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Public Health Wales

Healthcare Associated Infection, Antimicrobial Resistance and Prescribing Programme

Antimicrobial Resistance in Blood Cultures Wales 2016-2022

Version 1

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Introduction

In 2014, Lord O'Neill was commissioned by the UK Prime Minister to review the global impact of antimicrobial resistance. He estimated that by 2050, 10 million lives a year and a cumulative 100 trillion USD of economic output would be at risk due to the rise of drug resistant infections if no proactive solutions were found now to slow down the rise of drug resistance.

In response to Lord O'Neill's report and recommendations, in January 2019, the UK Government published its 20-year vision for antimicrobial resistance, and its five-year national action plan to tackle antimicrobial resistance. The vision is that stakeholders at local, national, and global levels collectively strengthen policy and practice, improve research and surveillance, and develop effective regulation to contain and control resistance.

Antimicrobial resistance is an increasing problem in Wales and has already led to a small number of difficult to treat infections, leading to failed therapy and potential complications. Treatment for most infections is started empirically before antimicrobial susceptibilities are known. A particular problem with the spread of antimicrobial resistance is that it becomes more difficult to select empirical therapy that will have reliable activity.

The aim of this report from the HARP team at Public Health Wales is to provide surveillance data that can be used to design empirical therapy guidance, and to track antimicrobial resistance trends in Wales.

Methodology

Resistance data

Data Sources

Antimicrobial susceptibility testing data was extracted from the Public Health Wales DataStore system.

Antimicrobial Groups

In 2012/2013 the European Committee on Antimicrobial Susceptibility Testing (EUCAST) methodology for antimicrobial susceptibility testing (AST) was implemented across the laboratories in Wales (https://eucast.org/clinical_breakpoints).

Key Points of Interest

Escherichia coli (the commonest cause of blood stream infections in Wales).

- In the 2022 All-Wales resistance rates to commonly used antibacterials varied:
  - Resistance to co-amoxiclav was **47.7%**.
  - Resistance to gentamicin was **10.0%**.
  - Resistance to piperacillin/tazobactam was **14.0%**.
  - Resistance to third generation cephalosporins was **11.9%**.
  - Resistance to fluoroquinolones was **18.1%**.
  - Resistance to co-trimoxazole was **31.0**.
- Carbapenem resistance remains below 1% in Wales.

Staphylococcus aureus

- The number of *Staphylococcus aureus* bloodstream infections for both MRSA and MSSA increased in 2022 compared with 2021.

***Klebsiella* spp.**

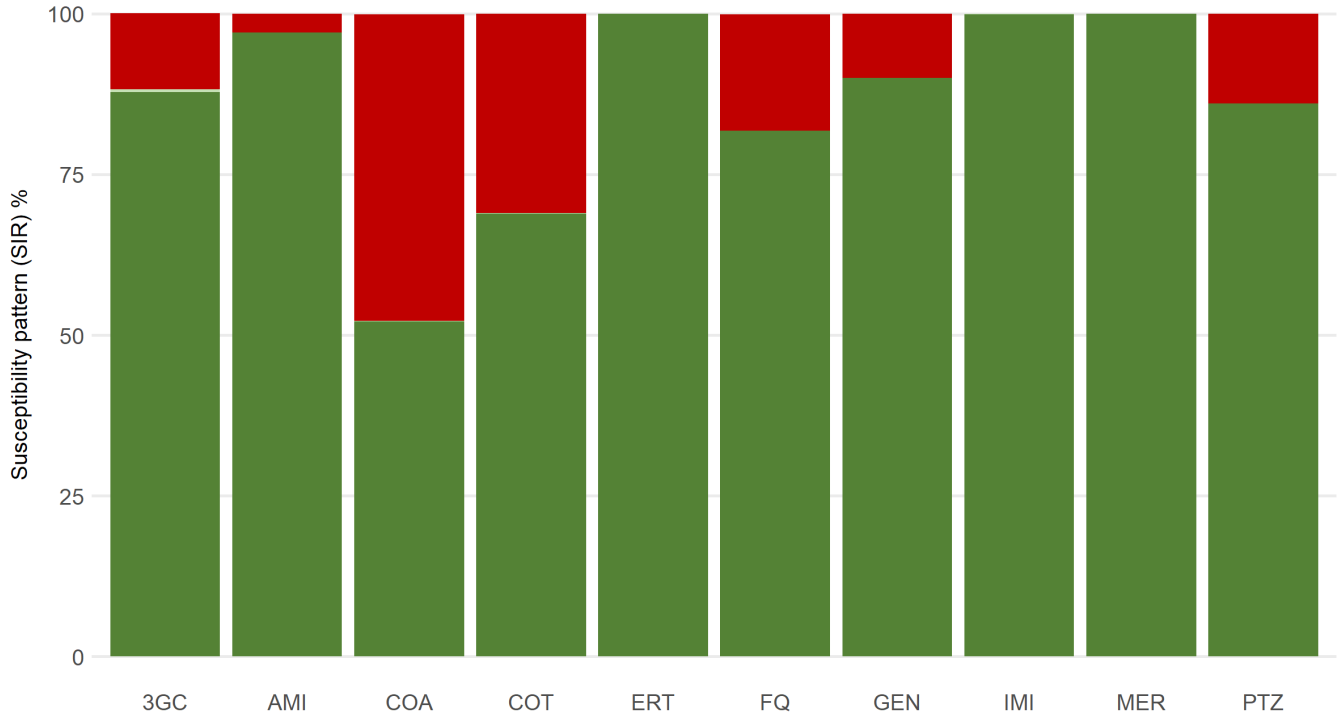
- In the 2022 All-Wales resistance rates to commonly used antibacterials varied:
  - Resistance to third generation cephalosporins was **21.9%**.
  - Resistance to amikacin was **1.7%**.
  - Resistance to co-amoxiclav was **39.5%**.
  - Resistance to co-trimoxazole was **27.7%**.
  - Resistance to ertapenem was **0.6%**.
  - Resistance to fluoroquinolones was **18.9%**.
  - Resistance to gentamicin was **15.2%**.
  - Resistance to imipenem and meropenem was **0.2%**.
  - Resistance to piperacillin/tazobactam was **28.5%**.

Antimicrobial resistance rates for the most common organisms causing bacteraemia

Escherichia coli (n = 2,107 in 2022)

E. coli is the commonest organism grown from blood cultures in Wales and the UK.

The All-Wales patterns of susceptibility (**S/I/R**) for *E. coli* bacteraemia in 2022 are shown in **Figure 1**. Trends in the resistance rates for the period 2016 to 2022 are shown in **Figure 2**.



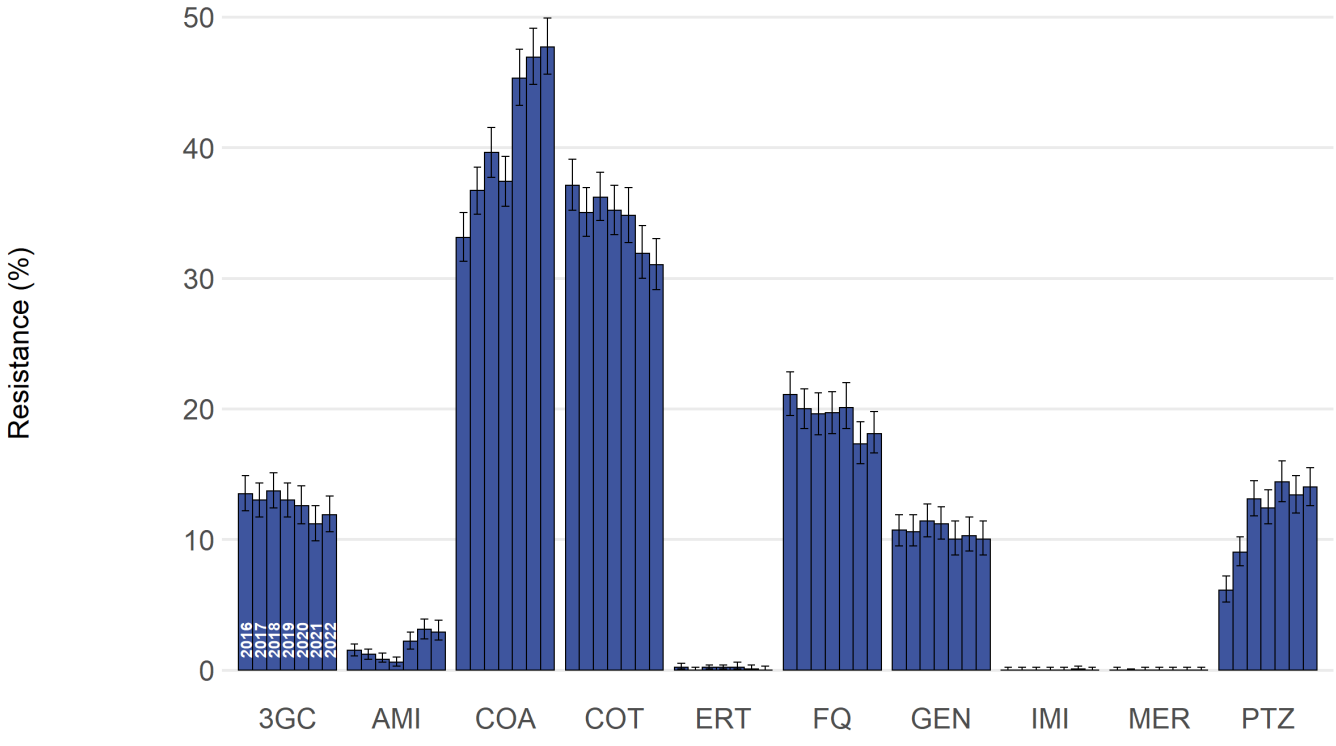
	3GC	AMI	COA	COT	ERT	FQ	GEN	IMI	MER	PTZ
%R	11.9	2.9	47.7	31.0	0.0	18.1	10.0	0.0	0.0	14.0
%I	0.4	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.0
%S	87.8	97.1	52.1	68.9	100	81.8	90.0	99.9	100	86.0

Key: 3GC = resistance to ceftazidime &/or cefotaxime, ceftriaxone, cefpodoxime, AMI = amikacin, COA = co-amoxiclav, COT = co-trimoxazole, ERT = ertapenem, FQ = ciprofloxacin &/or levofloxacin, or norfloxacin, GEN = gentamicin, IMI = imipenem, MER = meropenem, PTZ = piperacillin/tazobactam

Figure 1: All-Wales susceptibility patterns for *E. coli* bacteraemia (2022)

What the data shows

- Third generation cephalosporin resistance was relatively low at **11.9%** [10.6, 13.3].
- Amikacin resistance was less than **5%**.
- Co-amoxiclav resistance was **47.7%** [45.6, 49.9].
- Fluoroquinolone resistance was **18.1%** [16.6, 19.8].
- Gentamicin resistance was **10.0%** [8.8, 11.4].
- Piperacillin/tazobactam resistance was **14.0%** [12.6, 15.5].
- Resistance to ertapenem, imipenem, and meropenem was less than **0.5%**.



