (n=47 per 300 tested) in 2023. Resistance to co-trimoxazole and tetracycline was <5% over the period (data table Figure 18).

Figure 18. AMR of meticillin-susceptible *S. aureus* (MSSA) bacteraemia for children aged 5 to 17 years in England, 2019 to 2023

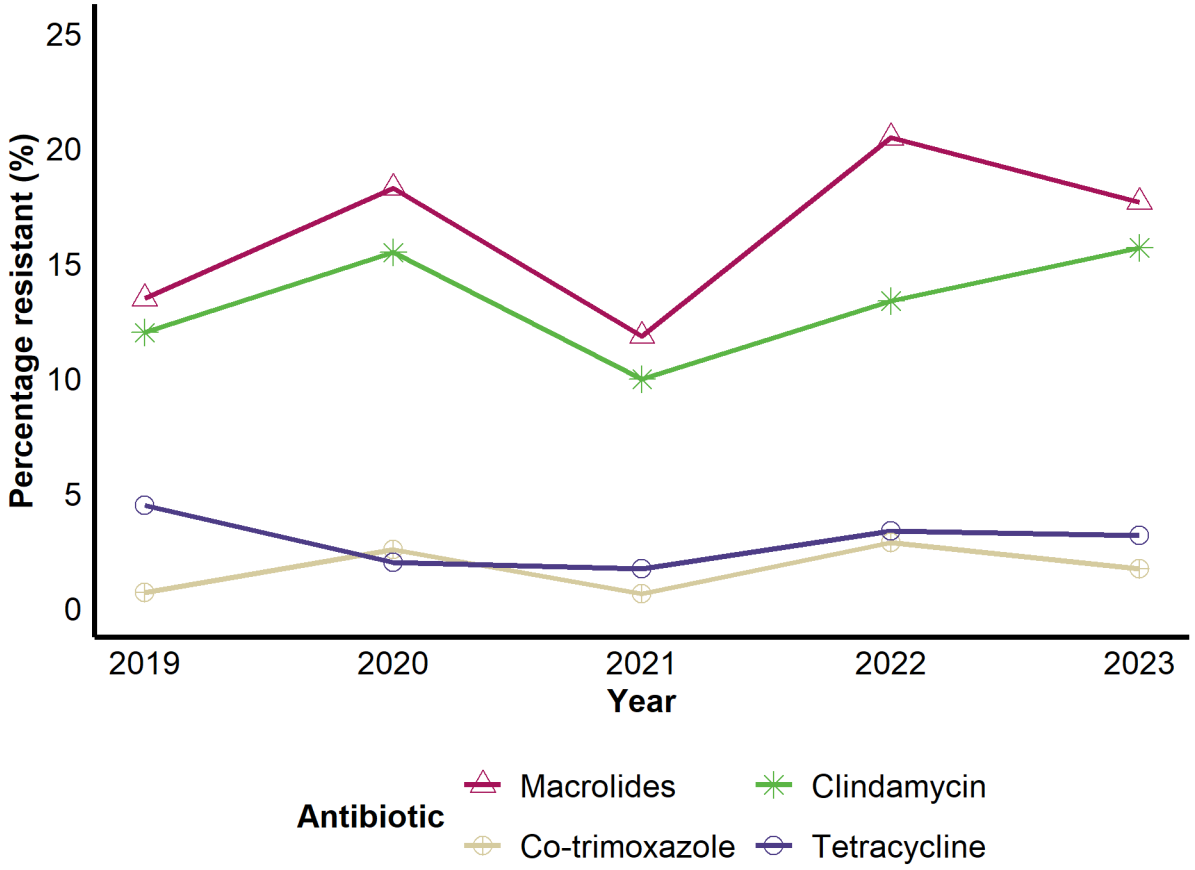
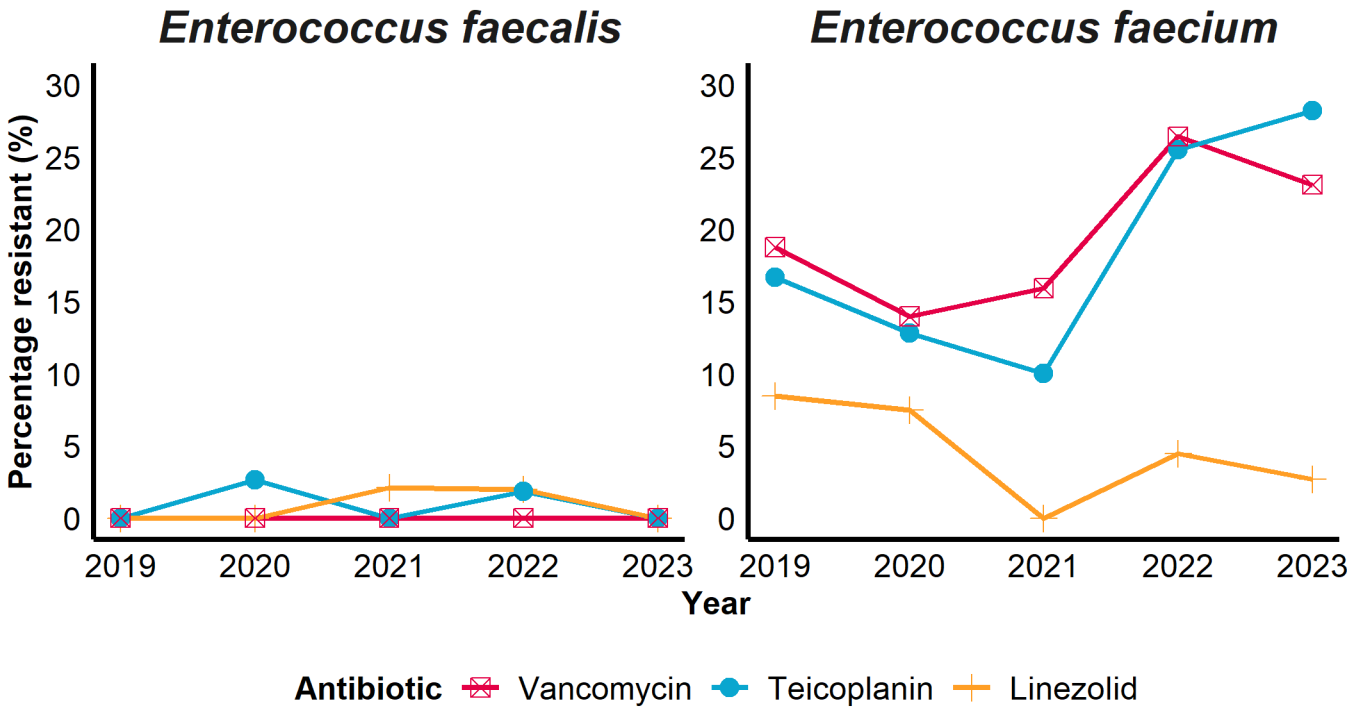


