Surveillance of Antimicrobial Use and Resistance in Northern Ireland

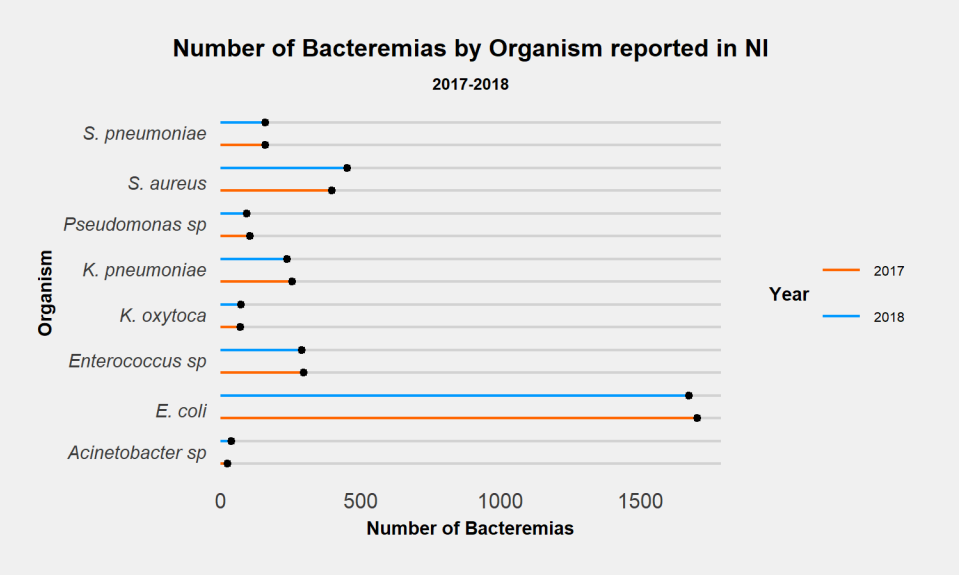
Annual Report 2019

HSC Public Health Agency

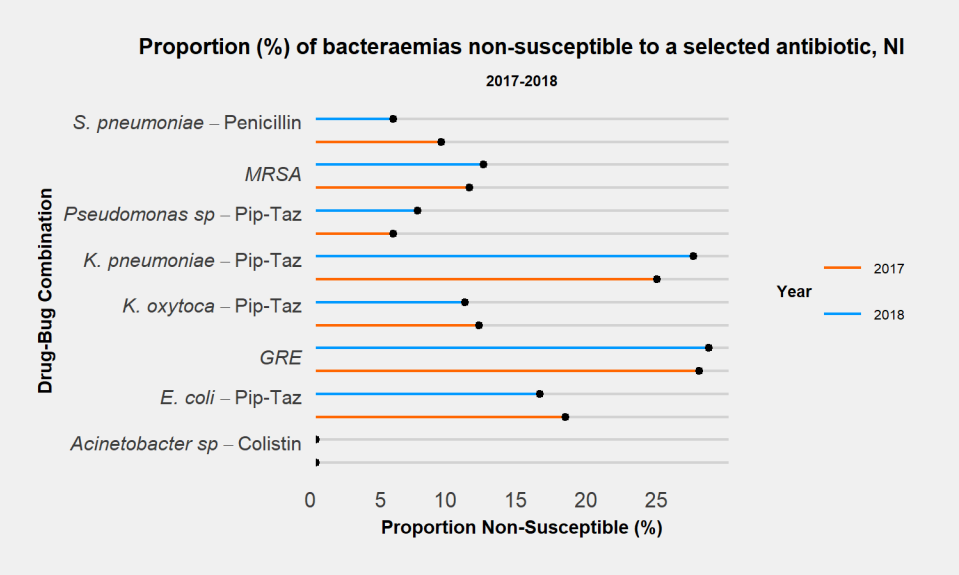
Contents

Executive summary

Antimicrobial Resistance



E. coli was the most commonly reported cause of bloodstream infection (bacteraemia) of the key selected organisms, accounting for more than 55% of those reported in 2018. Reports of bacteraemias caused by *E. coli* have however decreased over the past couple of years. Bloodstream infections caused by *S. aureus*, *K. oxytoca* and *Acinetobacter* have increased.

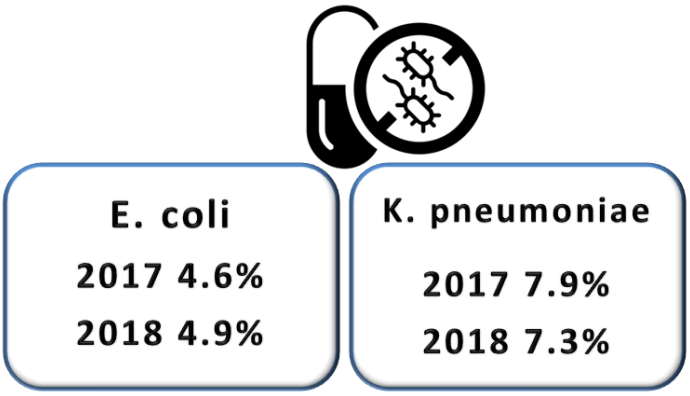


S. aureus resistance to Meticillin (MRSA) has slightly increased in 2018 (10.9% to 11.9%). The proportion of *K. pneumoniae* and *Pseudomonas sp* resistant to pip-taz has increased

between 2017 and 2018, however there was a decrease in the proportion of *E. coli* and *K. oxytoca* resistant to pip-taz (17.7% to 15.9% and 11.6% to 10.6%, respectively). During 2017 to 2018, there was an decrease in the proportion of *S. pneumoniae* resistant to penicillin (8.9% to 5.5%). The proportion of Glycopeptide Resistant Enterococcus (GRE) remained relatively stable between 2017 and 2018 (27.2% to 27.9%). There were no *Acinetobacter sp* isolates tested against colistin in 2018. Further information is contained within the results section of the report.

Multi-Drug Resistance

Multi-drug resistance has remained relatively stable in the selected organisms and drug combinations between 2017 and 2018.



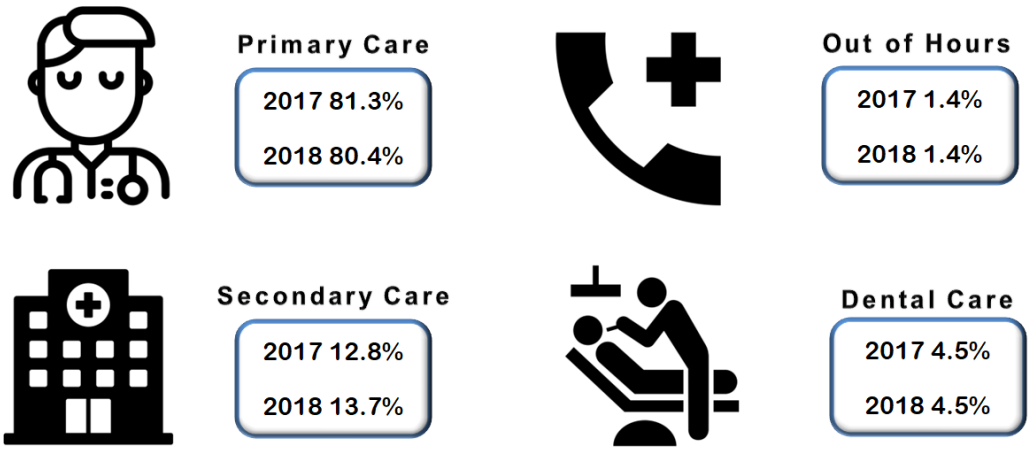
Carbapenemase Producing Enterobacteriaceae

Antibiotic Resistance to Neisseria Gonorrhoeae

In 2018, 30 *N. gonorrohoeae* isolates were cultured and sent to Public Health England for inclusion in EuroGASP, bringing the total number of isolates submitted to EuroGASP by NI since 2015 to 99. In 2018 two isolates were resistant to azithromycin, and one was resistant to ceftriaxone (6.7% and 3.3% respectively).

Antimicrobial Consumption

Proportion of Total Consumption by Setting



Total consumption of antibiotics decreased in 2018 from 29.33 to 28.5 per 1000 inhabitants per day. The overall decrease was mainly accounted for by a decrease in primary care prescribing (23.84 per to 22.91 per 1000 inhabitants per day 2017 to 2018 respectively). Prescribing from out-of-hours remained stable in 2018 at 0.4 per 1000 inhabitants per day. This year for the first time, dental prescribing was identified as an individual setting. Consumption of antibiotics in dental care accounted for ~5% of total antibiotic consumption.

Antimicrobial Consumption by Class

Class	Rate 2014	Trend	Rate 2017	Rate 2018	Change 2017- 18
Anti-folate agents	2.95		2.81	2.67	⇩
Aminoglycosides	0.15		0.17	0.17	⇨
Glycopeptides and Daptomycin	0.15		0.18	0.18	⇨
Penicillins	11.23		10.81	10.56	⇩
Carbapenems	0.07		0.06	0.06	⇨
Quinolones	0.72		0.69	0.66	⇩
Cephalosporins	0.58		0.53	0.51	⇩
Penicillin/beta lactamase inhibitor combinations	2.12		1.93	1.84	⇩
Macrolides	4.23		3.95	3.72	⇩
Tetracyclines and related drugs	6.96		7.44	7.36	⇩

Antibiotic prescribing in secondary care has slightly increased from 3.75 per 1000 inhabitants per day during 2017 to 3.91 per 1000 inhabitants per day in 2018. During 2018, the most frequently used antibiotics in both primary and secondary care in NI were penicillins (38.7% and 27% respectively), followed by tetracyclines and related drugs (27.8% and 13.4%) and macrolides (13.6% and 9.6%). Consumption of carbapenems has remained low and stable from 2015-2018 at 0.06 DDD per 1000 inhabitants per day. Penicillin/beta lactamase inhibitor combinations have been steadily decreasing from 2014 to 2018 (2.12 DDD per 1000 inhabitants per day in 2014 to 1.84 DDD per 1000 inhabitants per day in 2018) while consumption of piperacillin/tazobactam has remaining relatively stable.

WHO AWaRe Categories

WHO AWaRe Categories (Proportion (%) DDDs per 1000 inhabitants)				
Year	Access	Watch	Reserve	Unknown
2014	63.0%	36.8%	0.76%	0.06%
2015	63.9%	35.3%	0.72%	0.06%
2016	64.6%	34.6%	0.71%	0.06%
2017	64.8%	34.3%	0.78%	0.09%
2018	65.5%	33.6%	0.82%	0.13%

The World Health Organization (WHO) classifies antibiotics into three stewardship categories; Access, Watch and Reserve. The proportion of antibiotic consumption within the Access category has increased, while the proportion of consumption has decreased within the Watch category between 2014 and 2018, this is an encouraging trend. The

proportion of Reserve and antibiotics not categorised (unknown) have remained relatively stable between 2014 and 2018.

Engagement Activities & Future Work

ANTIBIOTIC GUARDIAN
Keep Antibiotics Working

During 2018 PHA engaged in a number of activities aimed at sharing key messages around antibiotic resistance with the public and HSC colleagues including supporting the antibiotic guardian awareness campaign and delivering E-bug training workshops in schools. Activities to reduce antibiotic consumption in 2018 included; TARGET toolkit workshops for healthcare staff, collaborative work on a systematic review of behavioural interventions to reduce prescribing and evaluation of a pilot point-of-care CRP testing for respiratory infections in primary care. Future work for 2019 and beyond includes: assessing the impact of the burden of AMR, conducting a study to understand the factors affecting primary care antibiotic prescribing and further engagement with the public and members of HSCNI including attending large-scale public events to promote the antibiotic guardian campaign and further roll-out of E-bug training workshops.

Authors

Danielle McMichael, BSc
Christopher Nugent, BSc, MSc
Lynsey Patterson, MSc, PhD, MFPH
Muhammad Sartaj, MBBS, MPH, DHSCM, FFPH

Acknowledgements

The information produced in this report is based on information derived from data submitted by Health and Social Care Trust microbiology and pharmacy staff, and we thank them for the time and effort involved in producing these data.

We also thank David Farren, Derek Fairley and Sara Hedderwick for their input into the original design of this report.

Image credits

- Hospital bed: Created by Wojciech Zasina
- Bacteria: Created by Maurizio Fusillo
- Doctor Consultation: Created by Esther Se Kim
- Pill: Created by Travis Bird
- Antibiotics: Created by IQON
- Doctor: Created by Olivia
- Hospital Helpline: Created by Creative Stall
- Dentist: Created by Luis Prado
- Hospital: Created by Adrien Coquet

Date generated: 28/10/2020

Background

Antibiotics have been one of the most important life-saving medical developments of the last century. However, they are not effective against all types of bacteria (so-called intrinsic resistance). In addition, some bacteria can develop tolerance to certain antibiotics or develop ways to break them down (so-called extrinsic resistance). In either case, if these go on to cause an infection it can be much more difficult to treat resistant bacteria. If the use of antibiotics remains unchecked, common infections will become more dangerous, and surgical procedures where antibiotics are used will become more difficult to perform safely. Antimicrobial-resistant infections already cause illness and death in patients, and also disrupt care in hospitals. Reducing the use of antibiotics where they are not necessary will help keep antibiotics working in the future. In recognition of this, the NI Department of Health (then the Department of Health, Social Services and Public Safety) published a five year Strategy for Tackling Antimicrobial Resistance (STAR 2012-2017) in 2012[1]. One of the key objectives of STAR was "to establish and maintain systems to monitor antimicrobial usage and surveillance of resistance". This report is a product of the systems that have been established in response to this goal.

In 2019 NI Department of Health, the Department of Agriculture, Environment and Rural Affairs, and the Food Standards Agency in conjunction with professionals in associated agencies have published an updated five-year action plan, developed in a whole system type approach to continue to tackle antimicrobial resistance (ONE HEALTH 2019-2024) [2]. The tasks of preventing and reducing antimicrobial resistant infections, and reducing antimicrobial consumption in Northern Ireland are led by the Strategic Antimicrobial Resistance and Healthcare-associated Infection (SAMRHAI) group, which includes representatives responsible for animal and environmental as well as human health. For translating policy and strategy into action for human health, the Public Health Agency leads a multi-agency group, the Healthcare-associated Infection and Antimicrobial Stewardship Improvement Board, which has a number of themed subgroups that are responsible for regional efforts to reduce harm from antimicrobial use and resistance in different settings.