	3GC	AMI	COA	COT	ERT	FQ	GEN	IMI	MER	PTZ
2016 (n = 2,451)	13.5	1.5	33.1	37.1	0.2	21.1	10.7	0.0	0.0	6.1
2017 (n = 2,681)	13.0	1.2	36.7	35.0	0.0	20.0	10.6	0.0	0.0	9.0
2018 (n = 2,477)	13.7	0.8	39.6	36.2	0.2	19.6	11.4	0.0	0.0	13.1
2019 (n = 2,464)	13.0	0.6	37.4	35.2	0.2	19.7	11.2	0.0	0.0	12.4
2020 (n = 2,016)	12.6	2.2	45.3	34.8	0.2	20.1	10.0	0.0	0.0	14.4
2021 (n = 2,105)	11.2	3.1	46.9	31.9	0.1	17.3	10.3	0.1	0.0	13.4
2022 (n = 2,107)	11.9	2.9	47.7	31.0	0.0	18.1	10.0	0.0	0.0	14.0

Key: 3GC = resistance to ceftazidime &/or cefotaxime, ceftriaxone, cefpodoxime, AMI = amikacin, COA = co-amoxiclav, COT = co-trimoxazole, ERT = ertapenem, FQ = ciprofloxacin &/or levofloxacin, or norfloxacin, GEN = gentamicin, IMI = imipenem, MER = meropenem, PTZ = piperacillin/tazobactam

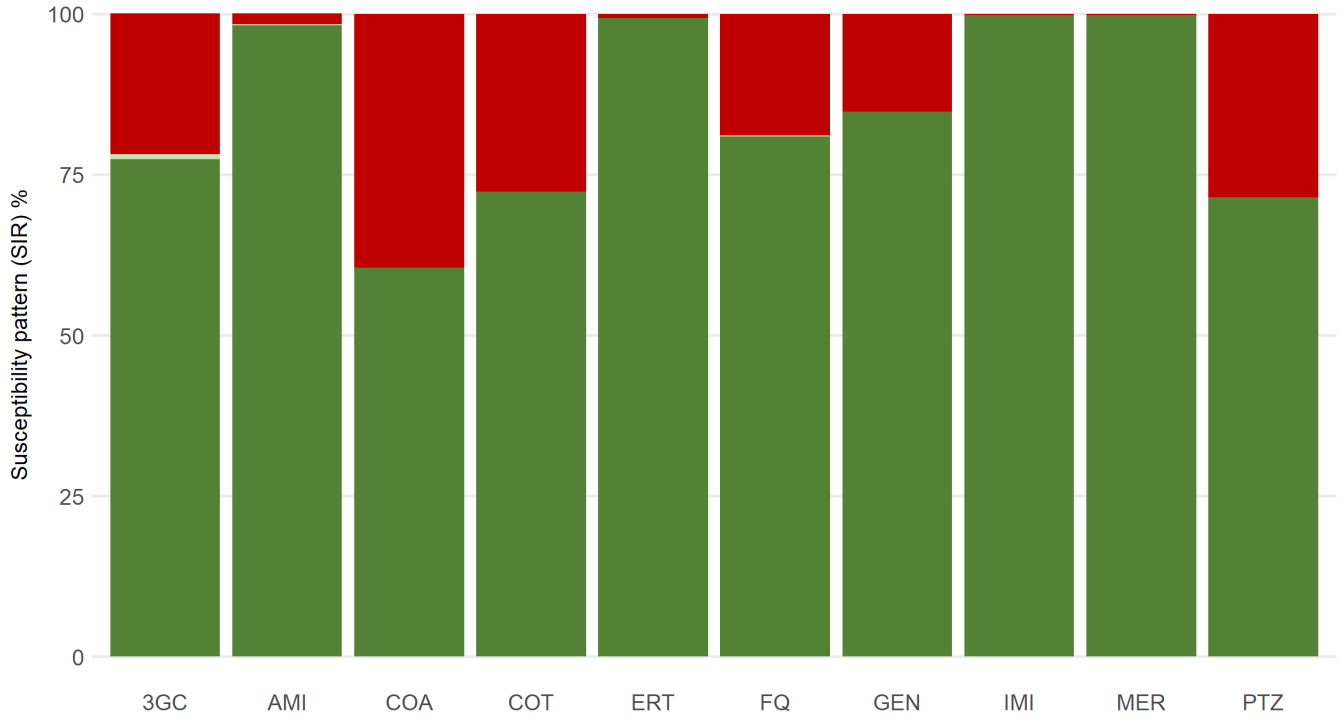
Figure 2: All-Wales antimicrobial resistance rates for *E. coli* bacteraemia (2016 - 2022)

What the data shows

- There has been a marked decrease in the number of *Escherichia coli* bacteraemia with results between 2019 and 2020, the numbers of isolates in 2022 are stable at **2,107.**
- There has been no significant change in resistance for third generation cephalosporins over time.
- There has been a small increase in amikacin resistance from 2019-2021, which has levelled off in 2022.
- There has been a statistically significant increase in co-amoxiclav resistance from **33.1%** in 2016 to **47.7%** in 2022.
- There has been a statistically significant decrease in co-trimoxazole resistance from **37.1%** in 2016 to **31.0%** in 2022.
- There has been a general decrease in fluoroquinolone resistance from 2016-2021, with resistance at **18.1%** in 2022.
- There has been no significant change in resistance for gentamicin.
- There has been a general increase in piperacillin/tazobactam resistance from 2016 onwards with resistance at **14.0%** in 2022.
- Carbapenem resistance (ertapenem, imipenem, and meropenem) remains **<1%**.

Klebsiella spp. (n = 658 in 2022)

Klebsiella spp. are the second commonest group of gram-negative organisms grown from blood cultures. The All-Wales patterns of susceptibility (**S/I/R**) for *Klebsiella* spp. bacteraemia in 2022 are shown in **Figure 3**. Trends in the resistance rates for the period 2016 to 2022 are shown in **Figure 4**.



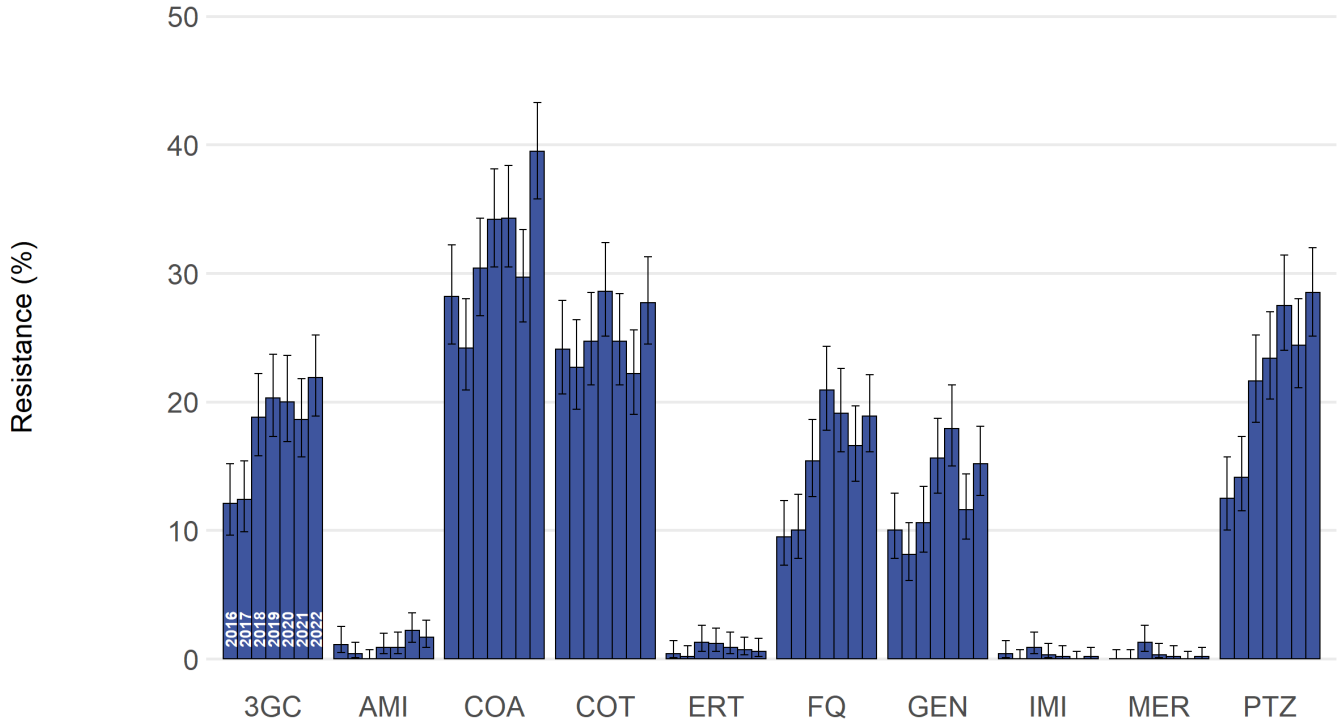
	3GC	AMI	COA	COT	ERT	FQ	GEN	IMI	MER	PTZ
%R	21.9	1.7	39.5	27.7	0.6	18.9	15.2	0.2	0.2	28.5
%I	0.8	0.2	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
%S	77.4	98.2	60.5	72.3	99.4	80.9	84.8	99.8	99.8	71.5

Key: 3GC = resistance to ceftazidime &/or cefotaxime, ceftriaxone, cefpodoxime, AMI = amikacin, COA = co-amoxiclav, COT = co-trimoxazole, ERT = ertapenem, FQ = ciprofloxacin &/or levofloxacin, or norfloxacin, GEN = gentamicin, IMI = imipenem, MER = meropenem, PTZ = piperacillin/tazobactam

Figure 3: All-Wales susceptibility patterns for *Klebsiella* spp. bacteraemia (2022)

What the data shows

- Third generation cephalosporin resistance was **21.9%** [18.9, 25.2].
- Amikacin resistance was less than **2%**.
- Co-amoxiclav resistance was **39.5%** [35.8, 43.3].
- Co-trimoxazole resistance was **27.7%** [24.5, 31.3].
- Fluoroquinolone resistance was **18.9%** [16.1, 22.1].
- Gentamicin resistance was **15.2%** [12.7, 18.1].
- Piperacillin/tazobactam resistance was **28.5%** [25.1, 32.0].
- Resistance to ertapenem, imipenem, and meropenem was less than **1%**.



	3GC	AMI	COA	COT	ERT	FQ	GEN	IMI	MER	PTZ
2016 (n = 528)	12.1	1.1	28.2	24.1	0.4	9.5	10.0	0.4	0.0	12.5
2017 (n = 558)	12.4	0.4	24.2	22.7	0.2	10.0	8.1	0.0	0.0	14.1
2018 (n = 559)	18.8	0.0	30.4	24.7	1.3	15.4	10.6	0.9	1.3	21.6
2019 (n = 591)	20.3	0.9	34.2	28.6	1.2	20.9	15.6	0.3	0.3	23.4
2020 (n = 559)	20.0	0.9	34.3	24.7	0.9	19.1	17.9	0.2	0.2	27.5
2021 (n = 609)	18.6	2.2	29.7	22.2	0.7	16.6	11.6	0.0	0.0	24.4
2022 (n = 658)	21.9	1.7	39.5	27.7	0.6	18.9	15.2	0.2	0.2	28.5

Key: 3GC = resistance to ceftazidime &/or cefotaxime, ceftriaxone, cefpodoxime, AMI = amikacin, COA = co-amoxiclav, COT = co-trimoxazole, ERT = ertapenem, FQ = ciprofloxacin &/or levofloxacin, or norfloxacin, GEN = gentamicin, IMI = imipenem, MER = meropenem, PTZ = piperacillin/tazobactam

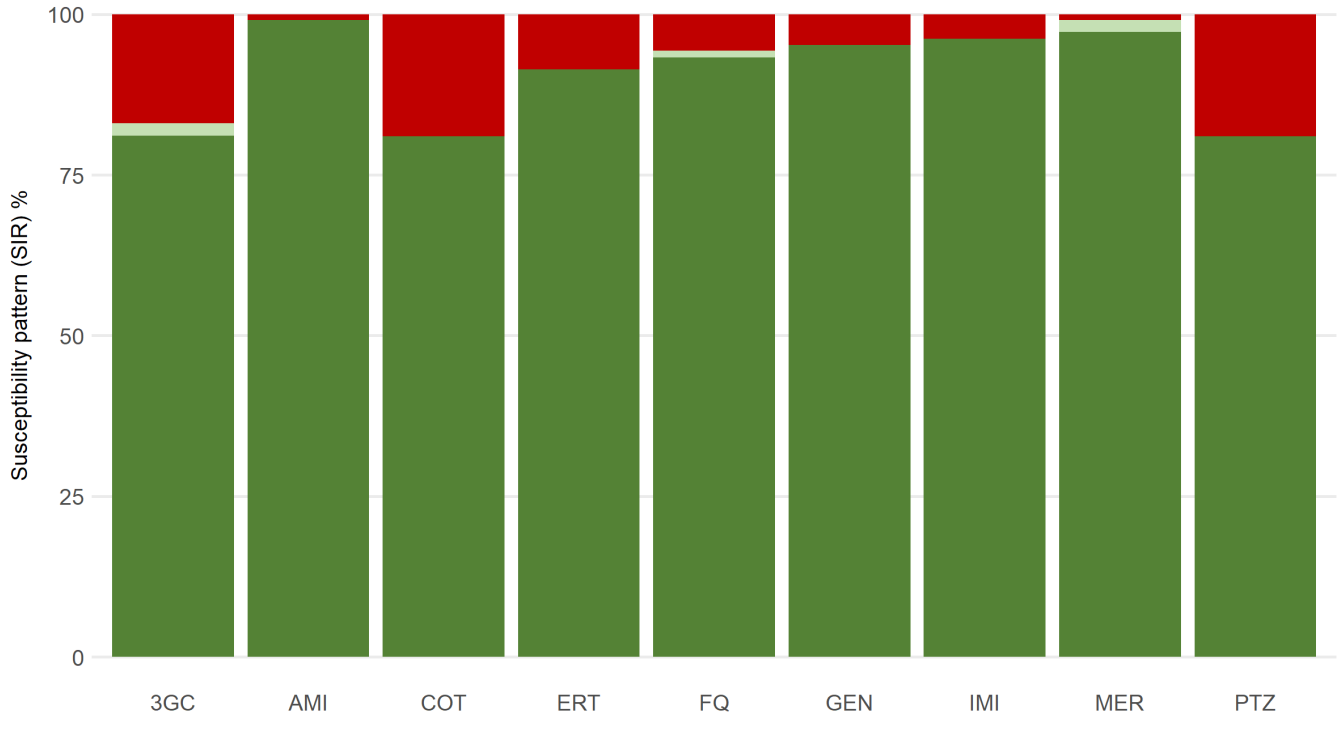
Figure 4: All-Wales antimicrobial resistance rates for *Klebsiella* spp. bacteraemia (2016 - 2022)