Figure 19. AMR of *Enterococcus* spp.* bacteraemia for children aged 5 to 17 years in England, 2019 to 2023



Between 2019 and 2023, *E. faecalis* resistance to teicoplanin and linezolid was stable at <3% (Figure 19). No vancomycin-resistant infection episodes were reported during this period.

E. faecium resistance to teicoplanin decreased from 16.7% (n=10 per 60 tested) in 2019 to 10.0% (n=4 per 40 tested) in 2021 before increasing to 28.2% (n=11 per 39 tested) in 2023 (Figure 19). Resistance to vancomycin fluctuated between 14.0% (n=6 per 43 tested) in 2020 and 26.4% (n=14 per 53 tested) in 2022 and was 23.1% (n=9 per 39 tested) in 2023. Resistance to linezolid decreased from 8.5% (n=5 per 59 tested) in 2019 to 2.7% (n=1 per 37 tested) in 2023.

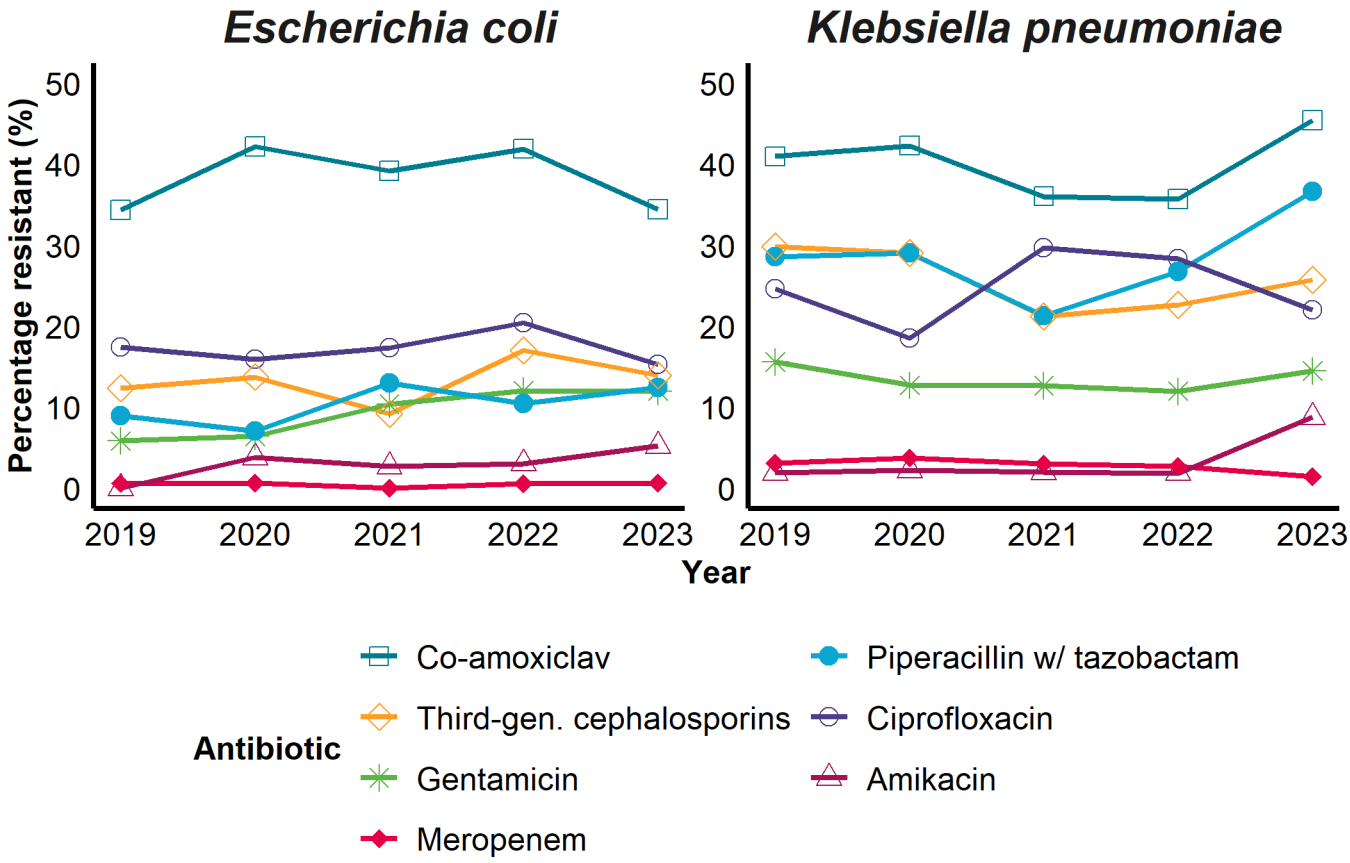
Gram-negative bacteraemia

In children aged 5 to 17 years, *E. coli* resistance to co-amoxiclav was stable, ranging from a minimum of 34.4% (n=56 per 163 tested) in 2019 to a maximum of 42.2% (n=62 per 147 tested) in 2020 (Figure 20). Third-generation cephalosporin resistance fluctuated between 9.2% (n=15 per 163 tested) in 2021 and 17.0% (n=31 per 182 tested) in 2022. Ciprofloxacin resistance remained stable and was at a five-year low in 2023 at 15.3% (n=23 per 150 tested). Resistance to gentamicin increased from 5.8% (n=10 per 171 tested) in 2019 to 12.0% (n=18 per 150 tested) in 2023. *E. coli* resistance to amikacin increased from 0.0% (n=0 per 121 tested) to 5.2% (n=6 per 115 tested) in 2023. Meropenem resistance remained <1%, with fewer than 5 resistant infection episodes reported during the five-year period.