This report is issued under the auspices of the Improvement Board and is divided into two major sections. The first describes trends in antibiotic resistance in Northern Ireland. Selected combinations of bacteria and antibiotics in line with those identified as key indicators as part of the UK Antimicrobial Resistance strategy [2] were chosen. In addition, bacteria-antibiotic combinations included in the English surveillance programme for antimicrobial utilisation and resistance (ESPAUR) report [3] were also chosen.

The second section describes the trends in antibiotic consumption in Northern Ireland. Antibiotic consumption is the key driver for the emergence of resistance in healthcare. Antibiotics are prescribed across a range of settings including primary care (GP), secondary care (hospitals) and by dentists. In this report, information from primary and secondary care, out-of-hours services and dental care are provided.

The aim of the report is to describe trends in antimicrobial resistance and antibiotic consumption in Northern Ireland. As surveillance data is 'information for action', this report will inform and drive best practice in antimicrobial prescribing.

Method

Antibiotic resistance

Data sources

Testing for bacteria in human specimens and their susceptibility to antibiotics is conducted in the laboratories of the five Health and Social Care Trusts in Northern Ireland. Infections that meet certain criteria, usually the most severe that occur in the blood (bacteraemias), are reported voluntarily to the Public Health Agency's CoSurv Information System directly from each Trust's laboratory. The resistance data included in this report includes selected bacteraemias that were reported to the PHA between 2009 - 2018 (presented by calendar year).

Detections of carbapenemase-producing organisms (CPOs) are reported to the PHA as part of a voluntary reporting service. In cases where a microbiology laboratory suspects a CPO, the specimen is submitted to Public Health England's (PHE) Antimicrobial Resistance and Healthcare Associated Infections (AMRHAI) reference unit for investigation. Most recently, some health and social care trusts have developed the capacity to perform this function locally. For the purposes of this report however, the focus will be on carbapenemase-producing enterobacteriaceae (CPE) only.

Definitions

The term "antimicrobial" refers to drugs used to treat infections caused by a range of microbes including; bacteria, viruses, fungi and parasites. While this term is used throughout the report, the data presented only reflects antibiotics which are utilised to treat bacterial infections.

Hospital microbiology laboratories report antimicrobial susceptibility test results "susceptible", "intermediate" or "resistant". For the purpose of this report, antibiotic susceptibility test results reported as "intermediate" or "resistant" were combined and presented as "non-susceptible". The terms "non-susceptible" and "resistant" are used interchangably throughout the report when refering to "intermediate" or "resistant" antibiotic susceptibility tests. For analysis of resistance to more than one antibiotic, multidrug resistance (MDR) was defined as acquired non-susceptibility to at least one agent in three or more antimicrobial classes.

Antibiotic consumption

Data sources

Consumption data for primary and secondary care was obtained using the data submitted to the European Antimicrobial Consumption Surveillance Network (ESAC-Net). The primary care antimicrobial consumption data were extracted from the Electronic Prescribing Database by the Health and Social Care Board. The data includes all Health and Social Care, general practitioner prescribing in practices and out-of-hours centres; all nurse, pharmacy and allied health professional HSC prescribing; and dental prescribing. The secondary care antimicrobial consumption data were extracted by each Trust's JAC Medicines Management System and aggregated for all five Trusts to give Northern Ireland totals. It was not possible to analyse at the level of inpatient or outpatient. The data for both settings are available from 2014 - 2018 and are presented by calendar year.

Data from Out-of-Hours settings was extracted from two sources; the JAC Medicines Management System and a private pharmaceutical company responsible for over-labelling of antibiotic packs.

Definitions

The classification of antibiotic used is based on the anatomical therapeutic chemical (ATC) classification system, using the WHO defined daily doses (DDD) for each drug and where grouped, this has been done according to Kucer's "The Use of Antibiotics" (6th edition)[4]. The data for both settings in this report include ATC classification groups J01, A07 and P01, please refer to Appendix 2 for specific inclusions.

Denominator

Mid-year population estimates for 2014-2018 were obtained from the Northern Ireland Statistics and Research Agency (NISRA) and used to express DDD's per 1,000 inhabitants per day. Hospital activity and occupancy statistics were obtained from data published by the Department of Health.

Results

Antibiotic resistance

E. coli bacteraemia

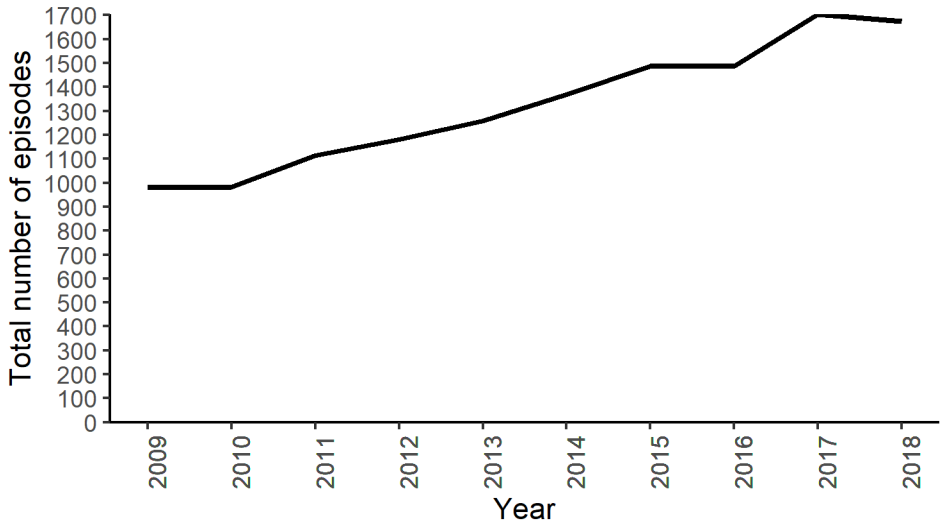


Figure 1: The number of *E. coli* bacteraemias reported to the Public Health Agency, 2009 - 2018

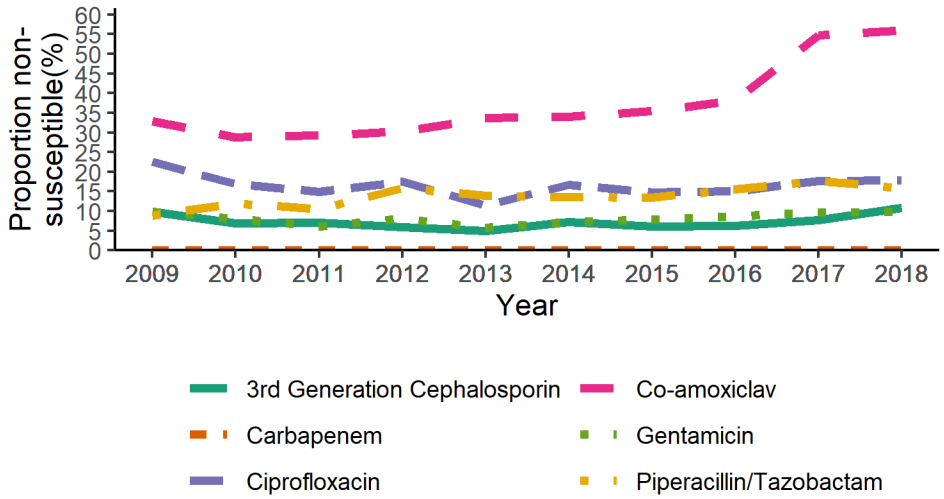


Figure 2: The proportion of *E. coli* bacteraemias resistant to selected antibiotics in NI, 2009 - 2018

The number of *E. coli* bacteraemias has decreased from 1703 in 2017 to 1675 cases in 2018 (Figure 1). The proportion of isolates tested against key antibiotics during 2018 is

shown in Appendix 3.

The overall proportion of *E. coli* bacteraemias resistant to selected antibiotics from 2017 to 2018 has remained stable (19.2%). Non-suseptibility to co-amoxiclav and third generation cephalosporins has increased between 2017 and 2018 (54.7% to 55.9% and 7.7% to 10.8% respectively). Meanwhile non-suseptibility to piperacillin/tazobactam has decreased over the time period (17.7% to 15.9%). The proportion of isolates resistant to gentamicin and ciprofloxacin has remained relatively stable from 2017 - 2018 (9.6% and 9.8% to 17.7% to 17.9% respectively). There were no *E. coli* isolates resistant to carbapenems detected from 2017 to 2018 (Figure 2).

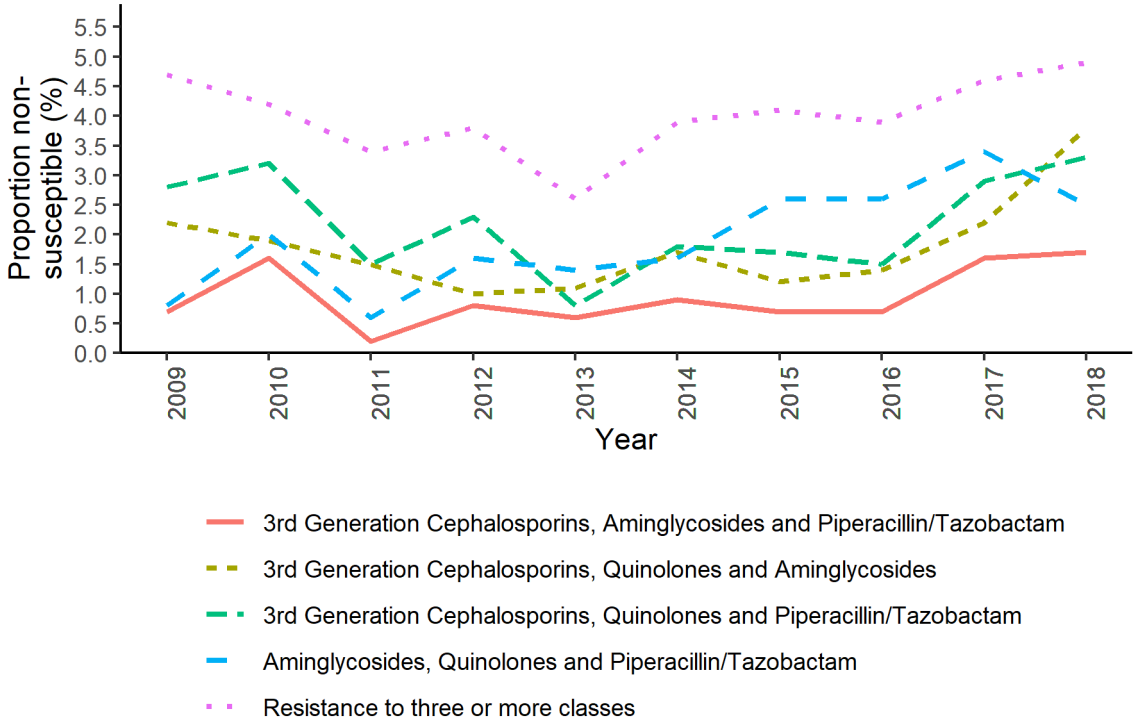


Figure 3: The proportion of *E. coli* bacteraemias reported to the Public Health Agency with multi-drug resistance, 2009 -2018

The proportion of *E. coli* bacteraemias showing multi-resistance remained relatively stable between 2017 to 2018 (4.6% to 4.9%). Within the combination of antibiotic classes, the highest proportion of non-suseptibility in 2018 was in 3rd generation cephalosporins, quinolones and aminglycosides (3.8%), there was a slight increase in comparison to 2017 (2.2%). The lowest proportion in 2018 was observed for third-generation cephalosporins, aminoglycosides and piperacillin/tazobactam (1.7%), again remaining relatively stable in comparison to 2017 (1.6%) (Figure 3).

K. pneumoniae bacteraemia

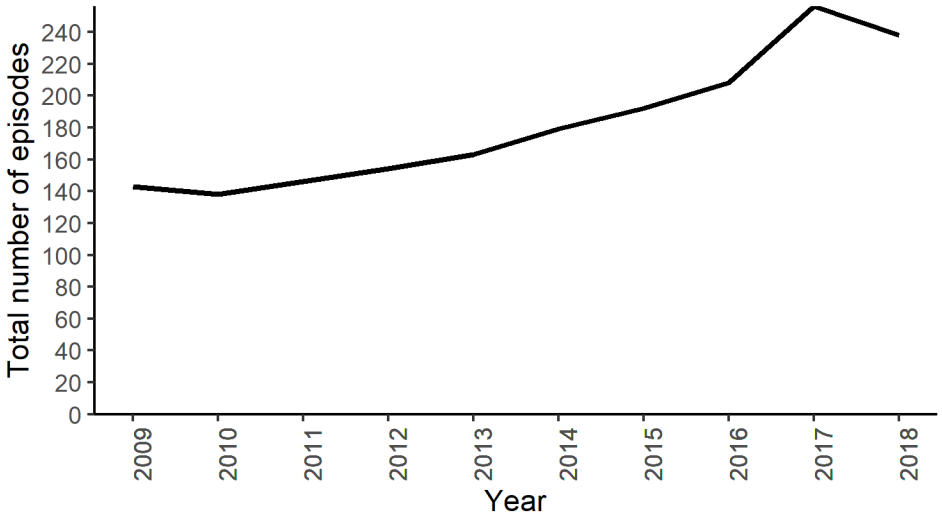


Figure 4: The number of *K. pneumoniae* bacteraemias reported to the Public Health Agency, 2009 -2018

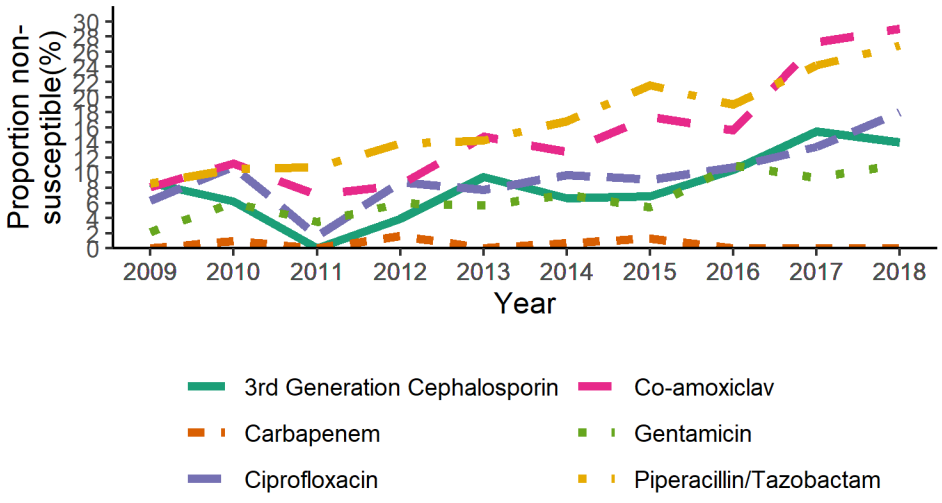


Figure 5: The proportion of *K. pneumoniae* bacteraemias resistant to selected antibiotics in NI, 2009 - 2018

The number of *K. pneumoniae* bacteraemias has decreased from 256 cases in 2017 to 238 cases in 2018 (Figure 4). The proportion of isolates tested against key antibiotics during 2018 is shown in Appendix 3.