What the data shows

- There has been an increase in the number of *Klebsiella* spp. bacteremia with results from **528** in 2016 to **658** in 2022.
- The increase in Klebsiella spp. numbers is partly due to the reclassification of *Enterobacter aerogenes* to *Klebsiella aerogenes* in 2019.
- There has been a significant increase in third generation cephalosporin resistance from **12.1%** in 2016 to **21.9%** in 2022.
- There has been no significant change in amikacin resistance.
- There has been a statistically significant increase in co-amoxiclav resistance from **28.2%** in 2016 to **39.5%** in 2022.
- There has been no significant change in co-trimoxazole resistance.
- There was an increase in fluoroquinolone resistance from 2016-2019, with resistance at **18.9%** in 2022.
- There has been variability in the resistance rates for gentamicin, with resistance at **15.2%** in 2022.
- There has been a significant increase in piperacillin/tazobactam resistance from 2016 **12.5%** in 2016 to **28.5%** in 2022.
- Imipenem, and meropenem resistance remains **<2%** across All-Wales.

Enterobacter spp. (n = 106 in 2022)

The All-Wales patterns of susceptibility (**S/I/R**) for *Enterobacter* spp. bacteraemia in 2022 are shown in **Figure 5**. Trends in the resistance rates for the period 2016 to 2022 are shown in **Figure 6**, and the 2022 All-Wales resistance rates are shown in **Table 1**.



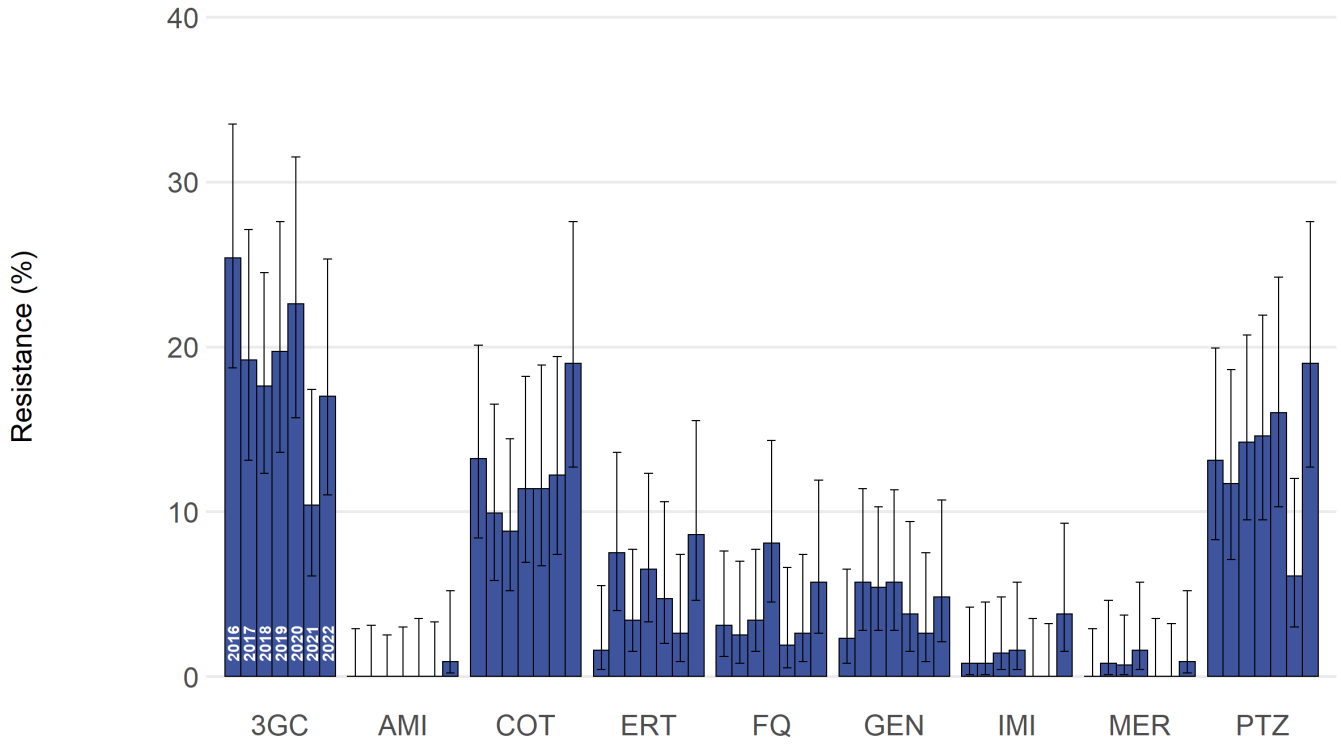
	3GC	AMI	COT	ERT	FQ	GEN	IMI	MER	PTZ
%R	17.0	0.9	19.0	8.6	5.7	4.8	3.8	0.9	19.0
%I	1.9	0.0	0.0	0.0	1.0	0.0	0.0	1.9	0.0
%S	81.1	99.1	81.0	91.4	93.3	95.2	96.2	97.2	81.0

Key: 3GC = resistance to ceftazidime &/or cefotaxime, ceftriaxone, cefpodoxime, AMI = amikacin, COT = co-trimoxazole, ERT = ertapenem, FQ = ciprofloxacin &/or levofloxacin, or norfloxacin, GEN = gentamicin, IMI = imipenem, MER = meropenem, PTZ = piperacillin/tazobactam

Figure 5: All-Wales susceptibility patterns for *Enterobacter* spp. bacteraemia (2022)

What the data shows

- Third generation cephalosporin resistance was **17.0%** [11.0, 25.3].
- Amikacin resistance was **0.9%** [0.2, 5.2].
- Co-trimoxazole resistance was **19.0%** [12.7, 27.6].
- Ertapenem resistance was **8.6%** [4.6, 15.5].
- Fluoroquinolone resistance was **5.7%** [2.6, 11.9].
- Gentamicin resistance was **4.8%** [2.1, 10.7].
- Imipenem resistance was **3.8%** [1.5, 9.3].
- Meropenem resistance was **0.9%** [0.2, 5.2].
- Piperacillin/tazobactam resistance was **19.0%** [12.7, 27.6].



	3GC	AMI	COT	ERT	FQ	GEN	IMI	MER	PTZ
2016 (n = 132)	25.4	0.0	13.2	1.6	3.1	2.3	0.8	0.0	13.1
2017 (n = 122)	19.2	0.0	9.9	7.5	2.5	5.7	0.8	0.8	11.7
2018 (n = 148)	17.6	0.0	8.8	3.4	3.4	5.4	1.4	0.7	14.2
2019 (n = 123)	19.7	0.0	11.4	6.5	8.1	5.7	1.6	1.6	14.6
2020 (n = 106)	22.6	0.0	11.4	4.7	1.9	3.8	0.0	0.0	16.0
2021 (n = 115)	10.4	0.0	12.2	2.6	2.6	2.6	0.0	0.0	6.1
2022 (n = 106)	17.0	0.9	19.0	8.6	5.7	4.8	3.8	0.9	19.0

Key: 3GC = resistance to ceftazidime &/or cefotaxime, ceftriaxone, cefpodoxime, AMI = amikacin, COT = co-trimoxazole, ERT = ertapenem, FQ = ciprofloxacin &/or levofloxacin, or norfloxacin, GEN = gentamicin, IMI = imipenem, MER = meropenem, PTZ = piperacillin/tazobactam

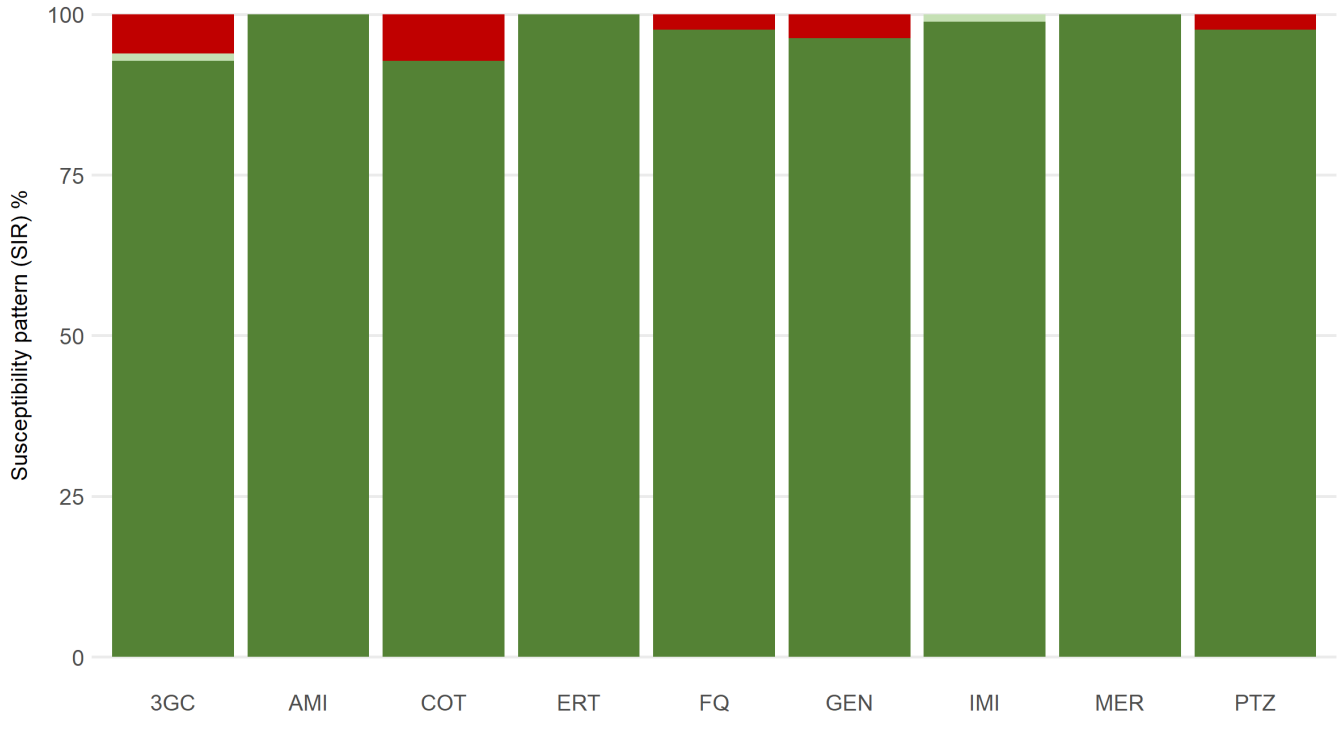
Figure 6: All-Wales antimicrobial resistance rates for *Enterobacter* spp. bacteraemia (2016 - 2022)

What the data shows

- There has been a decrease in the number of *Enterobacter* spp. bacteraemia with results from **132** in 2016 to **106** in 2022.
- The decrease in Enterobacter spp. numbers is partly due to the reclassification of *Enterobacter aerogenes* to *Klebsiella aerogenes* in 2019.
- Due to small numbers in 2022, confidence intervals are large, and apart from the notable downward trend in third generation cephalosporin resistance, the other rates are changeable with no clear trend.