Between 2019 and 2023, *K. pneumoniae* resistance to co-amoxiclav fluctuated between a minimum of 35.7% (n=25 per 70 tested) in 2022 and a maximum of 45.5% (n=30 per 66 tested) in 2023 (Figure 20). Third-generation cephalosporin resistance decreased from 29.9% (n=20 per 67 tested) in 2019 to 21.2% (n=14 per 66 tested) in 2021 before increasing to 25.7% (n=18 per 70 tested) in 2023. Ciprofloxacin resistance fluctuated between a minimum of 18.5% (n=10 per 54 tested) in 2020 and a maximum of 29.7% (n=19 per 64 tested) in 2021. Gentamicin resistance was stable and was 14.5% (n=10 per 69 tested) in 2023. Amikacin resistance increased from 1.9% (n=1 per 53 tested) in 2019 to 8.8% (n=5 per 57 tested) in 2023. Meropenem resistance remained <4% during the five-year period.

A change in EUCAST breakpoints for Enterobacterales and piperacillin with tazobactam complicates trend interpretation (see Methods). In 5 to 17 year olds, *E. coli* resistance to piperacillin with tazobactam ranged from 9.0% (n=14 per 156 tested) in 2019 to 13.0% (n=20 per 154 tested) in 2021. In *K. pneumoniae,* resistance increased from 28.6% (n=18 per 63 tested) in 2019 to 36.7% (n=22 per 60 tested) in 2023 (Figure 20). It is likely that part of this increase in resistance is attributable to the change in breakpoints as discussed in ESPAUR (1).