The overall proportion of *K. pneumoniae* bacteraemias resistant to selected antibiotics has increased from 2017 to 2018 (14.8% to 16.5%). In relation to selected antibiotics the following have increased from 2017 to 2018; ciprofloxacin (13.5% to 18%); gentamicin (9.4% to 11.1%); co-amoxiclav (27.2% to 29.1%) and piperacillin/tazobactam (24.2% to 26.8%). However resistance to cephalosporins decreased over the time period (15.5% to 14%). There were no isolates resistant to carbapenems detected from 2017 and 2018, with detections remaining sporadic between 2009 and 2018 (Figure 5).

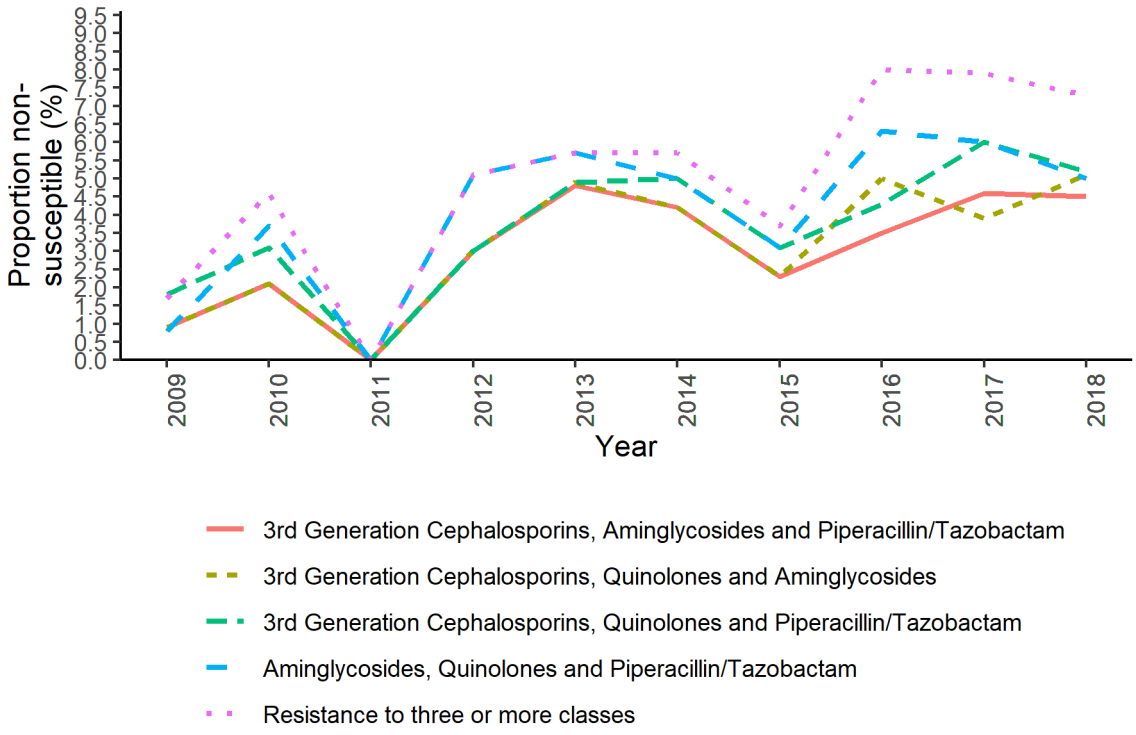


Figure 6: The proportion of *K.pneumoniae* bacteraemias reported to the Public Health Agency with multi-drug resistance, 2009 -2018

The proportion of *K. pneumoniae* bacteraemias showing multi-resistance remained relatively stable within the named antibiotic combinations from 2017 to 2018 (7.9% to 7.3%). Within the named combinations of antibiotic classes, the highest proportion of resistance was observed in third generation cephalosporins, quinolones and piperacillin/tazobactam (5.2%). The lowest was observed in third generation cephalosporins, aminglycosides and

piperacillin/Tazobactam, which remained relatively stable in comparison to 2017 (4.6% to 4.5%)(Figure 6).

K. oxytoca bacteraemia

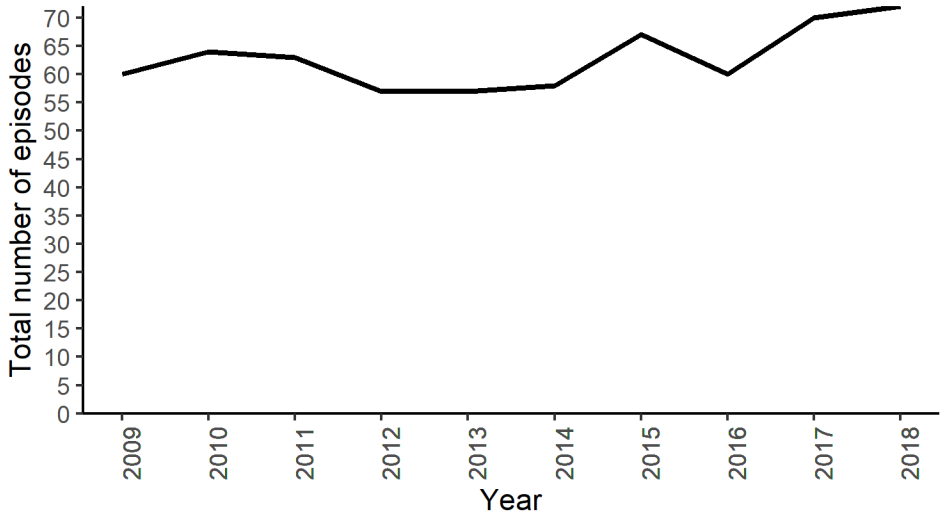


Figure 7: The number of *K. oxytoca* bacteraemias reported to the Public Health Agency, 2009 -2018

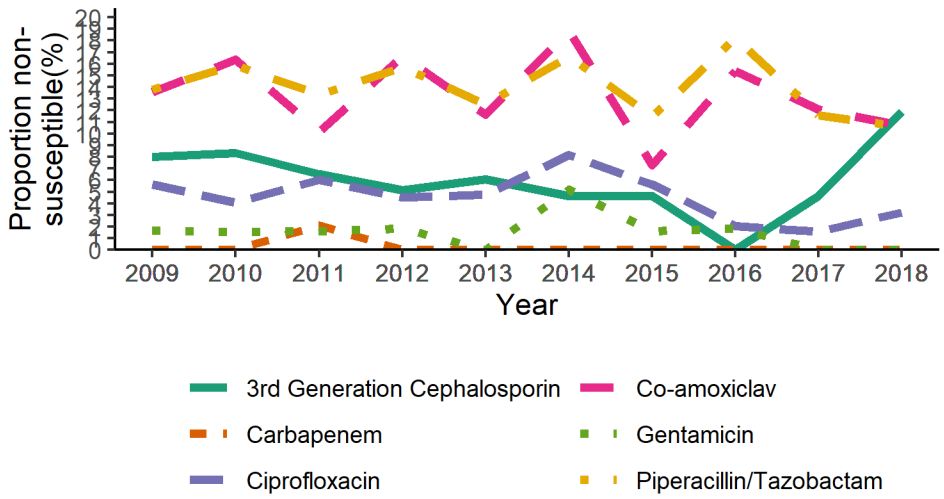


Figure 8: The proportion of *K. oxytoca* bacteraemias resistant to selected antibiotics in NI, 2009 - 2018

The number of *K. oxytoca* bacteraemias has increased slightly from 70 cases in 2017 to 72 cases in 2018 (Figure 7). The proportion of isolates tested against key antibiotics during 2018 is shown in Appendix 3.

The overall proportion of *K. oxytoca* bacteraemias resistant to selected antibiotics over the period has increased slightly from 2017 to 2018 (4.9% to 5.7% repectively). Within the

combination of antibiotic classes- when comparing 2017 to 2018- an increase in resistance was observed for; third generation cephalosporins (4.7% to 11.9%) and ciprofloxacin (1.6% to 3.2%). There was a decrease in the proportion of isolates resistant for both co-amoxiclav (12.1% to 10.7%) and piperacillin/tazobactam (11.6% to 10.6%). There was no resistance to carbapenems or gentamicin detected over the period (Figure 8).

Pseudomonas species bacteraemia

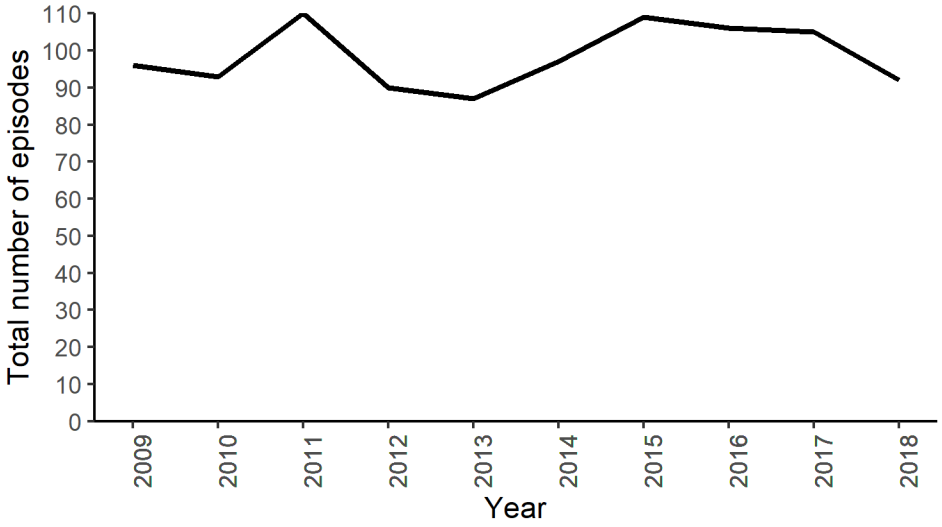


Figure 9: The number of Pseudomonas species bacteraemias reported to the Public Health Agency, 2009 - 2018

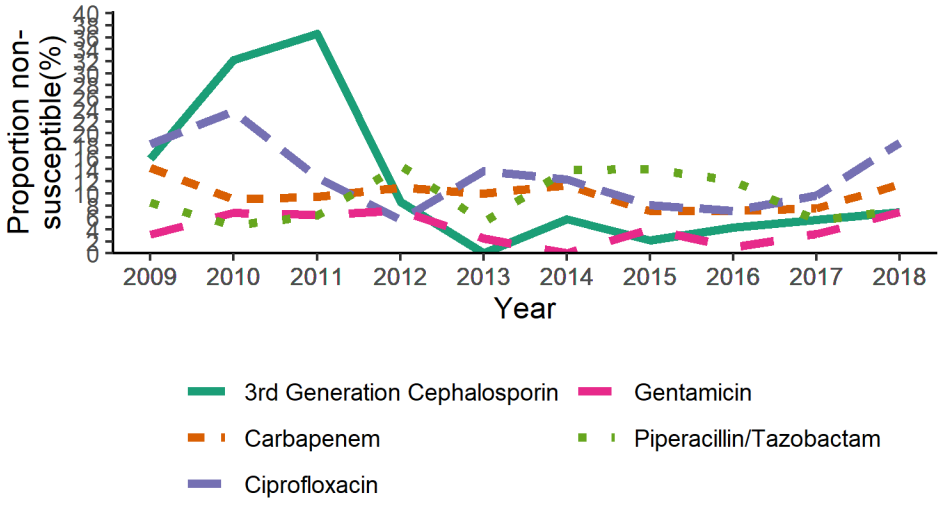


Figure 10: The proportion of Pseudomonas species bacteraemias resistant to selected antibiotics in NI, 2009 - 2018

The number of *Pseudomonas species* bacteremias has decreased from 105 cases in 2017 to 92 cases in 2018 (Figure 9). The proportion of isolates tested against key antibiotics during 2018 is shown in Appendix 3.

The overall proportion of *Pseudomonas species* bacteraemias resistant to selected antibiotics has increased from 2017 to 2018 (6.3% to 10.2% respectively). Within the selected antibiotic classes increases were observed for pipercillin/tazobactam (5.5% to 7.2%), third generation cephalosporins (5.6% to 6.9%), carbapenems (7.5% to 11.5%) and gentamicin (3.2% to 6.9%). The proportion of *pseudomonas* bacteremias resistant to ciprofloxacin has almost doubled from 2017 to 2018 (9.7% to 18.4% respectively) (Figure 10).