Serratia spp. (n = 82 in 2022)

The All-Wales patterns of susceptibility (**S/I/R**) for *Serratia* spp. bacteraemia in 2022 are shown in **Figure 7**. Trends in the resistance rates for the period 2016 to 2022 are shown in **Figure 8**, and the 2022 All-Wales resistance rates are shown in **Table 1**.



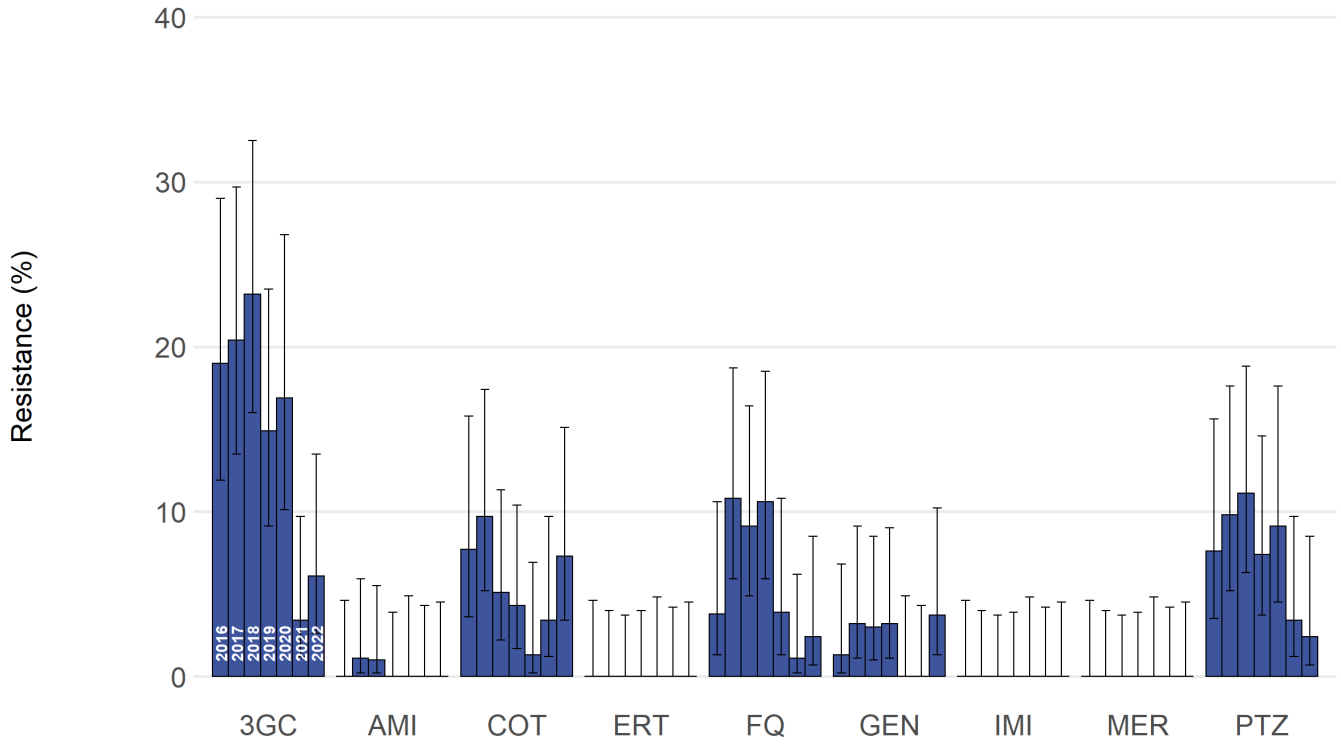
	3GC	AMI	COT	ERT	FQ	GEN	IMI	MER	PTZ
%R	6.1	0.0	7.3	0.0	2.4	3.7	0.0	0.0	2.4
%I	1.2	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0
%S	92.7	100	92.7	100	97.6	96.3	98.8	100	97.6

Key: 3GC = resistance to ceftazidime &/or cefotaxime, ceftriaxone, cefpodoxime, AMI = amikacin, COT = co-trimoxazole, ERT = ertapenem, FQ = resistance to ciprofloxacin &/or levofloxacin, GEN = gentamicin, IMI = imipenem, MER = meropenem, PTZ = piperacillin/tazobactam

Figure 7: All-Wales susceptibility patterns for *Serratia* spp. bacteraemia (2022)

What the data shows

- Third generation cephalosporin (3GC) resistance was **6.1%** [2.6, 13.5].
- Amikacin (AMI) resistance was **<1%**.
- Co-trimoxazole (COT) resistance was **7.3%** [3.4, 15.1].
- Fluoroquinolone (FQ) resistance was **2.4%** [0.7, 8.5].
- Gentamicin (GEN) resistance was **3.7%** [1.3, 10.2].
- Piperacillin/tazobactam (PTZ) resistance was **2.4%** [0.7, 8.5].
- Carbapenem (ertapenem, imipenem, meropenem) resistance was **<1%**.



	3GC	AMI	COT	ERT	FQ	GEN	IMI	MER	PTZ
2016 (n = 79)	19.0	0.0	7.7	0.0	3.8	1.3	0.0	0.0	7.6
2017 (n = 93)	20.4	1.1	9.7	0.0	10.8	3.2	0.0	0.0	9.8
2018 (n = 99)	23.2	1.0	5.1	0.0	9.1	3.0	0.0	0.0	11.1
2019 (n = 94)	14.9	0.0	4.3	0.0	10.6	3.2	0.0	0.0	7.4
2020 (n = 78)	16.9	0.0	1.3	0.0	3.9	0.0	0.0	0.0	9.1
2021 (n = 87)	3.4	0.0	3.4	0.0	1.1	0.0	0.0	0.0	3.4
2022 (n = 82)	6.1	0.0	7.3	0.0	2.4	3.7	0.0	0.0	2.4

Key: 3GC = resistance to ceftazidime &/or cefotaxime, ceftriaxone, cefpodoxime, AMI = amikacin, COT = co-trimoxazole, ERT = ertapenem, FQ = resistance to ciprofloxacin &/or levofloxacin, GEN = gentamicin, IMI = imipenem, MER = meropenem, PTZ = piperacillin/tazobactam

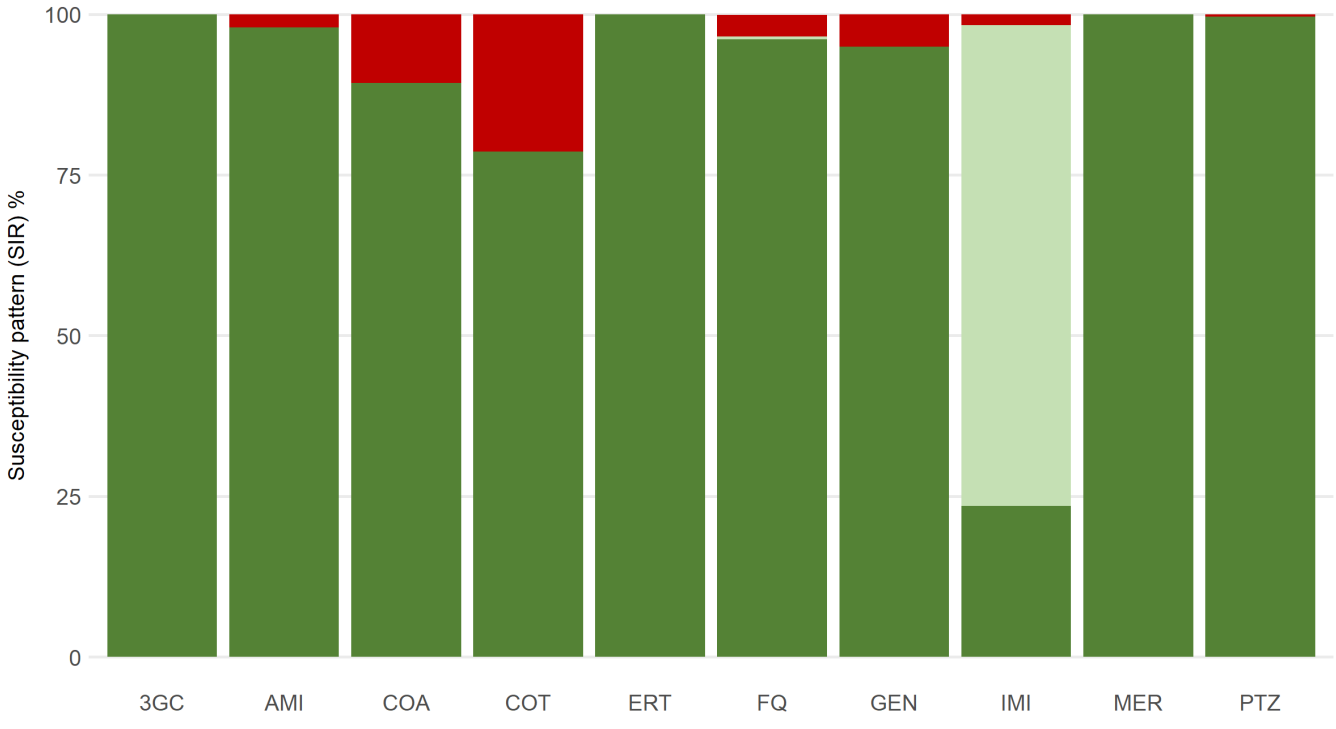
Figure 8: All-Wales antimicrobial resistance rates for *Serratia* spp. bacteraemia (2016 - 2022)

What the data shows

- There has been no significant change in the number of *Serratia* spp. bacteraemia with results - **79** in 2016 and **82** in 2022.
- There has been a decrease in third generation cephalosporin resistance (3GC) from **19.0%** in 2016 to **6.1%** in 2022.
- There has been no significant change in amikacin (AMI) resistance.
- There has been variability in co-trimoxazole (COT) resistance, with resistance at **7.3%** in 2022.
- There has been variability in fluoroquinolone (FQ) resistance, with resistance at **2.4%** in 2022.
- There has been no significant change in gentamicin (GEN) resistance.
- There has been a decrease in piperacillin/tazobactam resistance from **7.6%** in 2016 to **2.4%** in 2022.
- Carbapenem resistance (ertapenem, imipenem, and meropenem) remains **<1%**.

Proteus spp. (n = 235 in 2022)

The All-Wales patterns of susceptibility (**S/I/R**) for *Proteus* spp. bacteraemia in 2022 are shown in **Figure 9**. Trends in the resistance rates for the period 2016 to 2022 period are shown in **Figure 10**, and the 2022 All-Wales resistance rates are shown in **Table 1**.



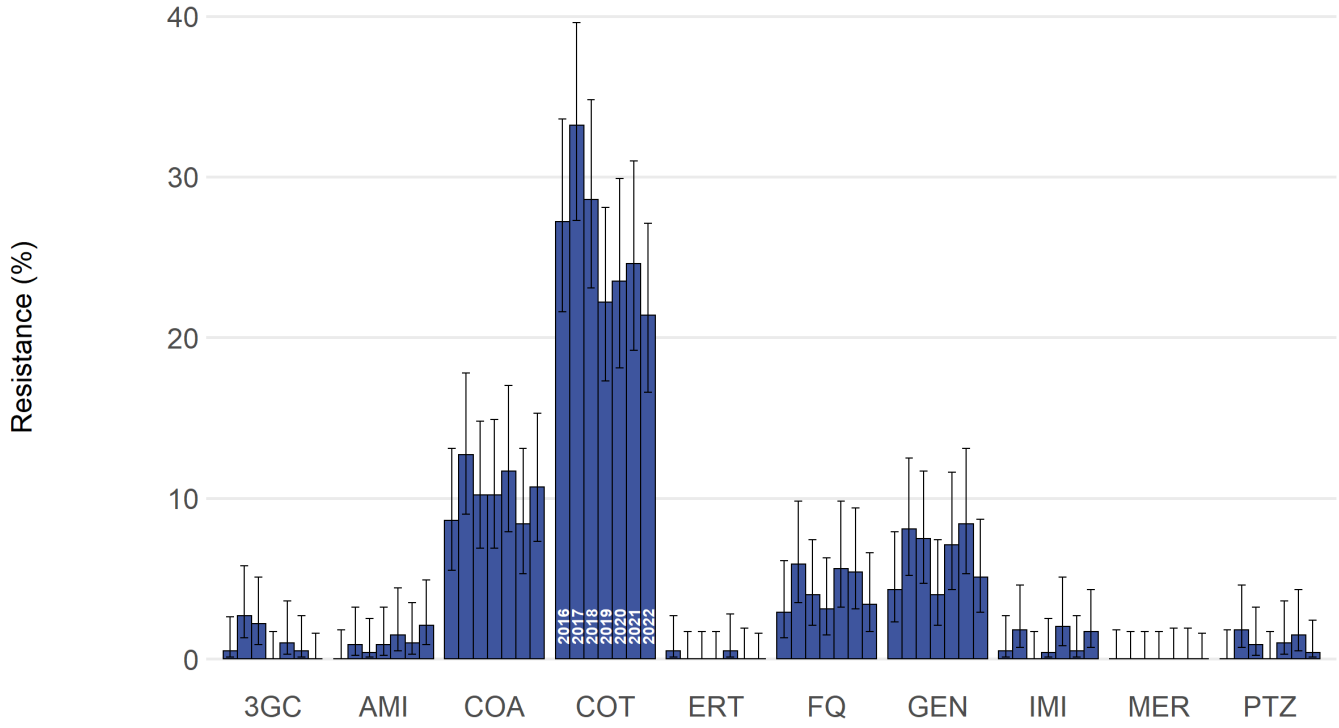
	3GC	AMI	COA	COT	ERT	FQ	GEN	IMI	MER	PTZ
%R	0.0	2.1	10.7	21.4	0.0	3.4	5.1	1.7	0.0	0.4
%I	0.0	0.0	0.0	0.0	0.0	0.4	0.0	74.8	0.0	0.0
%S	100	97.9	89.3	78.6	100	96.1	94.9	23.5	100	99.6