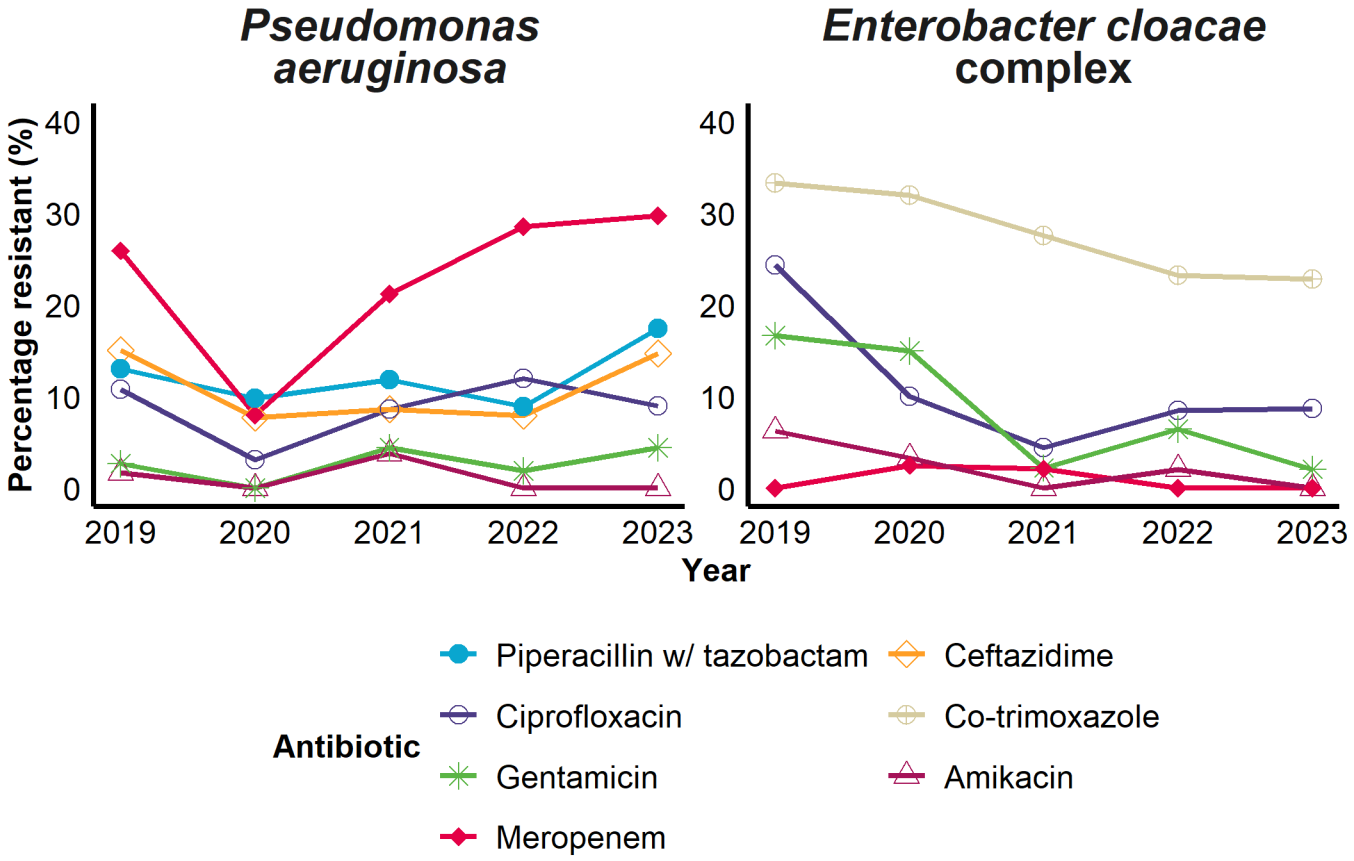
Figure 20. AMR of *Escherichia coli* and *Klebsiella pneumoniae* bacteraemia for children aged 5 to 17 years in England, 2019 to 2023.



P. aeruginosa resistance to piperacillin with tazobactam ranged from 8.9% (n=8 per 90 tested) in 2022 to 17.5% (n=11 per 63 tested) in 2023 (Figure 21). Ceftazidime resistance dipped from 15.1% (n=11 per 73 tested) in 2019 to 7.7% (n=5 per 65 tested) in 2020 before increasing to 14.7% (n=10 per 68 tested) in 2023. Ciprofloxacin resistance fluctuated between a minimum of 3.1% (n=2 per 65 tested) in 2020 and a maximum of 12.0% (n=11 per 92 tested) in 2022. Resistance to gentamicin and amikacin was <5% over the 2019-2023 period. Reported meropenem resistance fluctuated between 8.0% (n=2 resistant infection episodes per 25 tested for meropenem out of a total of 65 episodes) in 2020 and 29.7% (n=11 resistant infection episodes per 37 tested for meropenem out of a total of 70 episodes) in 2023.