S. aureus bacteraemia

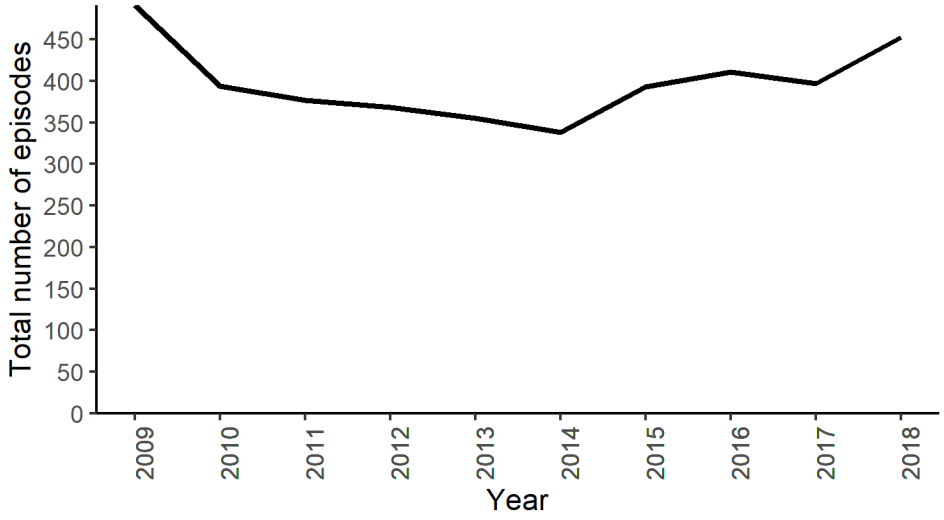


Figure 11: The number of *S. aureus* bacteraemias reported to the Public Health Agency, 2009 - 2018

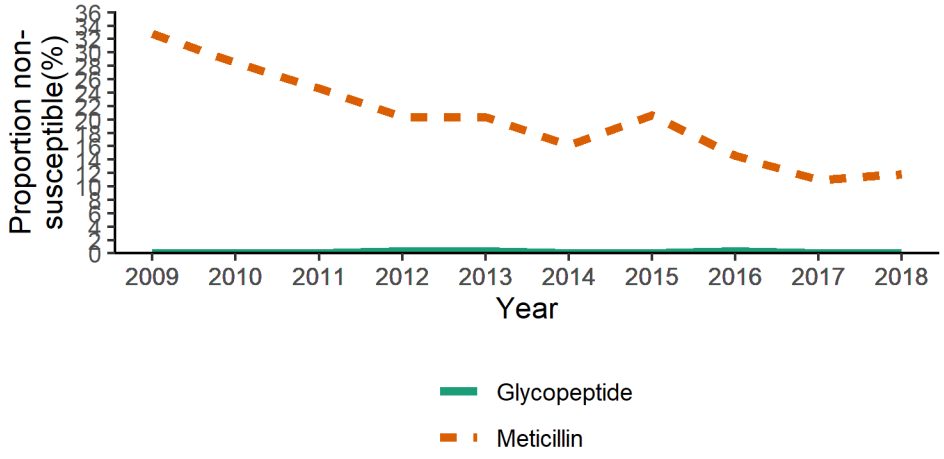


Figure 12: The proportion of *S. aureus* bacteraemias resistant to selected antibiotics in NI, 2009 - 2018

The number of *S. aureus* bacteraemias increased from 397 in 2017 to 453 in 2018 (Figure 11). The proportion of isolates tested against key antibiotics during 2018 is shown in Appendix 3. The proportion of *S. aureus* that are resistant to meticillin (MRSA) has been decreasing over the last 5 years, with a low of 10.9% in 2017. However a slight increase

was observed between 2017 and 2018 (10.9% to 11.9%). There was no resistance to glycopeptides (eg. Vancomycin or Teicoplanin) dectected during the period (Figure 12).

Enterococcus species bacteraemia

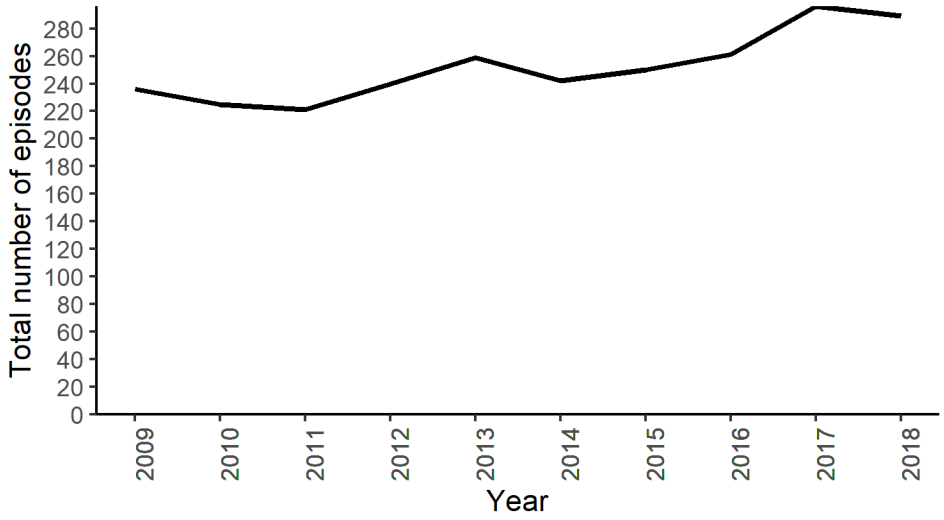


Figure 13: The number of Enterococcus species bacteraemias reported to the Public Health Agency, 2009 -2018

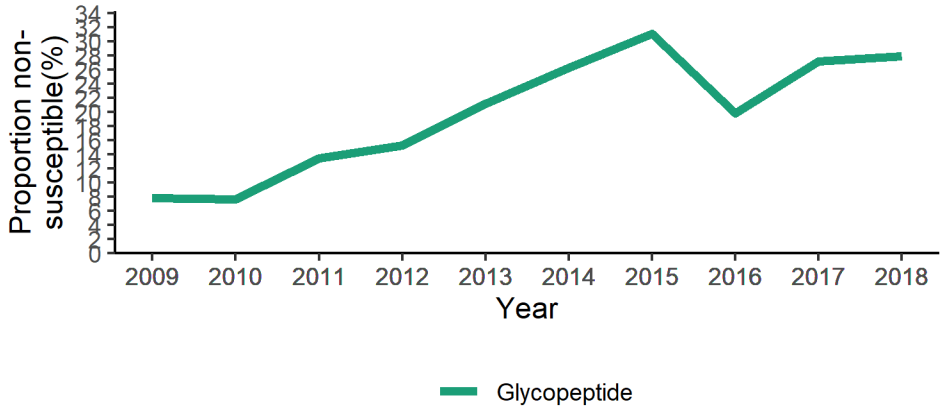


Figure 14: The proportion of Enterococcus species bacteraemias resistant to selected antibiotics in NI, 2009 -2018

The number of *Enterococcus species* bacteraemias has decreased slightly from 296 cases in 2017 to 289 in 2018 (Figure 13). The proportion of *Enterococcus species* bacteraemias resistant to glycopeptides remained relatively stable during 2017 to 2018 (27.2% to 27.9%) (Figure 14).

S. pneumoniae bacteraemia

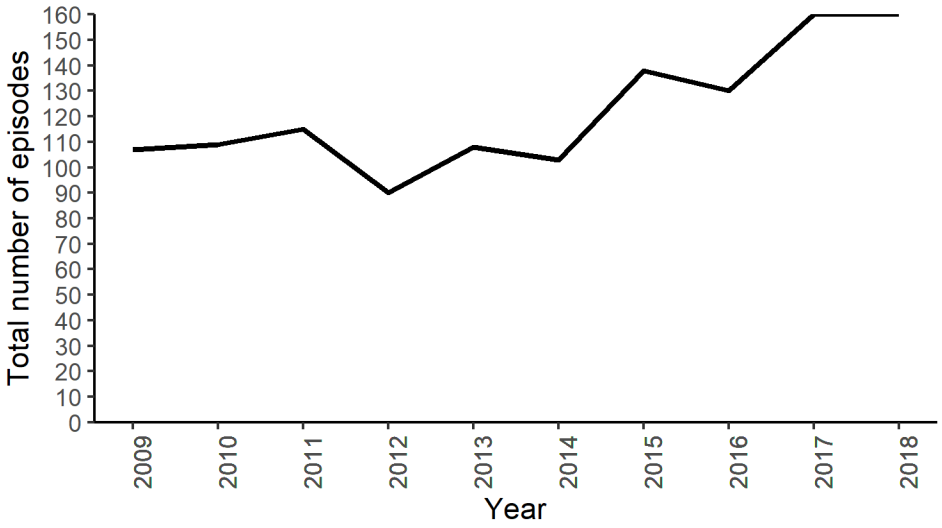


Figure 15: The number of *S. pneumoniae* bacteraemias reported to the Public Health Agency, 2009 -2018

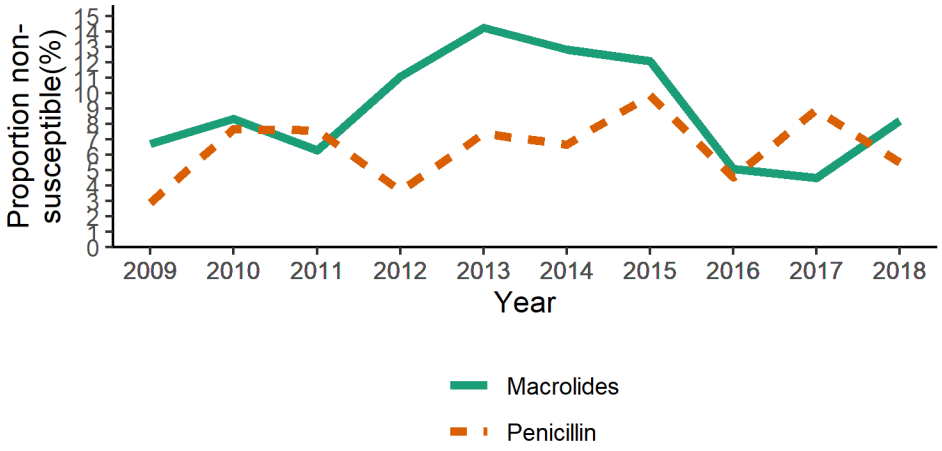


Figure 16: The proportion of *S. pneumoniae* bacteraemias resistant to selected antibiotics in NI, 2009 -2018

The number of *S. pneumoniae* bacteraemias has remained stable from 2017 to 2018 (160 cases) (Figure 15). The proportion of isolates tested against key antibiotics during 2018 is shown in Appendix 3. While the proportion of *S. pneumoniae* resistant to macrolides has almost doubled during 2017 to 2018 (4.5% to 8.2%). The proportion non-suseptible to penicillin has decreased (8.9% to 5.5%) (Figure 16).

Acinetobacter species bacteraemia

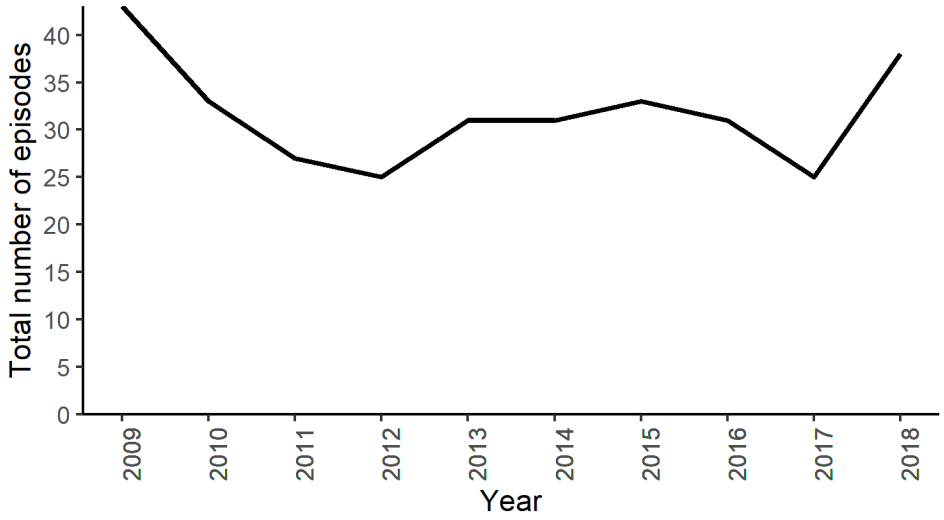


Figure 17: The number of Acinetobacter species bacteraemias reported to the Public Health Agency, 2009 - 2018

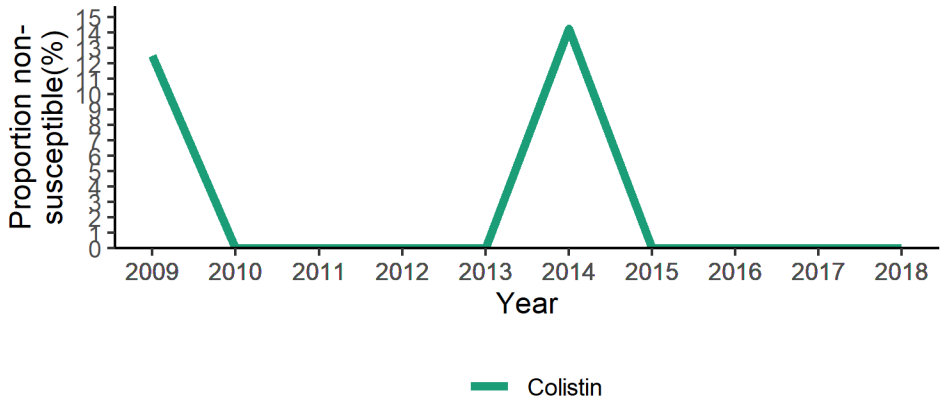


Figure 18: The proportion of Acinetobacter species bacteraemias resistant to selected antibiotics in NI, 2009 - 2018

The number of *Acinetobacter species* bacteraemias increased from 25 cases in 2017 to 38 cases in 2018 (Figure 17). During 2017, one isolate was tested against colistin, while there were no tests against colistin in 2018. Resistance to colistin among *Acinetobacter species* has remained at zero (Figure 18).