Key: 3GC = resistance to ceftazidime &/or cefotaxime, ceftriaxone, cefpodoxime, AMI = amikacin, COA = co-amoxiclav, COT = co-trimoxazole, ERT = ertapenem, FQ = resistance to ciprofloxacin &/or levofloxacin, GEN = gentamicin, IMI = imipenem, MER = meropenem, PTZ = piperacillin/tazobactam

Figure 9: All-Wales susceptibility patterns for *Proteus* spp. bacteraemia (2022)

What the data shows

- Third generation cephalosporin (3GC) resistance was **<1%**.
- Amikacin (AMI) resistance was **2.1%** [0.9, 4.9].
- Co-amoxiclav resistance was **10.7%** [7.3, 15.3].
- Co-trimoxazole (COT) resistance was **21.4%** [16.6, 27.1].
- Fluoroquinolone (FQ) resistance was **3.4%** [17, 6.6].
- Gentamicin (GEN) resistance was **5.1%** [2.9, 8.7].
- Imipenem (IMI) resistance was **1.7%** [0.7, 4.3].
- Piperacillin/tazobactam (PTZ) resistance was **<1%**.
- Ertapenem and meropenem resistance remains **<1%**.



	3GC	AMI	COA	COT	ERT	FQ	GEN	IMI	MER	PTZ
2016 (n = 211)	0.5	0.0	8.6	27.2	0.5	2.9	4.3	0.5	0.0	0.0
2017 (n = 221)	2.7	0.9	12.7	33.2	0.0	5.9	8.1	1.8	0.0	1.8
2018 (n = 227)	2.2	0.4	10.2	28.6	0.0	4.0	7.5	0.0	0.0	0.9
2019 (n = 225)	0.0	0.9	10.2	22.2	0.0	3.1	4.0	0.4	0.0	0.0
2020 (n = 196)	1.0	1.5	11.7	23.5	0.5	5.6	7.1	2.0	0.0	1.0
2021 (n = 203)	0.5	1.0	8.4	24.6	0.0	5.4	8.4	0.5	0.0	1.5
2022 (n = 235)	0.0	2.1	10.7	21.4	0.0	3.4	5.1	1.7	0.0	0.4

Key: 3GC = resistance to ceftazidime &/or cefotaxime, ceftriaxone, cefpodoxime, AMI = amikacin, COA = co-amoxiclav, COT = co-trimoxazole, ERT = ertapenem, FQ = resistance to ciprofloxacin &/or levofloxacin, GEN = gentamicin, IMI = imipenem, MER = meropenem, PTZ = piperacillin/tazobactam

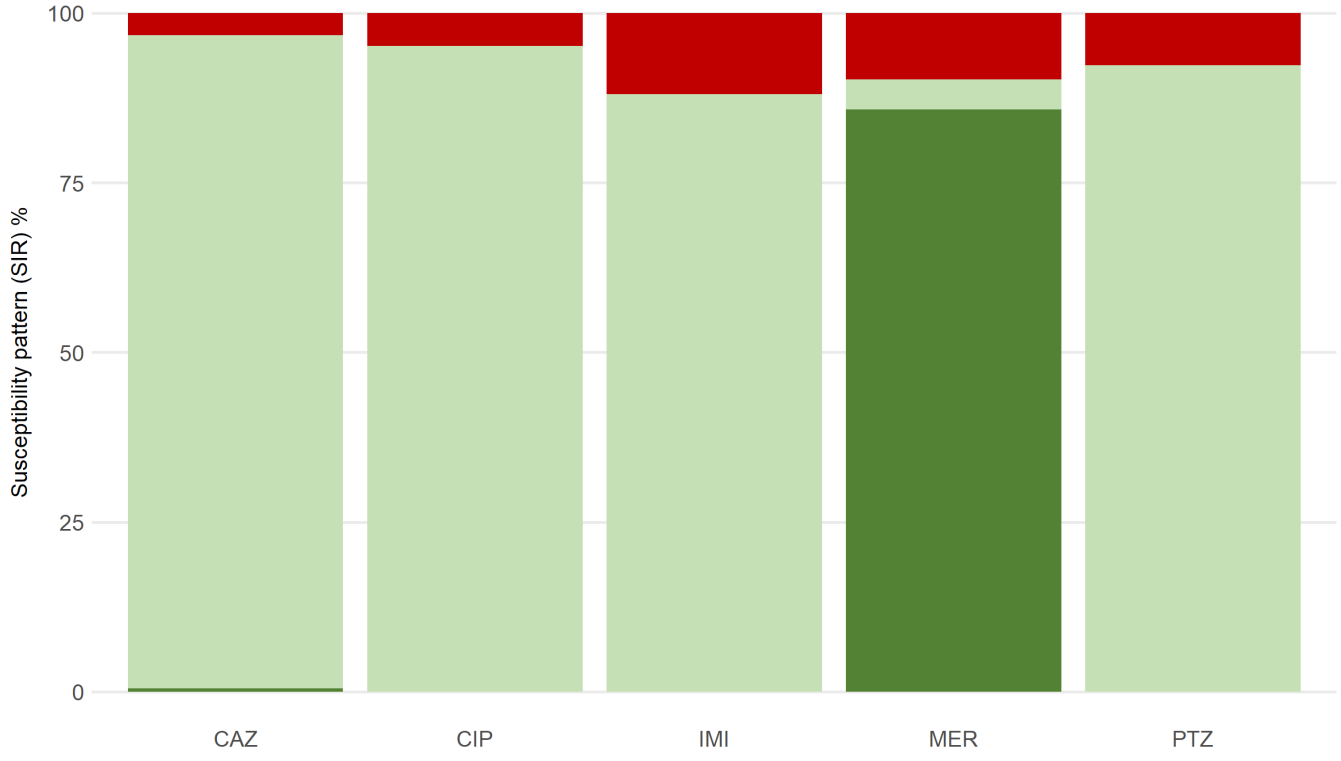
Figure 10: All-Wales antimicrobial resistance rates for *Proteus* spp. bacteraemia (2016 - 2022)

What the data shows

- There has been no significant change in the number of *Proteus* spp. bacteraemia with results - **211** in 2016 and **235** in 2022.
- There has been no significant change in third generation cephalosporin resistance.
- There has been a general increase in the resistance rates for amikacin (AMI) from **0.0%** in 2016 to **2.1%** in 2022.
- There has been no significant change in co-amoxiclav resistance.
- There has been a decrease co-trimoxazole (COT) resistance, from **27.2%** in 2016 to **21.4%** in 2022.
- There has been variability in fluoroquinolone (FQ) resistance, with resistance at **3.4%** in 2022.
- There has been variability in gentamicin resistance, with resistance at **5.1%** in 2022.
- There has been no significant change in piperacillin/tazobactam resistance.
- Carbapenem resistance (ertapenem, imipenem, and meropenem) was **<2%** in 2022.

Pseudomonas aeruginosa (n = 183 in 2022)

The All-Wales patterns of susceptibility (**S/I/R**) for *Ps. aeruginosa* bacteraemia in 2022 are shown in **Figure 11**. Trends in the resistance rates for the period 2016 to 2022 are shown in **Figure 12**, and the 2022 All-Wales resistance rates are shown in **Table 1**.



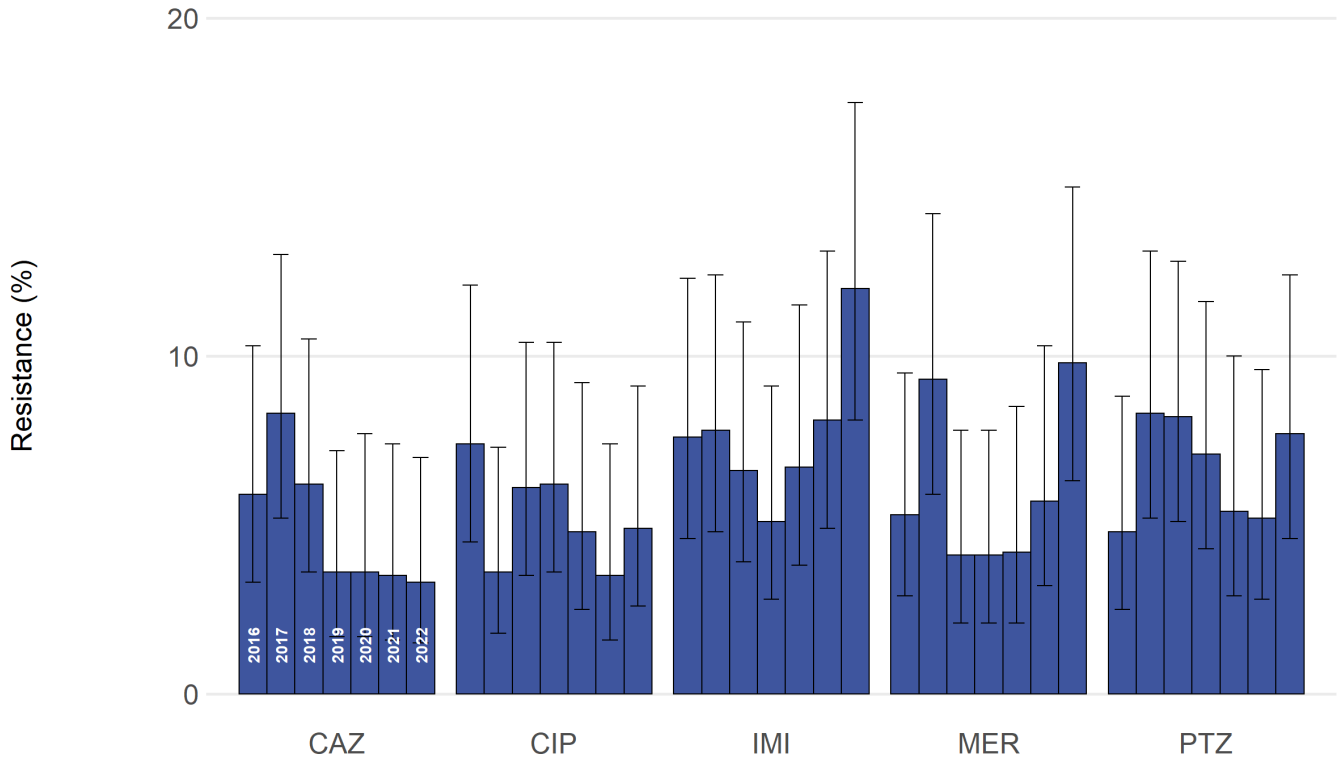
	CAZ	CIP	IMI	MER	PTZ
%R	3.3	4.9	12.0	9.8	7.7
%I	96.2	95.1	88.0	4.4	92.3
%S	0.5	0.0	0.0	85.8	0.0

Key: CAZ = ceftazidime, CIP = ciprofloxacin, IMI = imipenem, MER = meropenem, PTZ = piperacillin/tazobactam

Figure 11: All-Wales susceptibility patterns for *Ps. aeruginosa* bacteraemia (2022)

What the data shows

- Ceftazidime (CAZ) resistance was **3.3%** [1.5, 7.0].
- Ciprofloxacin (CIP) resistance was **4.9%** [2.6, 9.1].
- Imipenem (IMI) resistance was **12.0%** [8.1, 17.5].
- Meropenem (MER) resistance was **9.8%** [6.3, 15.0].
- Piperacillin/tazobactam (PTZ) resistance was **7.7%** [4.6, 12.4].