Finally, *Enterobacter cloacae* complex resistance to ciprofloxacin decreased from 24.4% (n=10 per 41 tested) in 2019 to 8.7% (n=4 per 46 tested) in 2023 (Figure 21). Resistance to gentamicin and amikacin decreased from 16.7% (n=7 per 42 tested) and 6.2% (n=2 per 32 tested) in 2019 to 2.1% (n=1 per 48 tested) and 0.0% (n=0 per 38 tested) in 2023, respectively. Meropenem resistance was <3%, with only 2 resistant infection episodes reported during the five-year period. Co-trimoxazole resistance decreased from 33.3% (n=9 per 27 tested) in 2019 to 22.9% (n=8 per 35 tested) in 2023.

Figure 21. AMR of *Pseudomonas aeruginosa* and *Enterobacter cloacae* complex bacteraemia for children aged 5 to 17 years in England, 2019 to 2023



4. Data sources and methods

This report focuses on the paediatric population (0 to 17 years). The age groups used in the incidence of laboratory-reported bacteraemia and antimicrobial susceptibility trends differ slightly due to susceptibility testing being low for some (younger) age groups (Table 2).

Table 2. Age categories used in the analysis for incidence of bacteraemia and AMR of bacteraemia

Age category for incidence of bacteraemia	Age category for AMR of bacteraemia
0 to 3 days	0 to 3 days
4 days to <1 month	4 days to <1 years
1 month to <1 years	
1 to 4 years	1 to 4 years
5 to 17 years	5 to 17 years

This report is based upon ESPAUR methodology (1). In summary, voluntary surveillance data on the antibiotic susceptibility of pathogens causing bacteraemia was obtained from SGSS (Second Generation Surveillance System) for the period 2019 to 2023 in England. The SGSS is a national database maintained by UK Health Security Agency (UKHSA) that contains laboratory data supplied electronically by approximately 98% of hospital microbiology laboratories in England. The antimicrobial resistance trends included within this report use data from the SGSS AMR module that was extracted on 19 July 2024. The rates of laboratory-reported bacteraemia from the SGSS CDR module were extracted on 8 May 2024. Data from both the AMR and CDR modules is provided on a voluntary basis and the isolates reported here have not all been confirmed by UKHSA's Antimicrobial Resistance and Healthcare Associated Infections Reference Unit (AMRHAI). Case ascertainment will have been incomplete, however, ascertainment of notifiable infections, such as invasive GAS and *S. pneumoniae*, should be high.

Hospital microbiology laboratories have reported antimicrobial susceptibility test results as 'susceptible', 'susceptible, increased exposure' or 'resistant'. These categories were defined, as per the European Committee on Antimicrobial Susceptibility Testing (EUCAST), as follows:

1. **Susceptible, standard dosing regimen (S)**: a bacterial strain is said to be susceptible to a given antibiotic when there is a high likelihood of therapeutic success using a standard dosing regimen
2. **Susceptible, increased exposure (I)**: a bacterial strain is said to be susceptible, increased exposure' when there is a high likelihood of therapeutic success because exposure to the

agent is increased by adjusting the dosing regimen or by its concentration at the site of infection

3. **Resistant (R)**: a bacterial strain is said to be resistant to a given antibiotic when there is a high likelihood of therapeutic failure even when there is increased exposure

The breakpoint criteria for categorising clinical isolates as susceptible, susceptible increased exposure or resistant to individual antibiotics have changed over time. As noted in the ESPAUR report 2019, in 2019 the EUCAST definitions were amended to rename the 'intermediate' category to 'susceptible, increased exposure' (with an adjusted increased dose), as the antibiotic should still work for treatment. The definition changes cannot be retrospectively applied.

As patients may have more than one positive blood culture taken, blood cultures taken from the same patient that yielded growth of the same pathogen during a rolling 14-day period from the initial positive blood culture were regarded as comprising the same episode of infection and were de-duplicated, retaining the worst-case scenario susceptibility result for each antibiotic tested (resistant > susceptible, increased exposure > susceptible).