Carbapenamase- Producing Enterobacteriaceae

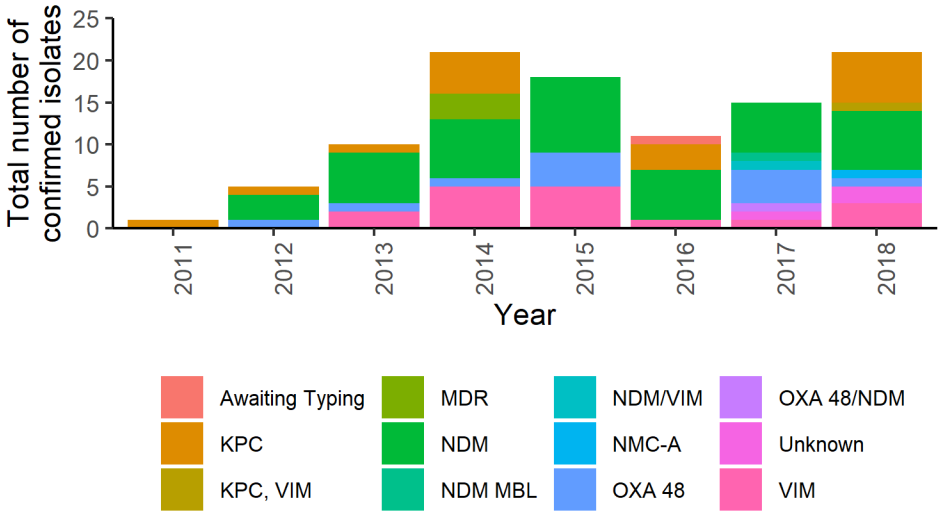


Figure 19: Carbapenamase activity among CPE confirmed isolates, 2011 - 2018

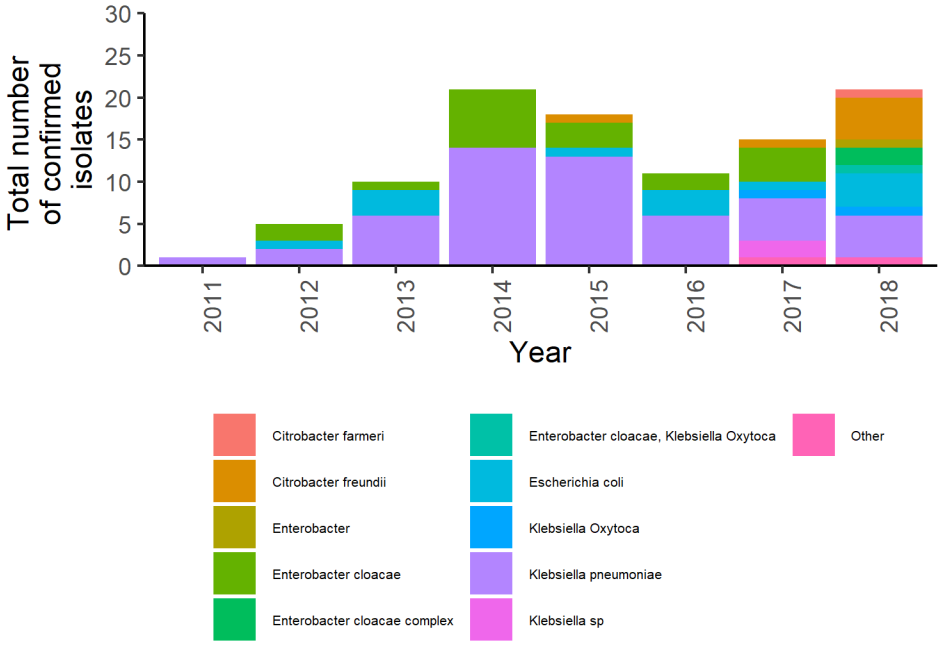


Figure 20: Carbapenamase- producing enterobacteriaceae confirmed isolates, 2011 - 2018

The number of CPE voluntarily reported to the PHA increased from 15 episodes in 2017 to 21 episodes during 2018 (Figure 19). New Delhi Metallo-Beta-lactamase (NDM) was the most common reported resistance mechanism from 2017 to 2018 (7 episodes) (Figure 19). The most commonly reported CPE between 2017 and 2018 was *Citrobacter freundii* and *Klebsiella pneumoniae* (5 episodes, respectively) (Figure 20).

Antibiotic resistance in *Neisseria gonorrhoeae*

Gonorrhoea has been identified as at risk of becoming an untreatable disease due to the emergence of antimicrobial resistance to successive standard treatments. This has necessitated changes to recommended antibiotic prescribing. In the UK, current recommended treatment guidelines include ceftriaxone with azithromycin, along with routine test of cure [5]. Third-generation cephalosporins are the last remaining effective antibiotics but reports of treatment failures and increasing minimum inhibitory concentrations (MIC) levels have raised concerns that they will no longer be a suitable treatment option [6]. Since 2015, NI has participated in the European Gonococcal Antimicrobial Surveillance Programme (Euro-GASP) [7] through the Royal Victoria Hospital, Belfast. This GUM clinic captured 61% of all gonorrhoea diagnoses made during 2017. In 2017, gonorrhoea diagnoses accounted for 12% (679/5,728) of all new STI diagnoses made in NI GUM clinics. In 2018, 30 N. gonorrohoeae isolates were cultured and sent to Public Health England for inclusion in EuroGASP, bringing the total number of isolates submitted to EuroGASP by NI since 2015 to 99.

Over the period 2015 to 2018, isolates submitted to the EuroGASP programme have displayed similar resistance patterns to isolates from the rest of the UK, with 9.1% resistant to azithromycin and 0% resistant to ceftriaxone. In 2018 two (6.7%) isolates were resistant to azithromycin, and none were resistant to ceftriaxone. The full report for this surveillance programme will be published on the PHA website.

Antibiotic consumption

Rates of antibiotic consumption by healthcare setting

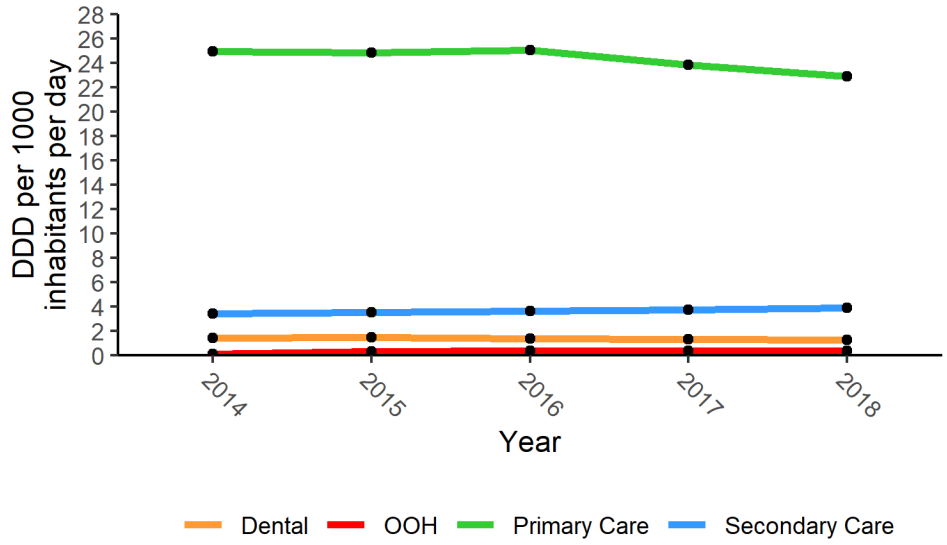


Figure 21: Total antibiotic consumption, expressed as DDD per 1000 inhabitants per day, NI, 2014-2018

Note: The use of new 2019 DDDs

The total consumption of antibiotics decreased from 29.33 per 1000 inhabitants per day in 2017 to 28.5 per 1000 inhabitants per day in 2018. The majority of antibiotic consumption in 2018took place in the primary care setting (80.4%) while the proportion of total antibiotic consumption accounted for by out-of-hours and dental settings remained relatively low and stable across the reporting period as a whole (0.4% and 4.8% in 2014, to 1.4% and 4.5 % in 2018, respectively). The proportion of total antibiotic consumption accounted for by secondary care increased slightly from 11.4% in 2017 to 13.7% in 2018 (Figure 21).

The proportion of antibiotic consumption accounted for by primary care has however decreased between 2017 and 2018 (from 81.3% to 80.4%). Similarly, the overall rate of prescribing in primary care has decreased from 23.84 per 1000 inhabitants per day in 2017 to 22.91 per 1000 inhabitants per day in 2018. The rate of antibiotic consumption in secondary care has increased slightly (3.75 per 1000 inhabitants per day during 2017 to 3.91 per 1000 inhabitants per day in 2018), while the rate of prescribing in out-of-hours and dental settings remained relatively stable (0.4 and 1.33 in 2017 to 0.4 and 1.27 per 1000 inhabitants per day in 2018, respectively).

Rates of antibiotic consumption in Secondary care

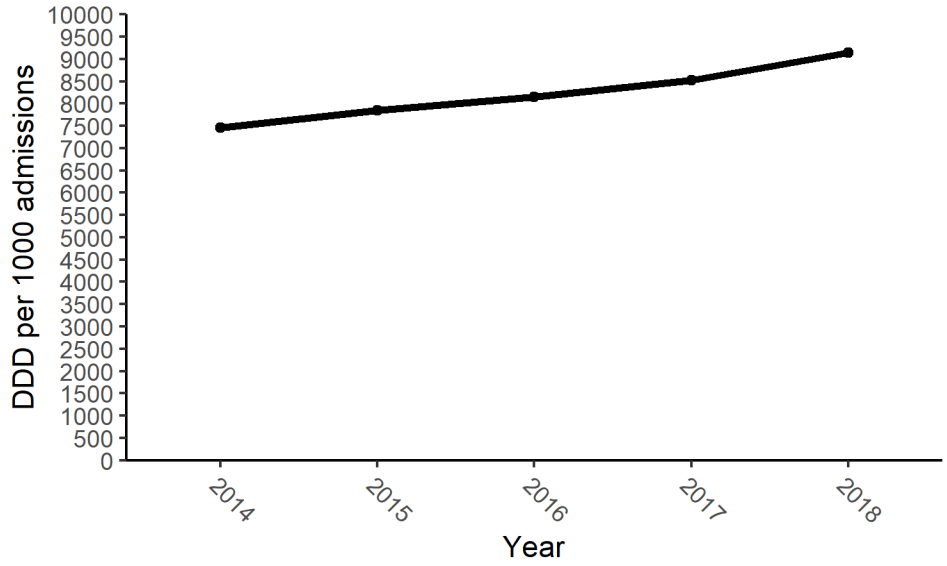


Figure 22: Total antibiotic consumption, expressed as DDD per 1000 admissions, NI, 2014-2018

There has been a gradual year on year increase in the rate of secondary care antibiotic consumption expressed as DDD per 1000 admissions, with rates of antibiotic consumption in secondary care increasing from 8526 in 2017 to 9138 DDD per 1000 admissions in 2018 (Figure 22).

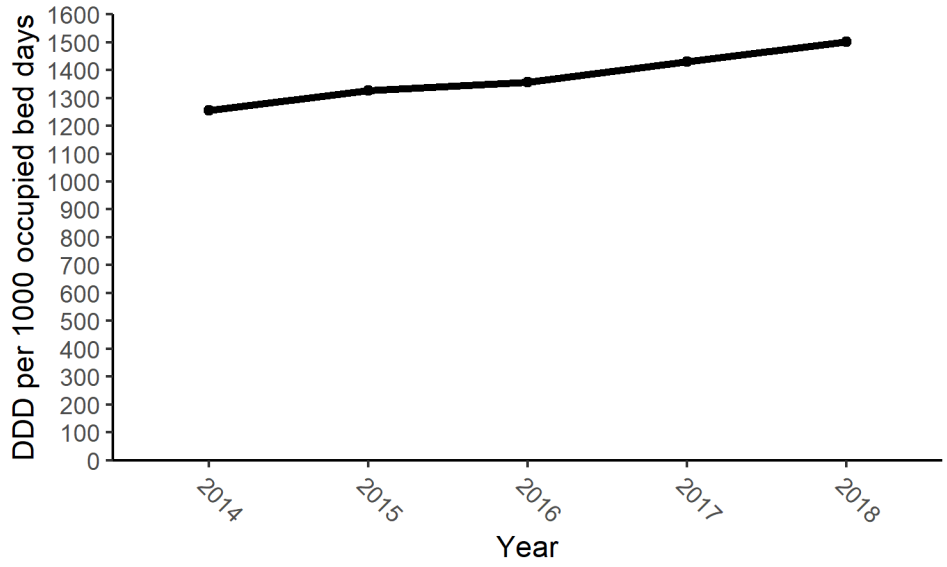


Figure 23: Total antibiotic consumption, expressed as DDD per 1000 occupied bed days, NI, 2014-2018

The rate of secondary care antibiotic consumption per 1000 occupied bed days has been gradually increasing. The rate of antibiotic consumption per 1000 occupied bed days increased from 1431 in 2017 to 1502 DDD per 1000 occupied beddays in 2018 (Figure 23).