	CAZ	CIP	IMI	MER	PTZ
2016 (n = 188)	5.9	7.4	7.6	5.3	4.8
2017 (n = 194)	8.3	3.6	7.8	9.3	8.3
2018 (n = 196)	6.2	6.1	6.6	4.1	8.2
2019 (n = 197)	3.6	6.2	5.1	4.1	7.1
2020 (n = 166)	3.6	4.8	6.7	4.2	5.4
2021 (n = 174)	3.5	3.5	8.1	5.7	5.2
2022 (n = 183)	3.3	4.9	12.0	9.8	7.7

Key: CAZ = ceftazidime, CIP = ciprofloxacin, IMI = imipenem, MER = meropenem, PTZ = piperacillin/tazobactam

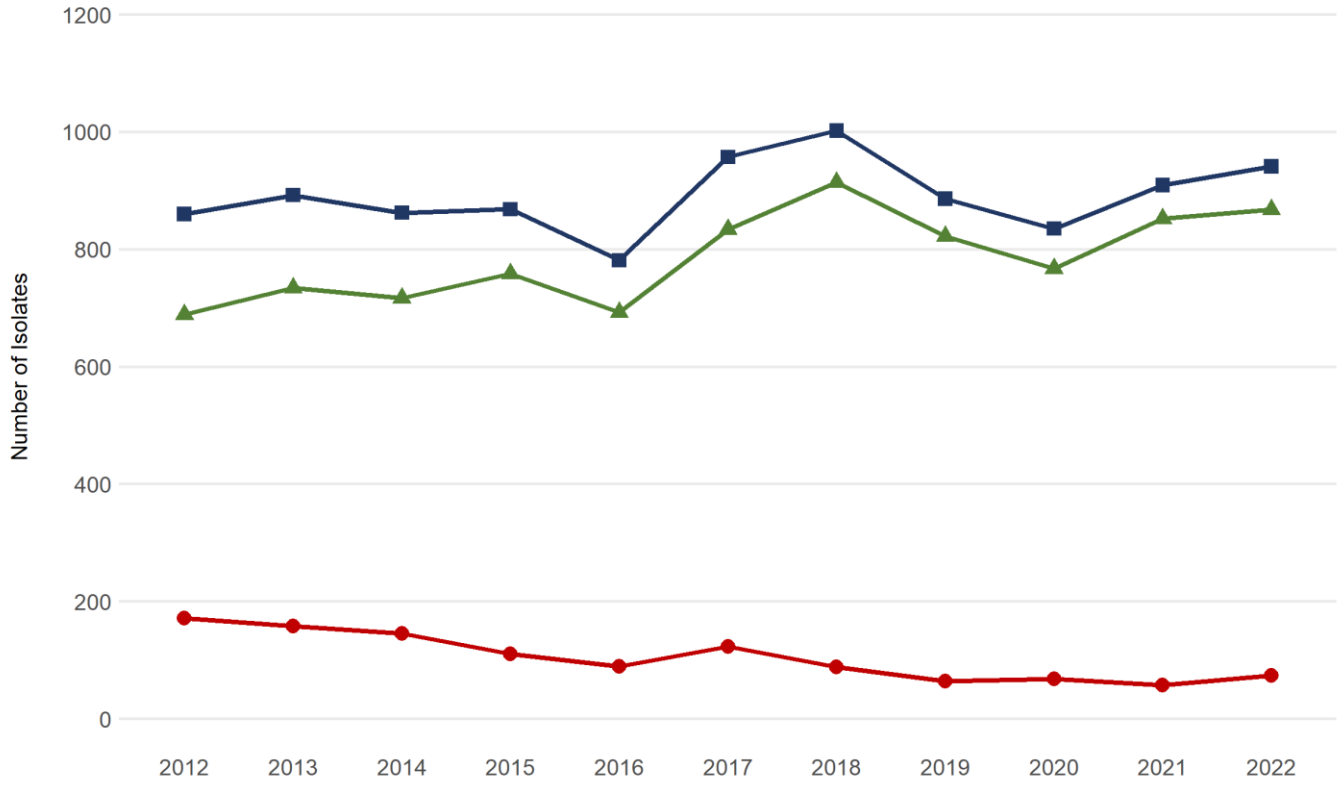
Figure 12: All-Wales antimicrobial resistance rates for *Ps. aeruginosa* bacteraemia (2016 - 2022)

What the data shows

- There has been no significant change in the number of *Ps. aeruginosa* bacteraemia with results - **188** in 2016 and **183** in 2022.
- There has been a general decrease in ceftazidime (CAZ) resistance from **8.3%** in 2017 to **3.3%** in 2022.
- There has been variability in ciprofloxacin (CIP) resistance, with resistance at **4.9%** in 2022.
- There has been variability in imipenem (IMI) resistance, with resistance at **12.0%** in 2022.
- There has been variability in meropenem (MER) resistance, with resistance at **9.8%** in 2022.
- There has been variability in piperacillin/tazobactam (PTZ) resistance, with resistance at **7.7%** in 2022.

Staphylococcus aureus (n = 941 in 2022)

Trends in the All-Wales resistance rates for *S. aureus* bacteraemias in the period 2012 to 2022 are shown in **Figure 13**.



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
MRSA	171	158	145	110	89	123	88	64	68	57	74
MSSA	689	734	717	758	692	834	914	822	767	852	867
SAUR	860	892	862	868	781	957	1002	886	835	909	941

Figure 13: All-Wales *S. aureus* bacteraemia total number of isolates numbers (2016 - 2022)

What the data shows

- There has been a general increase in the number of *Staphylococcus aureus* (SAUR) bacteraemia with results from **860** in 2012 to **941** in 2022, with a marked peak of **1,002** in 2018.
- There has been a general decrease in the number of methicillin resistant *S. aureus* (MRSA) from **171** in 2012 to **74** in 2022.
- There has been a general increase in the number of methicillin sensitive *S. aureus* (MSSA) from **689** in 2012 to **867** in 2022, with a marked peak of **914** in 2018.

Methicillin Resistant *Staphylococcus aureus* (n = 74 in 2022)

The All-Wales patterns of susceptibility (**S/I/R**) for Methicillin Resistant *S. aureus* (MRSA) in 2022 are shown in **Figure 14**. Trends in the All-Wales resistance rates for the period 2016 to 2022 are shown in **Figure 15**.

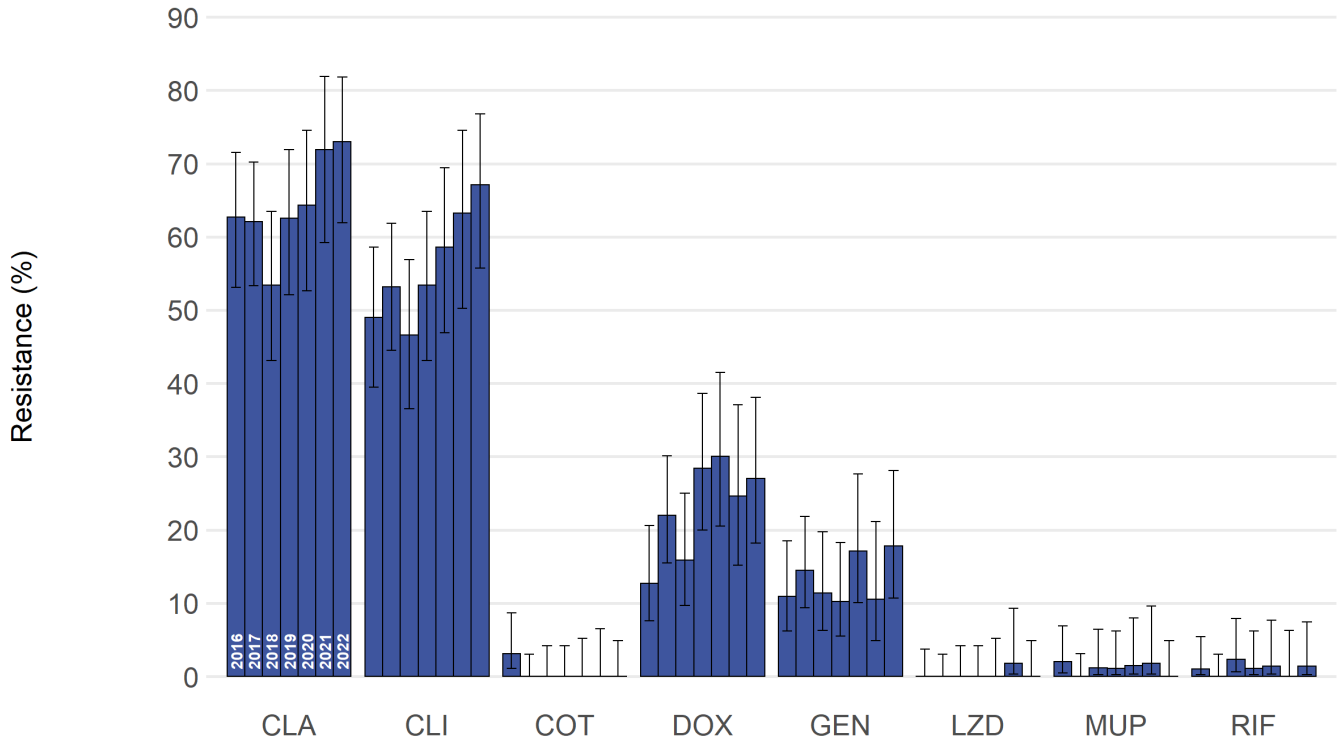
	CLA	CLI	COT	DOX	GEN	LZD	MUP	RIF
%R	73.0	67.1	0.0	27.0	17.8	0.0	0.0	1.4
%I	0.0	0.0	0.0	0.0	0.0	0.0	4.1	0.0
%S	27.0	32.9	100	73.0	82.2	100	95.9	98.6

Key: CLA = clarithromycin, CLI = clindamycin, COT = co-trimoxazole, DOX = doxycycline, GEN = gentamicin, LZD = linezolid, MUP = mupirocin, RIF = rifampicin

Figure 14: All-Wales susceptibility patterns for MRSA bacteraemia (2022)

What the data shows

- Clarithromycin (CLA) resistance was **73.0%** [61.9, 81.8].
- Clindamycin (CLI) resistance was **67.1%** [55.7, 76.8].
- Co-trimoxazole (COT) resistance was **<1%**.
- Doxycycline (DOX) resistance was **27.0%** [18.2, 38.1].
- Gentamicin (GEN) resistance was **17.8%** [10.7, 28.1].
- Linezolid (LZD) resistance was **<1%**.
- Mupirocin (MUP) resistance was **<1%**.
- Rifampicin (RIF) resistance was **1.4%** [0.2, 7.4].