Rates of laboratory-reported bacteraemia per 100,000 were calculated using the relevant year's Office for National Statistics (ONS) mid-year resident population estimates for England as the denominator (8). At the time of analysis, there was no 2023 mid-year population estimate, therefore, the 2022 mid-year population estimate was used as a proxy. All reported bacteraemia episodes to SGSS were included in calculating reported bacteraemia incidence rates.

In 2021, a change in EUCAST breakpoints for Enterobacterales and piperacillin with tazobactam resulted in an artificial increase in reported resistance in *E. coli* and *K. pneumoniae,* partially but not fully accounting for the overall rise in resistance observed across the population of England (1)

Laboratories are reminded to send isolates with exceptional antibiotic resistant phenotypes to the AMRHAI Reference Unit for confirmation. This includes:

- Enterobacterales isolates with a meropenem MIC above the EUCAST screening cut-off (0.125 mg/L) but negative for the 'big' 4/5 carbapenemases, to rule out the presence of rarer carbapenemase families – isolates positive for the 'big 4/5' carbapenemase families and from invasive infections should also be referred for inclusion in the national strain archive
- Enterobacterales resistant to ceftazidime/avibactam, meropenem/vaborbactam or imipenem/relebactam and negative for class B (NDM, VIM or IMP) carbapenemases
- Enterobacterales (excluding *Serratia* spp., *Proteus* spp., *Hafnia* spp. and *Morganella* spp.), *Acinetobacter* spp. and *P. aeruginosa* resistant to colistin by broth microdilution
- *Acinetobacter* spp. suspected to produce a metallo-carbapenemase

- *P. aeruginosa* resistant to all of imipenem, meropenem, ceftazidime and piperacillin/tazobactam and exhibiting strong imipenem/EDTA synergy and positive for VIM, NDM and IMP carbapenemases should be referred for inclusion in the national strain archive – isolates negative for VIM, NDM or IMP carbapenemases and exhibiting strong imipenem/EDTA synergy, and/or resistance to ceftolozane/tazobactam, should be referred to rule out presence of rarer carbapenemase families

Further referral criteria and guidance on how to do this is available in the Bacteriology Reference Department user manual.

In Figures 2 to 21, where the annual number of tests <20 for a specific drug-bug combination, percentage resistance was not calculated, and the trend was not displayed in the figure. In the corresponding data tables, the percentage resistance was not calculated and replaced with 'ND' (no data).

In data tables Accessory 6 to 8, the percentage contribution of each organism to the overall change in bacteraemia incidence between 2019 and 2023 was calculated by dividing the organism-specific incidence difference by the overall incidence difference for that age group and multiplying by 100 to convert this to a percentage.

The priority organisms are defined as the most frequently reported organisms from blood cultures in the paediatric population, which include, GAS, GBS, *S. pneumoniae*, *S. aureus*, *E. faecalis*, *E. faecium*, *E. coli*, *K. pneumoniae*, *P. aeruginosa*, and *Enterobacter cloacae* complex.

The AMR bacteraemia section includes the priority organisms for each age group (data table Figure 1.2 and data tables Accessory 1 to 5) and selected antibiotics for each organism (defined in Table 3). In some of the age groups (for example, 0 to 3 day olds) not all of the priority organisms are analysed, because the annual number of reported bacteraemia was low (<20).

The antimicrobials included in the antimicrobial susceptibility reporting are clinically important in the treatment of Gram-positive or Gram-negative paediatric infections. The following antimicrobial groupings were used:

- meticillin (comprised of meticillin, oxacillin, cefoxitin, and flucloxacillin)
- third-generation cephalosporins (comprised of cefotaxime, ceftazidime, ceftriaxone, and cefpodoxime; except for *Pseudomonas* spp. where only ceftazidime was included; and *S. pneumoniae* where only cefpodoxime, cefotaxime, ceftriaxone were included)
- macrolides (comprised of azithromycin, clarithromycin, and erythromycin)

Several organism species were grouped together during data processing:

- oral and other streptococci, comprises *Streptococcus* spp. in groups *S. anginosus, S. bovis, S. mitis, S. mutans, S. salivarius,* and *S. sanguinis*.
- *Enterobacter cloacae* complex includes *Enterobacter asburiae, Enterobacter bugandensis, Enterobacter cloacae, Enterobacter cloacae* complex, *Enterobacter hormaechei, Enterobacter kobei, Enterobacter xianfangensis*, and unspeciated *Enterobacter* (the latter comprises approximately 92.4% of reported *Enterobacter* sp. in 2023)
- *S. aureus* includes all isolates identified as *S. aureus*, including MRSA and MSSA and those that cannot be categorised as either due to no test results for meticillin, oxacillin, cefoxitin, or flucloxacillin in SGSS
- MRSA is any *S. aureus* isolate that had a resistant test result to meticillin (comprised of meticillin, oxacillin, cefoxitin, or flucloxacillin) in SGSS
- MSSA is any *S. aureus* isolates that was tested for meticillin (comprised of meticillin, oxacillin, cefoxitin, or flucloxacillin) and found to not be resistant in SGSS

Table 3. Organisms and key antibiotics included in the AMR analysis by age category

Organisms	0 to 3 days	4 days to <1 year	1 to 4 years	5 to 17 years
GAS	Organism not included for age group	- Penicillin - Macrolides - Clindamycin - Co-trimoxazole - Tetracycline		
GBS	- Penicillin - Macrolides - Clindamycin - Co-trimoxazole		Organism not included for age group	
S. pneumoniae	- Organism not included for age group	- Penicillin - Macrolides - Clindamycin - Co-trimoxazole - Tetracycline - Third-generation cephalosporins		
S. aureus	- Meticillin			

Organisms	0 to 3 days	4 days to <1 year	1 to 4 years	5 to 17 years
MRSA	- Macrolides - Clindamycin - Co-trimoxazole - Tetracycline - Fusidic acid - Mupirocin			
MSSA	- Macrolides - Clindamycin - Co-trimoxazole - Tetracycline - Fusidic acid - Mupirocin			
E. faecalis	- Teicoplanin - Vancomycin - Linezolid			
E. faecium	Organism not included for age group	- Teicoplanin - Vancomycin - Linezolid		
E. coli	- Co-amoxiclav - Piperacillin with tazobactam - Third-generation cephalosporins - Ciprofloxacin			

Organisms	0 to 3 days	4 days to <1 year	1 to 4 years	5 to 17 years
	- Gentamicin - Amikacin - Meropenem			
K. pneumoniae	Organism not included for age group	- Co-amoxiclav - Piperacillin with tazobactam - Third-generation cephalosporins - Ciprofloxacin - Gentamicin - Amikacin - Meropenem		
Enterobacter cloacae complex	Organism not included for age group	- Ciprofloxacin - Co-trimoxazole - Gentamicin - Amikacin - Meropenem		
P. aeruginosa	Organism not included for age group	- Piperacillin with tazobactam - Ceftazidime - Ciprofloxacin - Gentamicin - Amikacin - Meropenem		

5. Acknowledgements

These reports would not be possible without the weekly contributions from microbiology colleagues in laboratories across England, without whom there would be no surveillance data. The support from colleagues within the UKHSA and UKHSA AMRHAI Reference Unit (9) in particular, is valued in the preparation of the report. Feedback and specific queries about this report are welcome and can be sent to hcai.amrdepartment@ukhsa.gov.uk.

6. References

1. UKHSA (2024) 'English surveillance programme for antimicrobial utilisation and resistance (ESPAUR) report 2023 to 2024'
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About the UK Health Security Agency

UKHSA is responsible for protecting every member of every community from the impact of infectious diseases, chemical, biological, radiological and nuclear incidents, and other health threats. We provide intellectual, scientific, and operational leadership at national and local level, as well as on the global stage, to make the nation health secure.

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