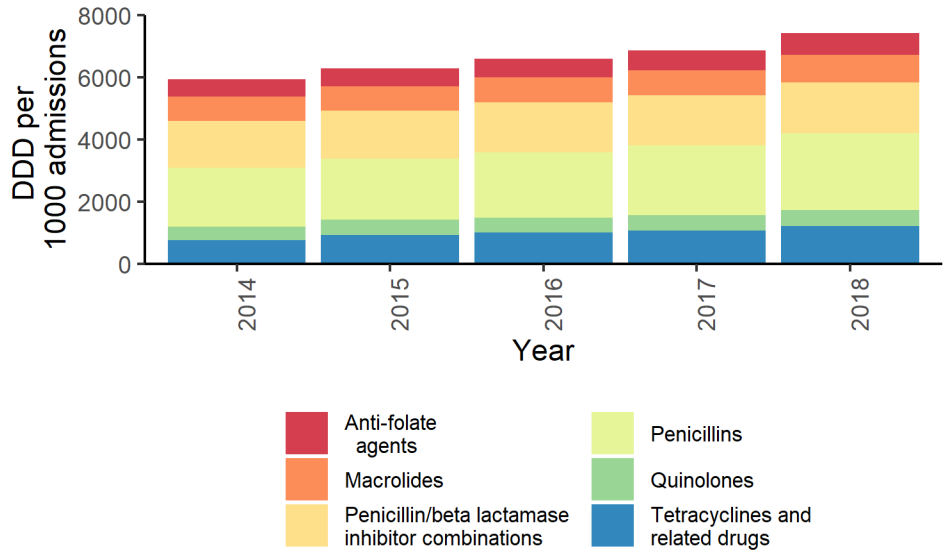
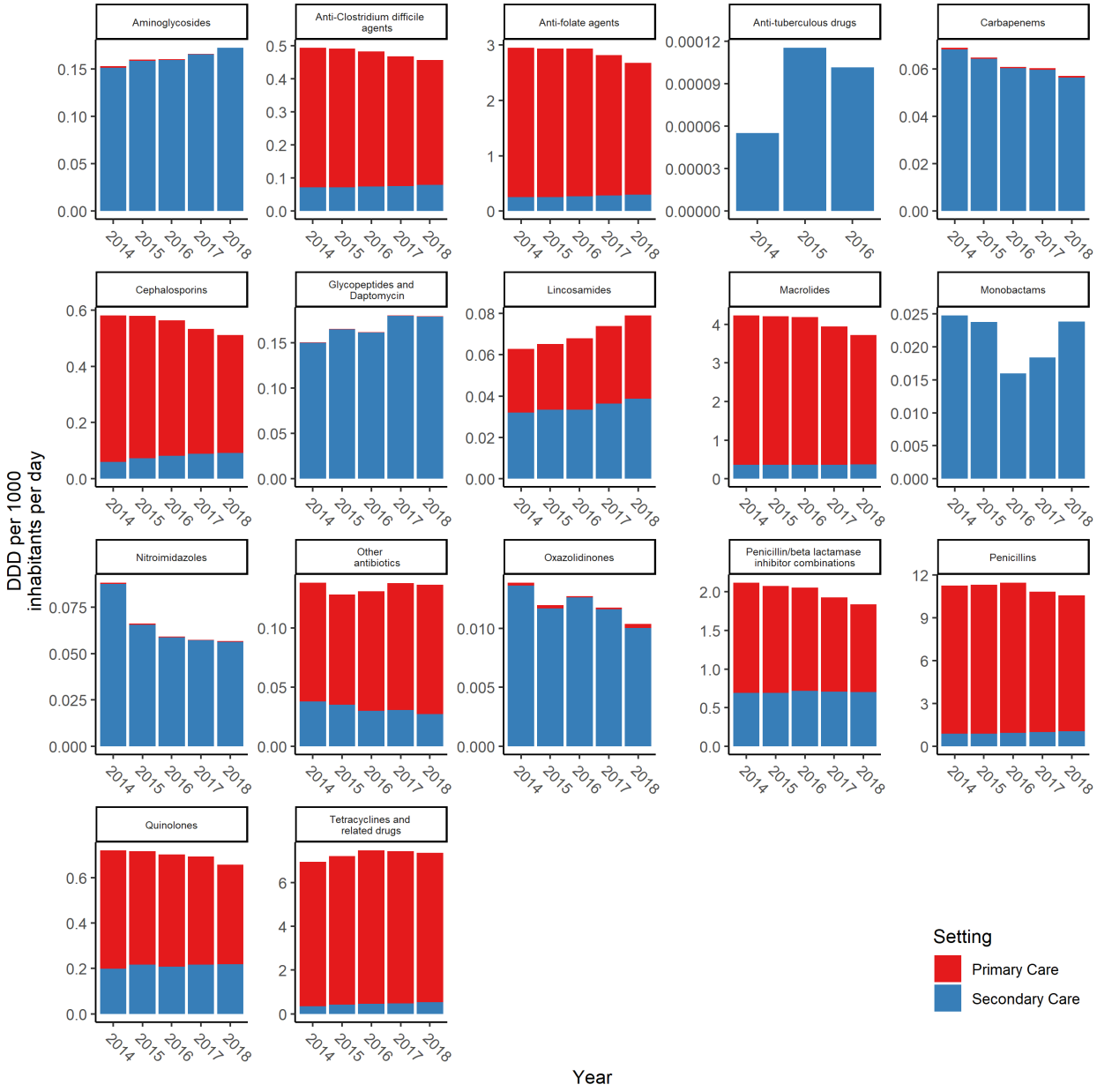


Figure 24: Total antibiotic consumption by key agents in secondary care, expressed as DDD per 1000 admissions, NI, 2014-2018

This figure shows the top 6 key agents prescribed in secondary care. In 2018, the highest rates of antibiotic consumption were for penicillins, which increased from 2248 in 2017 to 2469 DDD per 1000 admissions in 2018. Penicillin/beta lactamase inhibitor combinations have increased from 1605 to 1642 DDD per 1000 admissions and tetracyclines and related drugs have also increased from 1081 in 2017 to 1223 DDD per 1000 admissions in 2018 (Figure 24).

Antibiotic consumption by key agents



Note: differing scales on y-axis

During 2018, the most frequently used antibiotics in both primary and secondary care in NI were penicillins (38.7% and 27% respectively), tetracyclines and related drugs (27.8% and 13.4% respectively) and macrolides (13.6% and 9.6% respectively) (**??**).

Antibiotic consumption by class and individual antibiotics

Penicillins

Table 1: Total rate of Penicillins expressed as DDD per 1000 inhabitants per day, NI, 2014-2018.

Year	Class	DDD	Population	rate
2014	Penicillins	7546729	1840498	11.23
2015	Penicillins	7647854	1851621	11.32
2016	Penicillins	7775285	1862137	11.44
2017	Penicillins	7381358	1870834	10.81
2018	Penicillins	7252387	1881641	10.56

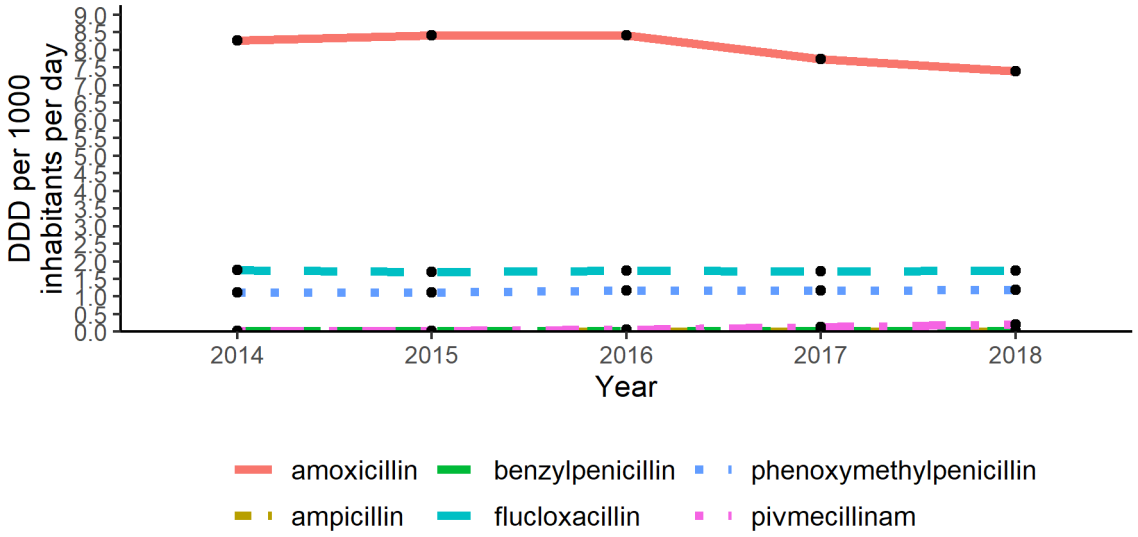


Figure 25: Consumption of most commonly used penicillins expressed per 1000 inhabitants per day, NI, 2014 -2018

The figure represents the top six antimicrobial agents used in the Penicillins class. Penicillins accounted for 37.1% of total antibiotic consumption in 2018. The rate of penicillin consumption has slightly decreased from 10.81 in 2017 to 10.56 per 1000 inhabitants per day in 2018. The highest rate was for amoxicillin, which has remained relatively stable between 2017 and 2018 (7.39 DDD per 1000 inhabitants per day in 2018) (Figure 25).

Cephalosporins

Table 2: Total rate of Cephalosporins expressed as DDD per 1000 inhabitants per day, NI, 2014-2018.

Year	Class	DDD	Population	rate
2014	Cephalosporins	390760	1840498	0.58
2015	Cephalosporins	391763	1851621	0.58
2016	Cephalosporins	382856	1862137	0.56
2017	Cephalosporins	363775	1870834	0.53
2018	Cephalosporins	351269	1881641	0.51

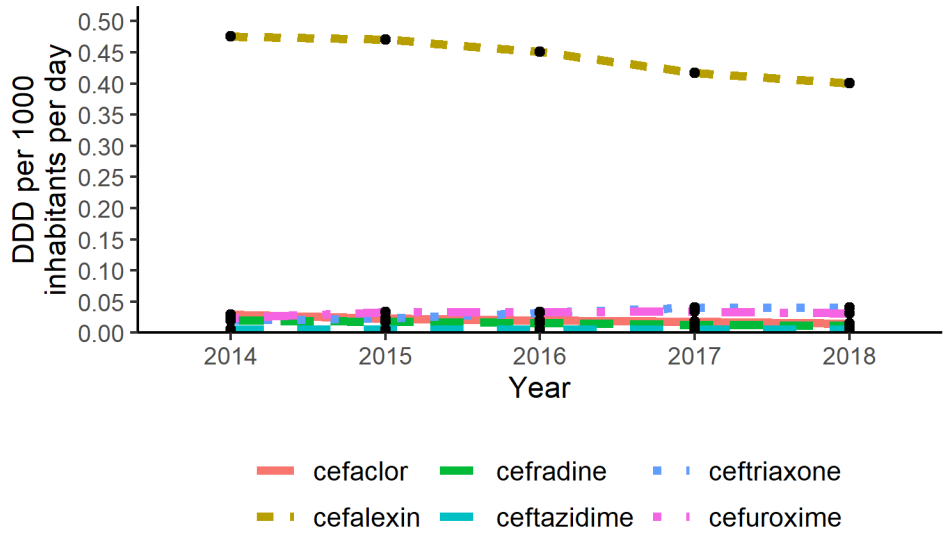


Figure 26: Consumption of most commonly used cephalosporins expressed per 1000 inhabitants per day, NI, 2014 -2018

The figure represents the top six agents used in the Cephalosporins class. In 2018 the overall rate of cephalosporin consumption decreased slightly from 0.53 DDD per 1000 inhabitants per day in 2017 to 0.51 DDD per 1000 inhabitants per day in 2018. The highest rate was for cefalexin, which has decreased slightly between 2017 and 2018 (0.42 DDD per 1000 inhabitants per day to 0.4 DDD per 1000 inhabitants per day) (Figure 26).

Tetracyclines and related drugs

Table 3: Total rate of Tetracyclines and related drugs consumption expressed as DDD per 1000 inhabitants per day, NI, 2014-2018.

Year	Class	DDD	Population	rate
2014	Tetracyclines and related drugs	4675462	1840498	6.96
2015	Tetracyclines and related drugs	4874348	1851621	7.21
2016	Tetracyclines and related drugs	5085295	1862137	7.48
2017	Tetracyclines and related drugs	5077903	1870834	7.44
2018	Tetracyclines and related drugs	5057579	1881641	7.36

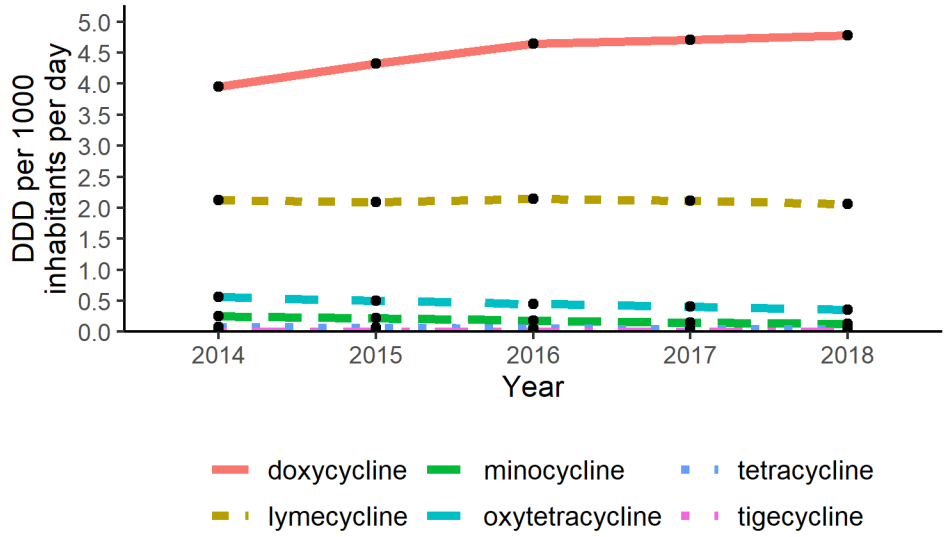


Figure 27: Consumption of most commonly used tetracyclines and related drugs[1] expressed per 1000 inhabitants per day, NI, 2014 -2018

The figure represents the top six agents used in the tetracyclines and related drugs class. Tetracyclines and related drugs accounted for 25.8% of total antibiotic consumption in 2018. The consumption rate of tetracyclines and related drugs has decreased between 2017 to 2018 from 7.44 to 7.36 DDD per 1000 inhabitants per day, respectively. The highest rate was for doxycycline, the rate of which has increased slightly between 2017 and 2018 (4.71 to 4.78 DDD per 1000 inhabitants per day) (Figure 27).