	CLA	CLI	COT	DOX	GEN	LZD	MUP	RIF
2016 (n = 102)	62.7	49.0	3.1	12.7	10.9	0.0	2.0	1.0
2017 (n = 125)	62.1	53.2	0.0	22.0	14.5	0.0	0.0	0.0
2018 (n = 88)	53.4	46.6	0.0	15.9	11.4	0.0	1.2	2.3
2019 (n = 88)	62.5	53.4	0.0	28.4	10.2	0.0	1.1	1.1
2020 (n = 70)	64.3	58.6	0.0	30.0	17.1	0.0	1.5	1.4
2021 (n = 57)	71.9	63.2	0.0	24.6	10.5	1.8	1.8	0.0
2022 (n = 74)	73.0	67.1	0.0	27.0	17.8	0.0	0.0	1.4

Key: CLA = clarithromycin, CLI = clindamycin, COT = co-trimoxazole, DOX = doxycycline, GEN = gentamicin, LZD = linezolid, MUP = mupirocin, RIF = rifampicin

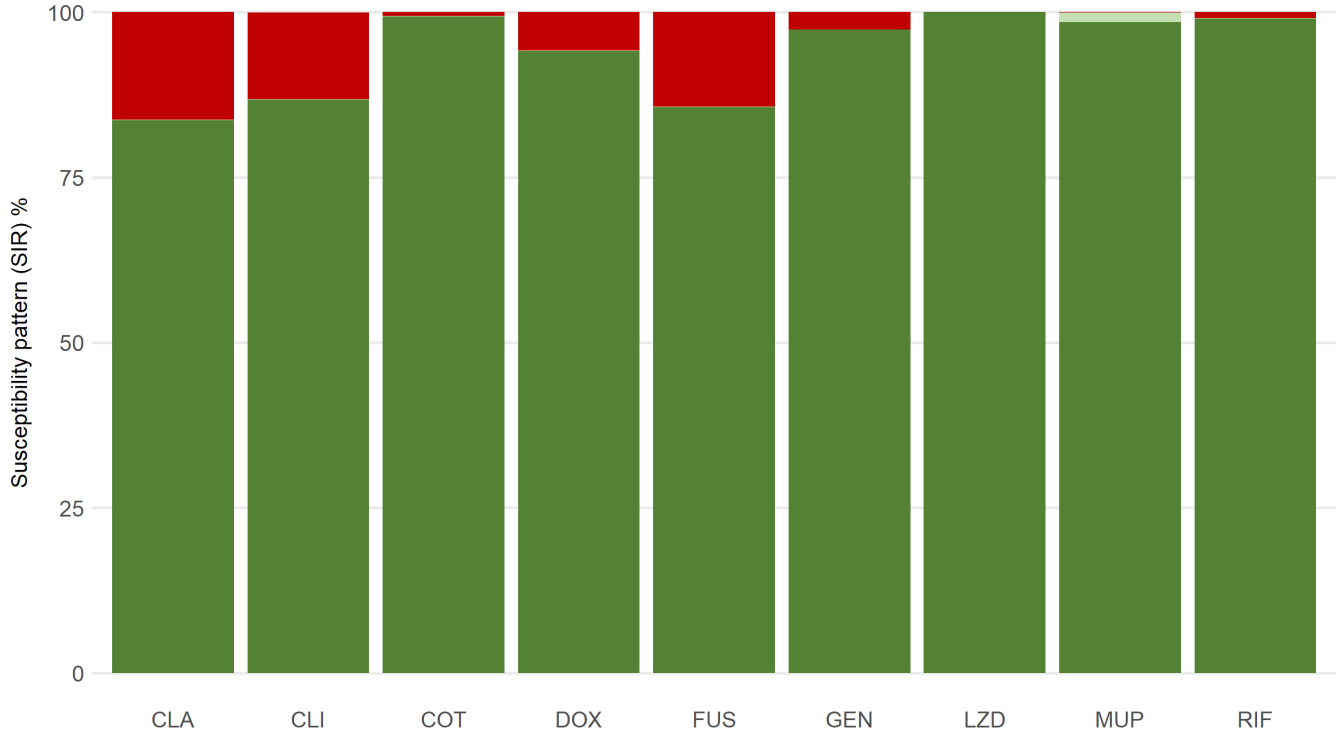
Figure 15: All-Wales antimicrobial resistance rates for MRSA bacteraemia (2016 - 2022)

What the data shows

- There has been an increase in the number of MRSA bacteraemia with results - **57** in 2021 and **74** in 2022.
- There has been a general increase in clarithromycin (CLA) resistance from **62.7%** in 2016 to **73.0%** in 2022.
- There has been an increase in clindamycin (CLI) resistance from **49.0%** in 2016 to **67.1%** in 2022.
- Resistance rates for co-trimoxazole (COT) has remained **<1%** from 2017 to 2022.
- There has been a general increase in doxycycline (DOX) resistance from **12.7%** in 2016 to **27.0%** in 2022.
- There has been no significant change in gentamicin (GEN) resistance across time.
- Resistance rates for linezolid (LZD), mupirocin (MUP) and rifampicin (RIF) has remained **<1%**.

Methicillin Sensitive *Staphylococcus aureus* (n = 867 in 2022)

The All-Wales patterns of susceptibility (**S/I/R**) for Methicillin Sensitive *Staphylococcus aureus* (MSSA) bacteraemia in 2022 are shown in **Figure 16**. Trends in the All-Wales resistance rates for the period 2016 to 2022 are shown in **Figure 17**.



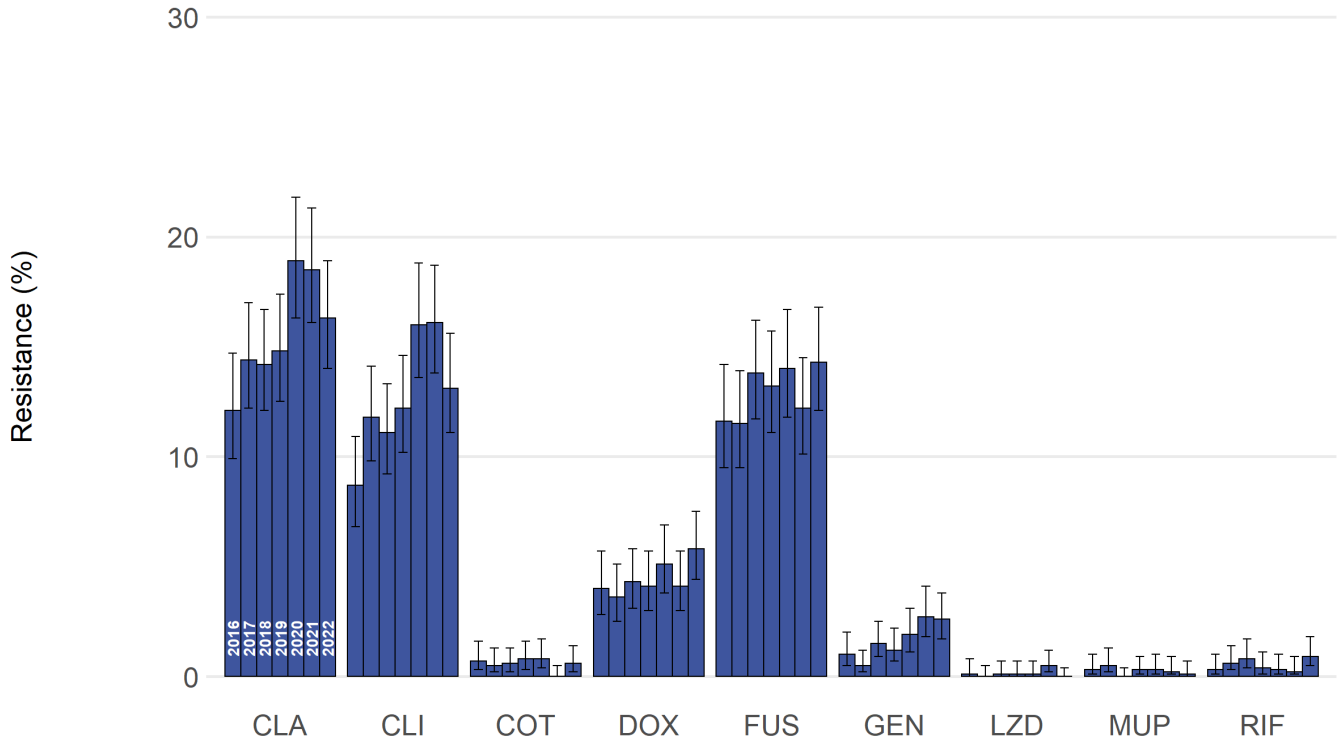
	CLA	CLI	COT	DOX	FUS	GEN	LZD	MUP	RIF
%R	16.3	13.1	0.6	5.8	14.3	2.6	0.0	0.1	0.9
%I	0.1	0.1	0.1	0.1	0.1	0.0	0.0	1.4	0.1
%S	83.6	86.7	99.3	94.1	85.6	97.4	100	98.5	99.0

Key: CLA = clarithromycin, CLI = clindamycin, COT = co-trimoxazole, DOX = doxycycline, FUS = fusidic acid, GEN = gentamicin, LZD = linezolid, MUP = mupirocin, RIF = rifampicin

Figure 16: All-Wales susceptibility patterns for MSSA bacteraemia (2022)

What the data shows

- Clarithromycin (CLA) resistance was **16.3%** [14.0, 18.9].
- Clindamycin (CLI) resistance was **13.1%** [11.0, 15.6].
- Co-trimoxazole (COT) resistance was **<1%**.
- Doxycycline (DOX) resistance was **5.8%** [4.4, 7.5].
- Fusidic acid (FUS) resistance was **14.3%** [12.1, 16.8].
- Gentamicin (GEN) resistance was **2.6%** [1.7, 3.8].
- Linezolid (LZD) resistance was **<1%**.
- Mupirocin (MUP) resistance was **<1%**.
- Rifampicin (RIF) resistance was **<1%**.



	CLA	CLI	COT	DOX	FUS	GEN	LZD	MUP	RIF
2016 (n = 727)	12.1	8.7	0.7	4.0	11.6	1.0	0.1	0.3	0.3
2017 (n = 832)	14.4	11.8	0.5	3.6	11.5	0.5	0.0	0.5	0.6
2018 (n = 885)	14.2	11.1	0.6	4.3	13.8	1.5	0.1	0.0	0.8
2019 (n = 827)	14.8	12.2	0.8	4.1	13.2	1.2	0.1	0.3	0.4
2020 (n = 764)	18.9	16.0	0.8	5.1	14.0	1.9	0.1	0.3	0.3
2021 (n = 852)	18.5	16.1	0.0	4.1	12.2	2.7	0.5	0.2	0.2
2022 (n = 867)	16.3	13.1	0.6	5.8	14.3	2.6	0.0	0.1	0.9

Key: CLA = clarithromycin, CLI = clindamycin, COT = co-trimoxazole, DOX = doxycycline, FUS = fusidic acid, GEN = gentamicin, LZD = linezolid, MUP = mupirocin, RIF = rifampicin

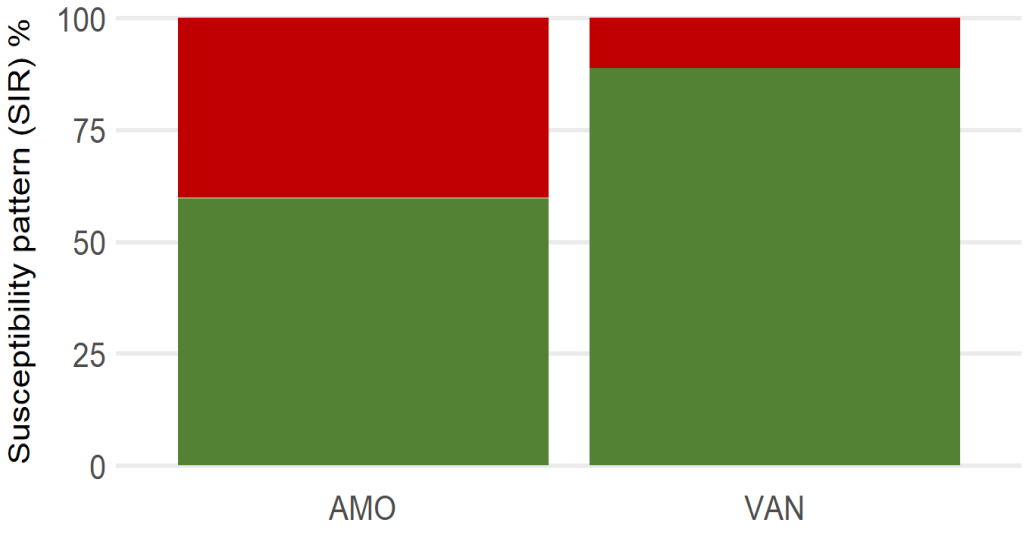
Figure 17: All-Wales antimicrobial resistance rates for MSSA bacteraemia (2016 - 2022)

What the data shows

- There has been an increase in MSSA bacteraemia with results - **764** in 2020 and **867** in 2022.
- There has been a statistically significant increase in clarithromycin (CLA) resistance from **12.0%** in 2016 to **18.9%** in 2020, with resistance at **16.3%** in 2022.
- There has been a general increase in clindamycin (CLI) resistance from **8.6%** in 2016 **16.1%** in 2021, with resistance at **13.1%** in 2022.
- Resistance rates for co-trimoxazole (COT) has remained **<1%**.
- There has been a general increase in doxycycline (DOX) resistance from **3.6%** in 2017 to **5.8%** in 2022.
- There has been a general increase in fusidic acid (FUS) resistance from **11.5%** in 2017 to **14.3%** in 2022.
- There has been a general increase in gentamicin (GEN) resistance from **0.5%** in 2017 to **2.6%** in 2022.
- Resistance rates for linezolid (LZD), mupirocin (MUP) and rifampicin (RIF) has remained **<1%**.