[1]While demeclocycline and lymecycline are not primarily used for their antimicrobial effects they have been included as they can still be considered drivers of resistance.

Quinolones

Table 4: Total rate of Quinolones expressed as DDD per 1000 inhabitants per day, NI, 2014-2018.

Year	Class	DDD	Population	rate
2014	Quinolones	483785	1840498	0.72
2015	Quinolones	483988	1851621	0.72
2016	Quinolones	477462	1862137	0.70
2017	Quinolones	472919	1870834	0.69
2018	Quinolones	451703	1881641	0.66

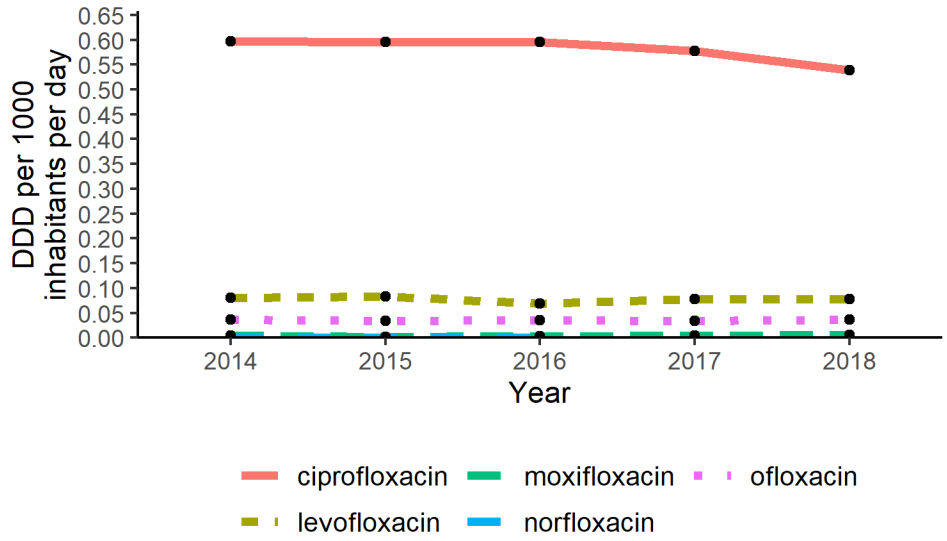


Figure 28: Consumption of most commonly used quinolones expressed per 1000 inhabitants per day, NI, 2014 -2018

The rate of Quinolones consumption has decreased slightly from 0.69 DDD per 1000 inhabitants per day in 2017 to 0.66 DDD per 1000 inhabitants per day in 2018. The highest rate was for ciprofloxacin, the rate of which has decrease slightly between 2017 and 2018 (0.54 to 0.58 DDD per 1000 inhabitants per day) (Figure 28).

Macrolides

Table 5: Total rate of Macrolides expressed as DDD per 1000 inhabitants per day, NI, 2014-2018.

Year	Class	DDD	Population	rate
2014	Macrolides	2844119	1840498	4.23
2015	Macrolides	2844317	1851621	4.21
2016	Macrolides	2843917	1862137	4.18
2017	Macrolides	2695669	1870834	3.95
2018	Macrolides	2554082	1881641	3.72

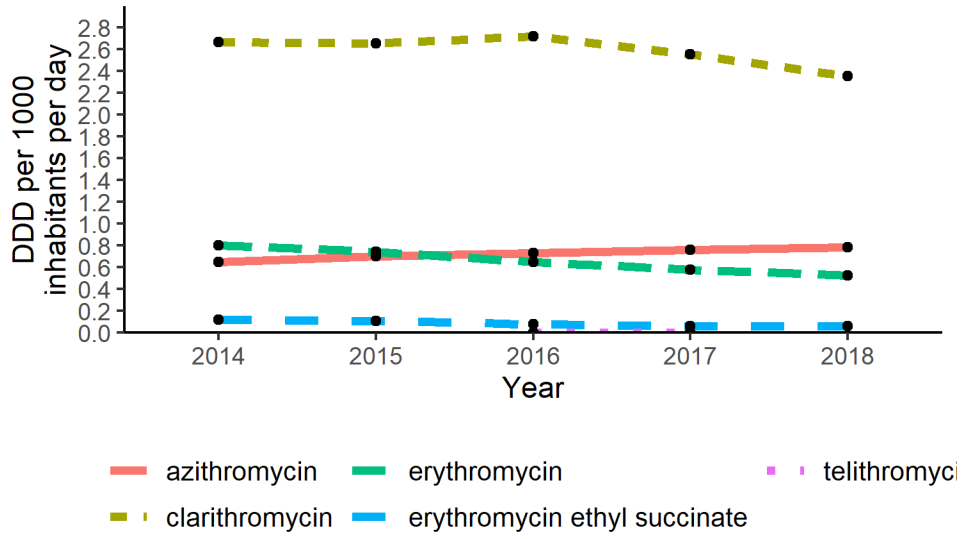


Figure 29: Consumption of most commonly used macrolides expressed per 1000 inhabitants per day, NI, 2014 -2018

Macrolides accounted for 13.1% of total antibiotic consumption in 2018. The rate of Macrolides consumption has decreased from 3.95 DDD per 1000 inhabitants per day in 2017 to 3.72 DDD per 1000 inhabitants per day in 2018. The highest rate was for clarithromycin which decreased from 2.55 DDD per 1000 inhabitants per day in 2017 to 2.35 DDD per 1000 inhabitants per day in 2018 (Figure 29).

Carbapenems

Table 6: Total rate of Carbapenems expressed as DDD per 1000 inhabitants per day, NI, 2014-2018.

Year	Class	DDD	Population	rate
2014	Carbapenems	46292	1840498	0.07
2015	Carbapenems	43779	1851621	0.06
2016	Carbapenems	41383	1862137	0.06
2017	Carbapenems	41207	1870834	0.06
2018	Carbapenems	39126	1881641	0.06

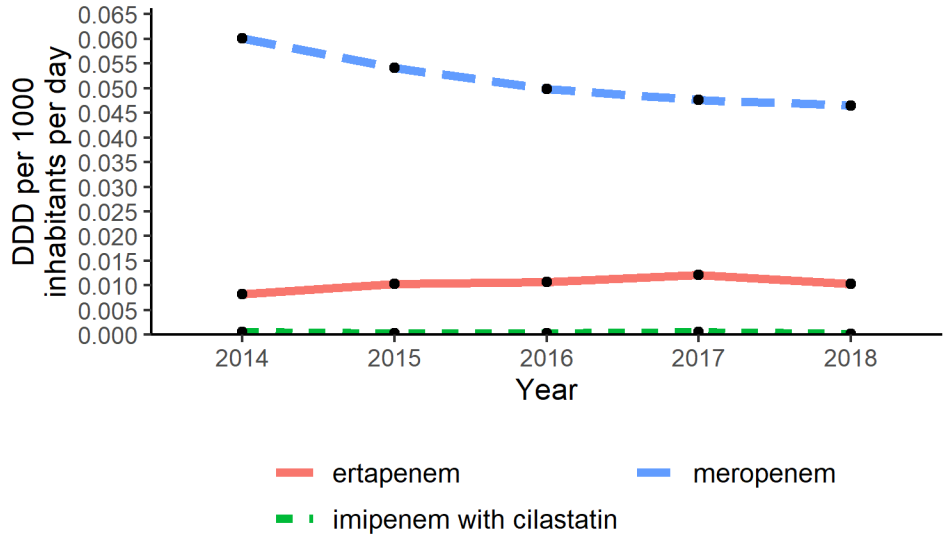


Figure 30: Consumption of most commonly used carbapenems expressed per 1000 inhabitants per day, NI, 2014 -2018

The rate of Carbapenems consumption has remained stable from 2017 to 2018 at 0.06 DDD per 1000 inhabitants per day, respectively. The highest rate was for meropenem, which has remained stable between 2017 and 2018 at 0.05 DDD per 1000 inhabitants per day (Figure 30).

Penicillin/beta lactamase inhibitor combinations

Table 7: Total rate of Penicillin/beta lactamase inhibitor combinations expressed as DDD per 1000 inhabitants per day, NI, 2014-2018.

Year	Class	DDD	Population	rate
2014	Penicillin/beta lactamase inhibitor combinations	1421704	1840498	2.12
2015	Penicillin/beta lactamase inhibitor combinations	1403783	1851621	2.08
2016	Penicillin/beta lactamase inhibitor combinations	1395671	1862137	2.05
2017	Penicillin/beta lactamase inhibitor combinations	1316396	1870834	1.93
2018	Penicillin/beta lactamase inhibitor combinations	1262664	1881641	1.84

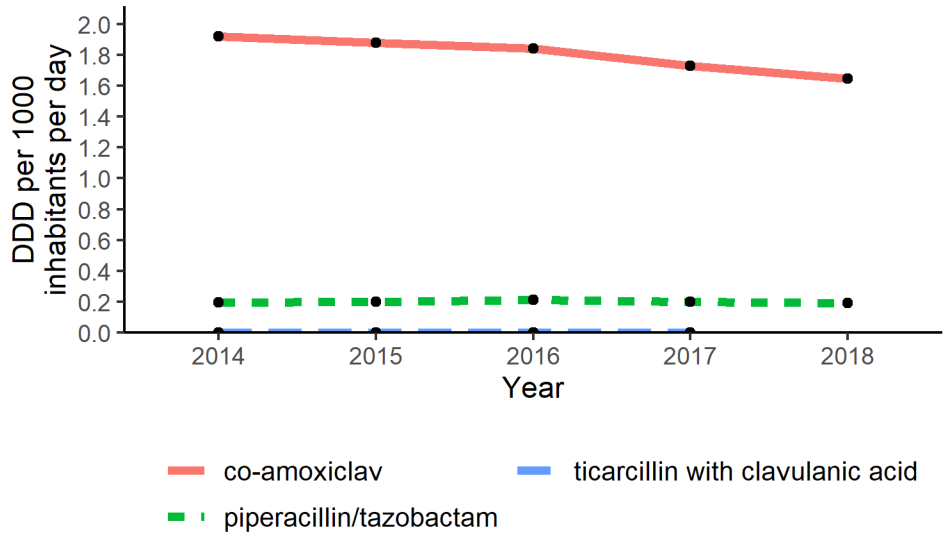


Figure 31: Consumption of most commonly used Penicillin/beta lactamase inhibitor combinations expressed per 1000 inhabitants per day, NI, 2014 -2018

The rate of consumption of Penicillin/beta lactamase inhibitor combinations has decreased from 1.93 DDD per 1000 inhabitants per day in 2017 to 1.84 DDD per 1000 inhabitants per day in 2018. The highest rate was for co-amoxiclav which has continued to decrease from 2017 to 2018 (1.73 to 1.65 DDD per 1000 inhabitants per day). The use of piperacillin/tazobactam decreased slightly from 0.2 DDD per 1000 inhabitants per day in 2017 to 0.19 DDD per 1000 inhabitants per day in 2018 (Figure 31).

Glycopeptides and daptomycin

Table 8: Total rate of Glycopeptides and Daptomycin expressed as DDD per 1000 inhabitants per day, NI, 2014-2018.

Year	Class	DDD	Population	rate
2014	Glycopeptides and Daptomycin	101103	1840498	0.15
2015	Glycopeptides and Daptomycin	111767	1851621	0.17
2016	Glycopeptides and Daptomycin	110029	1862137	0.16
2017	Glycopeptides and Daptomycin	123197	1870834	0.18
2018	Glycopeptides and Daptomycin	123184	1881641	0.18

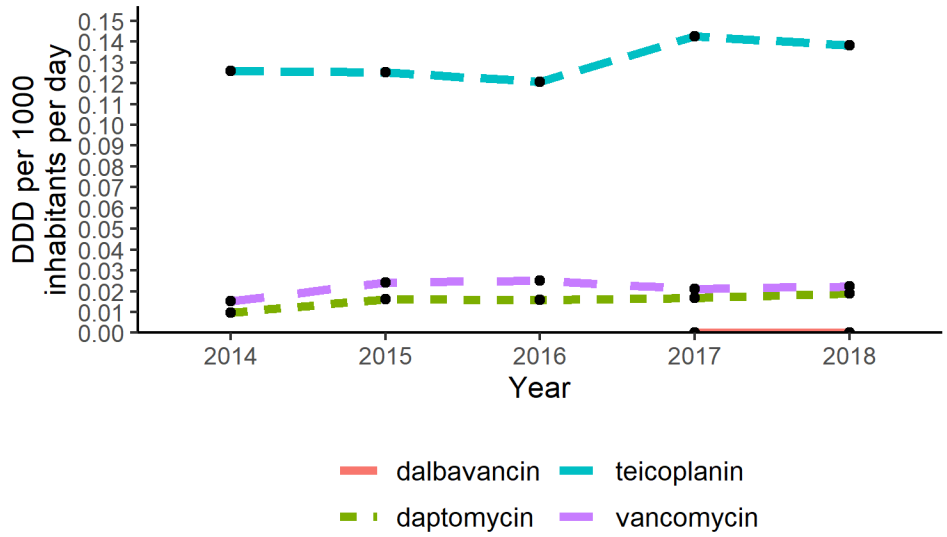


Figure 32: Consumption of most commonly used glycopeptides and daptomycin expressed per 1000 inhabitants per day, NI, 2014 -2018

The rate of glycopeptide and daptomycin consumption has remained stable from 2017 to 2018 at 0.18 DDD per 1000 inhabitants per day. The highest rate was for teicoplanin which has remained stable between 2017 and 2018 (0.14 DDD per 1000 inhabitants per day (Figure 32).

Anti-folate agents

Table 9: Total rate of Anti-folate agents expressed as DDD per 1000 inhabitants per day, NI, 2014-2018.