Enterococcus spp. (n = 549 in 2022)

The All-Wales patterns of susceptibility (**S/I/R**) for *Enterococcus* spp. bacteraemia in 2022 are shown in **Figure 18**. Trends in the All-Wales resistance rates for the period 2016 to 2022 are shown in **Figure 19**.



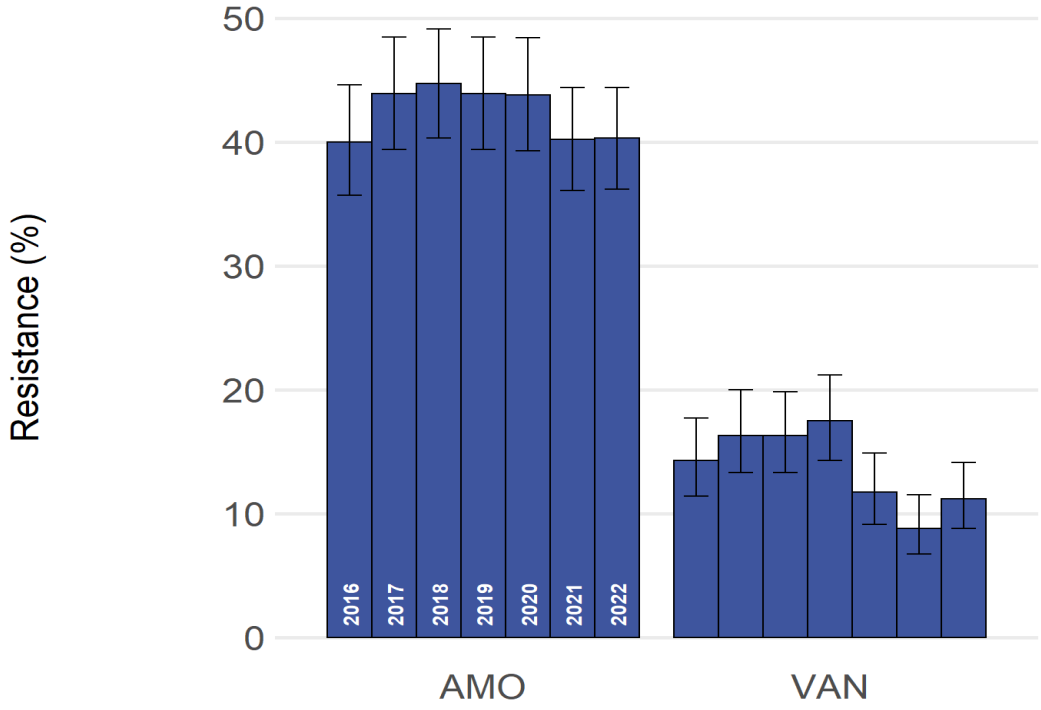
	AMO	VAN
%R	40.3	11.2
%I	0.2	0.0
%S	59.6	88.8

Key: AMO = amoxicillin, VAN = vancomycin

Figure 18: All-Wales susceptibility patterns for *Enterococcus* spp. bacteraemia (2022)

What the data shows

- Amoxicillin (AMO) resistance was **40.3%** [36.2, 44.4].
- Vancomycin (VAN) resistance was **11.2%** [8.8, 14.1].



	AMO	VAN
2016 (n = 473)	40.0	14.3
2017 (n = 465)	43.9	16.3
2018 (n = 494)	44.7	16.3
2019 (n = 469)	43.9	17.5
2020 (n = 463)	43.8	11.7
2021 (n = 534)	40.2	8.8
2022 (n = 549)	40.3	11.2

Key: AMO = amoxicillin, VAN = vancomycin

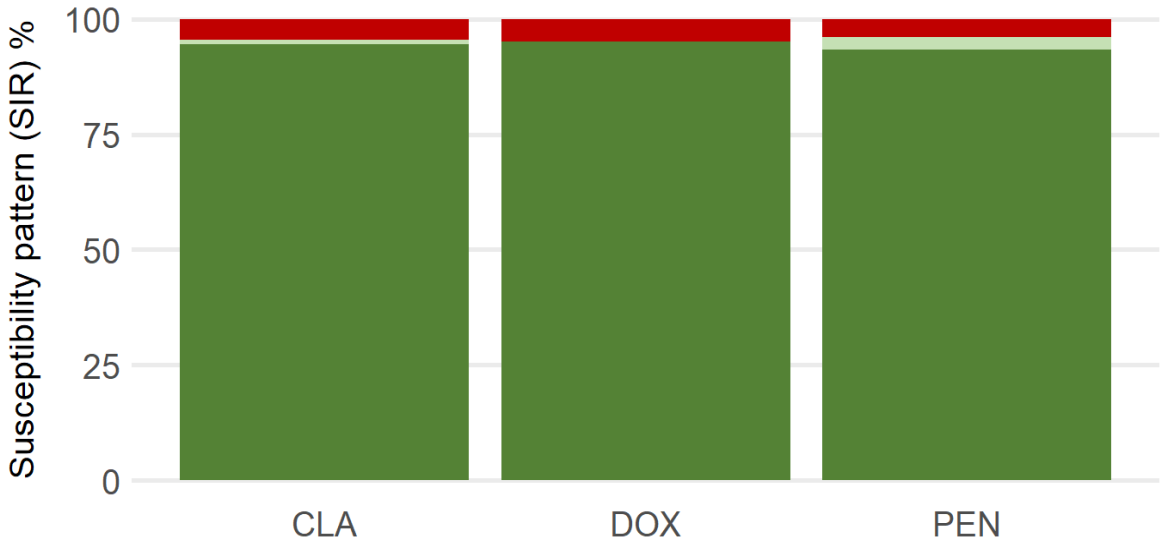
Figure 19: All-Wales antimicrobial resistance rates for *Enterococcus* spp. bacteraemia (2016 - 2022)

What the data shows

- There has been an increase in the number of *Enterococcus* spp. bacteraemia with results from **473** in 2016 to **549** in 2022.
- In 2022, the All-Wales resistance for amoxicillin rate in *Enterococcus* spp. was **40.3%**. Susceptibility to amoxicillin is a guide to speciation of the organism, *E. faecalis* being normally susceptible and *E. faecium* being normally resistant, and suggests that in 2022, **59.7%** of entercoccal bacteraemias were due to *E. faecalis.*
- There has been variability in resistance to vancomycin (VAN), with resistance at **11.2%** in 2022.

Streptococcus pneumoniae (n = 260 in 2022)

The All-Wales patterns of susceptibility (**S/I/R**) for *St. pneumoniae* bacteraemia in 2022 are shown in **Figure 20**. Trends in the All-Wales resistance rates for the period 2016 to 2022 are shown in **Figure 21**.



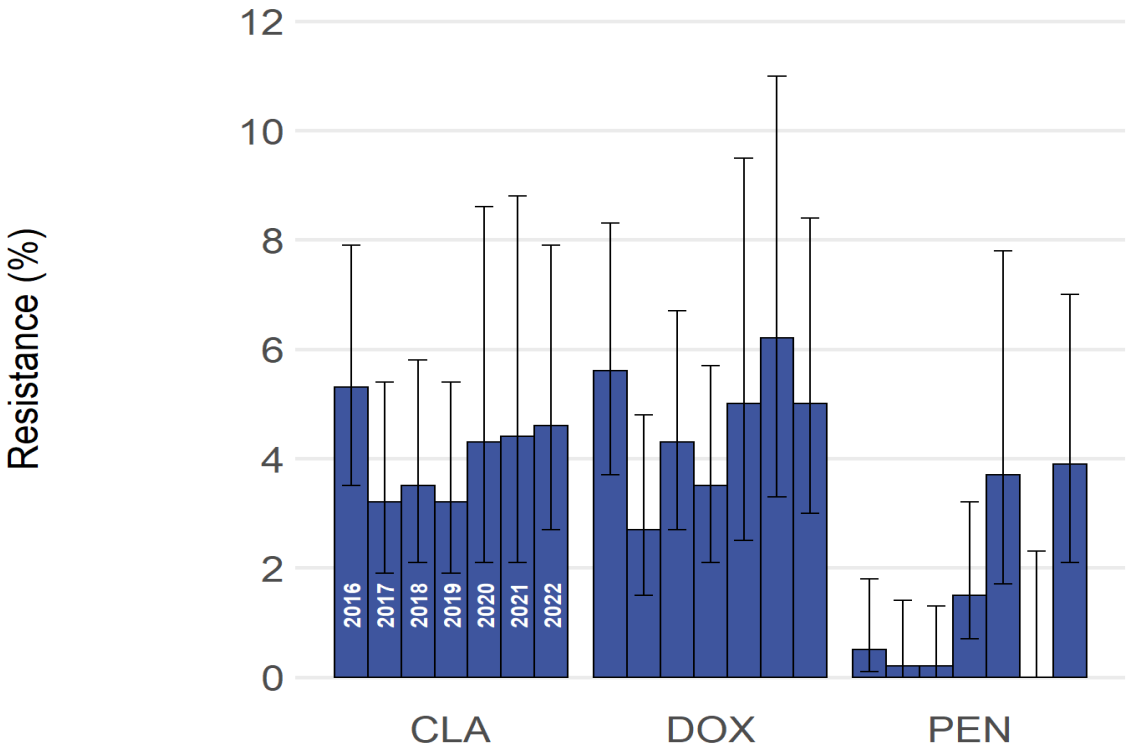
	CLA	DOX	PEN
%R	4.6	5.0	3.9
%I	0.8	0.0	2.7
%S	94.6	95.0	93.4

Key: CLA = clarithromycin, DOX = doxycycline, PEN = penicillin

Figure 20: All-Wales susceptibility patterns for *St. pneumoniae* bacteraemia (2022)

What the data shows

- Clarithromycin (CLA) resistance was **4.6%** [2.7, 7.9].
- Doxycycline (DOX) resistance was **5.0%** [3.0, 8.4].
- Penicillin (PEN) resistance was **3.9%** [2.1, 7.0].



	CLA	DOX	PEN
2016 (n = 400)	5.3	5.6	0.5
2017 (n = 405)	3.2	2.7	0.2
2018 (n = 400)	3.5	4.3	0.2
2019 (n = 405)	3.2	3.5	1.5
2020 (n = 163)	4.3	5.0	3.7
2021 (n = 161)	4.4	6.2	0.0
2022 (n = 260)	4.6	5.0	3.9

Key: CLA = clarithromycin, DOX = doxycycline, PEN = penicillin

Figure 22: All-Wales antimicrobial resistance rates for *St. pneumoniae* bacteraemia (2016 - 2022)

What the data shows

- There has been a marked decrease in the number of *St. pneumoniae* bacteraemia with results from **400** in 2016 to **260** in 2022.
- There has been no significant change in the resistance rates for clarithromycin (CLA) and doxycycline (DOX) over time.
- There has also been variability in penicillin (PEN) resistance, with resistance at **3.9%** in 2022.

Useful links:

Review on Antimicrobial Resistance May 2016
https://amr-review.org/

UK Antimicrobial Resistance Strategy 2013 – 18
https://www.gov.uk/government/publications/uk-5-year-antimicrobial-resistance-strategy-2013-to-2018

Antimicrobial Resistance Delivery Plan (Wales) 'Together for Health: Tackling antimicrobial resistance & improving antibiotic prescribing.
http://www.wales.nhs.uk/sitesplus/documents/888/Antimicrobial%20Resistance%20Delivery%20Plan.pdf

UK 20-year vision for antimicrobial resistance
https://www.gov.uk/government/publications/uk-20-year-vision-for-antimicrobial-resistance

Antimicrobial resistance: UK launches 5-year action plan and 20-year vision
https://www.gov.uk/government/news/antimicrobial-resistance-uk-launches-5-year-action-plan-and-20-year-vision

EUCAST EUROPEAN COMMITTEE ON ANTIMICROBIAL SUSCEPTIBILITY TESTING
European Society of Clinical Microbiology and Infectious Diseases

https://eucast.org/clinical_breakpoints/