Year	Class	DDD	Population	rate
2014	Anti-folate agents	1980783	1840498	2.95
2015	Anti-folate agents	1983958	1851621	2.94
2016	Anti-folate agents	1995202	1862137	2.94
2017	Anti-folate agents	1920030	1870834	2.81
2018	Anti-folate agents	1836423	1881641	2.67

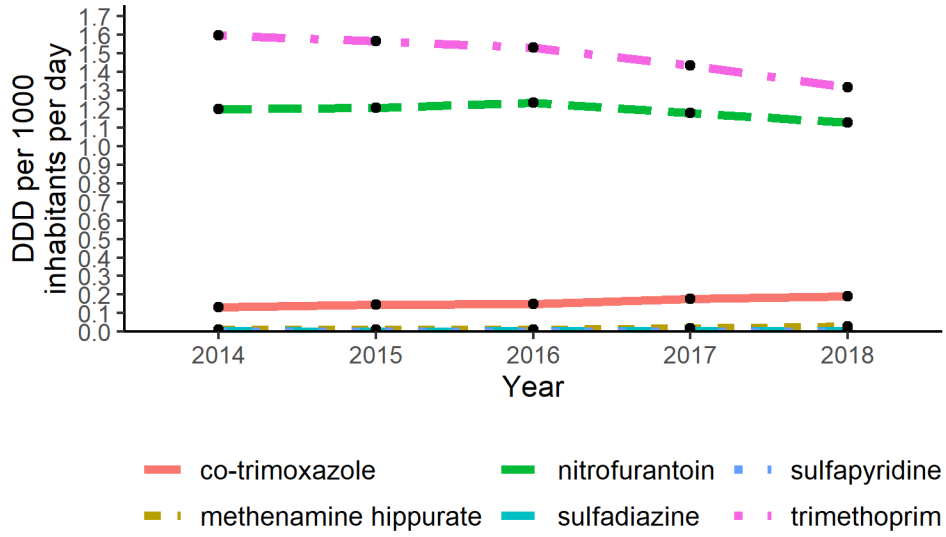


Figure 33: Consumption of most commonly used anti-folate agents expressed per 1000 inhabitants per day, NI, 2014 -2018

Anti-folate agents accounted for 9.4% of total antibiotic consumption in 2018. The rate of consumption of Anti-folate agents slightly decreased from 2.81 DDD per 1000 inhabitants per day in 2017 to 2.67 DDD per 1000 inhabitants per day in 2018. The highest rate was for trimethoprim which also decreased slightly from 1.43 in 2017 to 1.32 DDD per 1000 inhabitants per day in 2018 (Figure 33).

Antibiotic consumption of key agents by healthcare setting

Trimethoprim

Table 10: Total rate of trimethoprim consumption expressed as DDD per 1000 inhabitants per day, NI, 2014-2018.

Year	Antibiotic	DDD	Population	rate
2014	trimethoprim	1073366	1840498	1.60
2015	trimethoprim	1059077	1851621	1.57
2016	trimethoprim	1041351	1862137	1.53
2017	trimethoprim	978456	1870834	1.43
2018	trimethoprim	904666	1881641	1.32

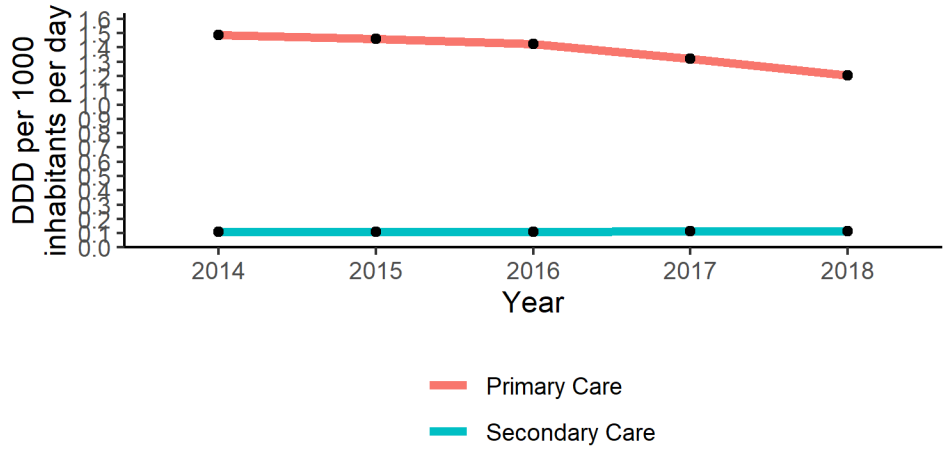


Figure 34: Consumption of trimethoprim by prescriber location expressed per 1000 inhabitants per day, NI, 2014 -2018

The rate of trimethoprim consumption has continued to decrease from 1.43 DDD per 1000 inhabitants per day in 2017 to 1.32 DDD per 1000 inhabitants per day in 2018. The rate of trimethopim consumption in primary care has decreased between 2017 to 2018 (1.32 to 1.2 DDD per 1000 inhabitants per day) with no change in secondary care, remaining stable at 0.11 DDD per 1000 inhabitants per day (Figure 34).

Nitrofurantoin

Table 11: Total rate of nitrofurantoin consumption expressed as DDD per 1000 inhabitants per day, NI, 2014-2018.

Year	Antibiotic	DDD	Population	rate
2014	nitrofurantoin	806022	1840498	1.20
2015	nitrofurantoin	815244	1851621	1.21
2016	nitrofurantoin	838475	1862137	1.23
2017	nitrofurantoin	803820	1870834	1.18
2018	nitrofurantoin	774974	1881641	1.13

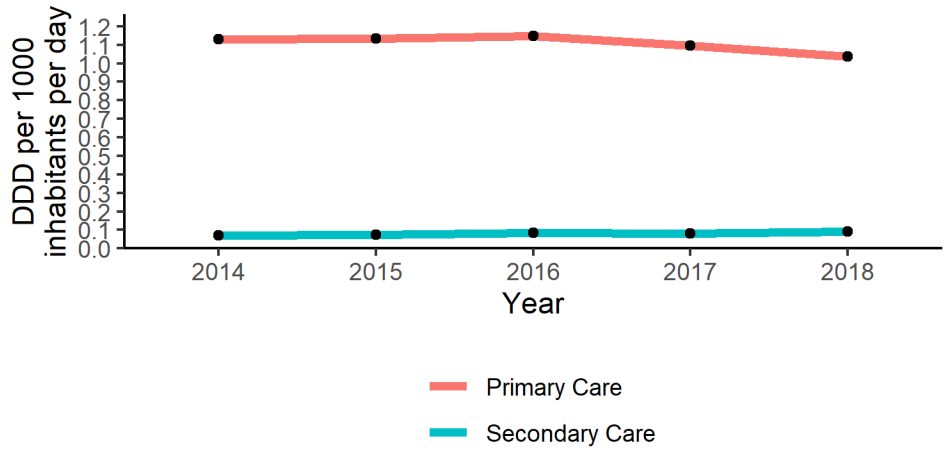


Figure 35: Consumption of nitrofurantoin by prescriber location expressed per 1000 inhabitants per day, NI, 2014 -2018

The rate of nitrofurantoin consumption decreased slightly between 2017 to 2018 from 1.18 DDD per 1000 inhabitants per day in 2017 to 1.13 DDD per 1000 inhabitants per day in 2018. Rates in primary care have slightly decreased from 1.09 DDD per 1000 inhabitants per day in 2017 to 1.04 DDD per 1000 inhabitants per day in 2018. The rate of consumption in secondary care has increased slightly from 0.08 DDD per 1000 inhabitants per day in 2017 to 0.09 DDD per 1000 inhabitants per day in 2018 (Figure 35).

Aminoglycosides

Table 12: Total rate of Aminoglycosides expressed as DDD per 1000 inhabitants per day, NI, 2014-2018.

Year	Class	DDD	Population	rate
2014	Aminoglycosides	102531	1840498	0.15
2015	Aminoglycosides	107798	1851621	0.16
2016	Aminoglycosides	108891	1862137	0.16
2017	Aminoglycosides	113206	1870834	0.17
2018	Aminoglycosides	118259	1881641	0.17

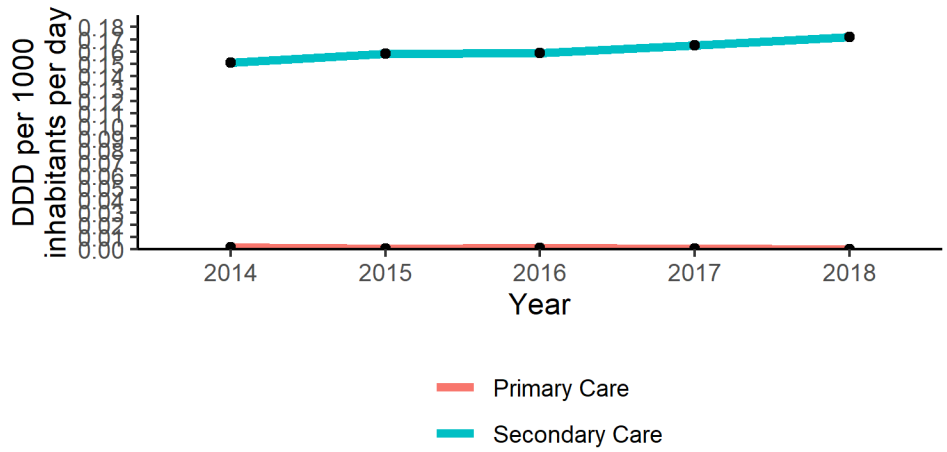


Figure 36: Consumption of aminoglycosides by prescriber location expressed per 1000 inhabitants per day, NI, 2014 -2018

The overall consumption rate of Aminoglycosides remained stable from 2017 to 2018 at 0.17 DDD per 1000 inhabitants per day. The rate of consumption in both primary and secondary care also remained stable at 0 and 0.17 DDD per 1000 inhabitants per day, respectively (Figure 36).

Glycopeptides and daptomycin

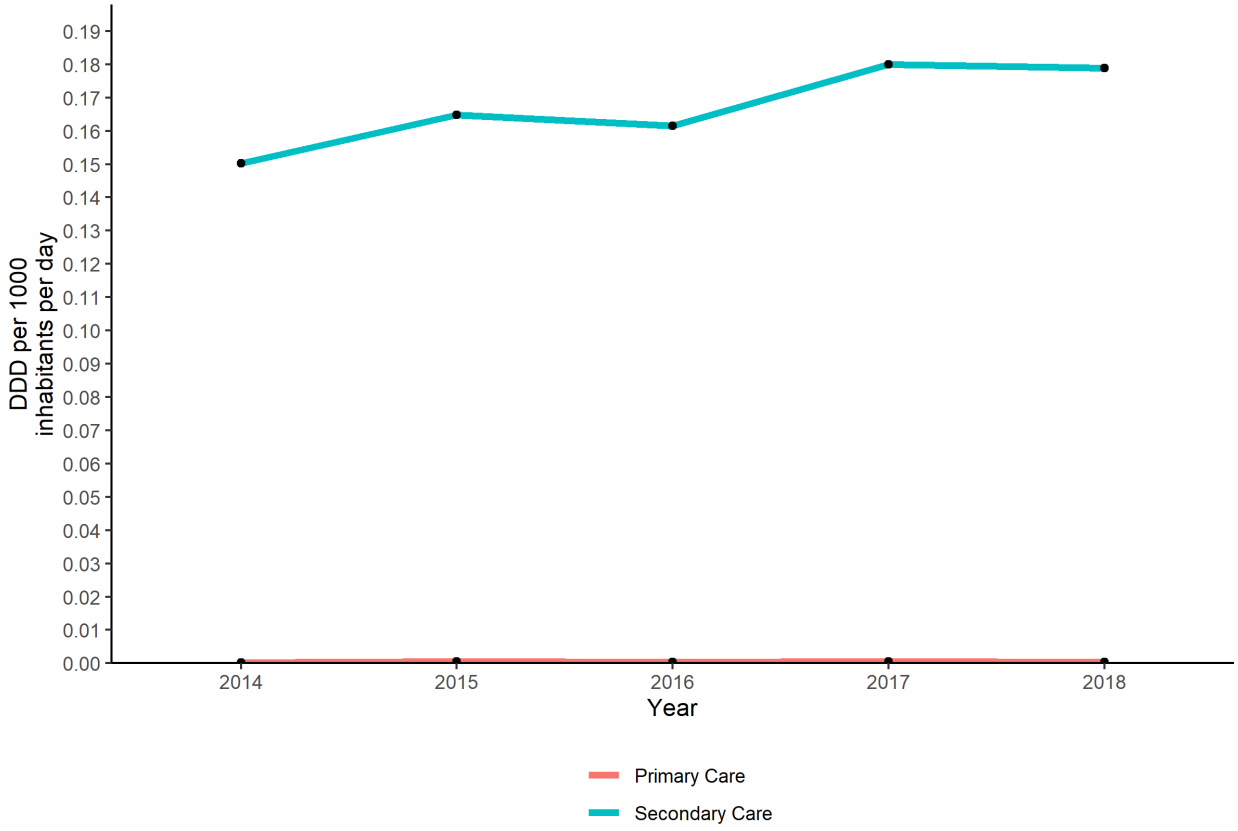


Figure 37: Consumption of glycopeptide and daptomycin by prescriber location expressed per 1000 inhabitants per day, NI, 2014 -2018

The total consumption rate of glycopeptides and daptomycin has remained stable in both primary and secondary care from 2017 to 2018. The rate of consumption in primary care remained at 0 DDD per 1000 inhabitants per day, with the rate in secondary care remaining at 0.18 DDD per 1000 inhabitants per day. *Please note DDDs in primary care are not absolute zero* (Figure 37).

Colistin

Table 13: Total rate of colistin consumption expressed as DDD per 1000 inhabitants per day, NI, 2014-2018.

Year	Antibiotic	DDD	Population	rate
2014	colistin	60158	1840498	0.09
2015	colistin	55889	1851621	0.08
2016	colistin	62217	1862137	0.09
2017	colistin	68209	1870834	0.10
2018	colistin	70760	1881641	0.10

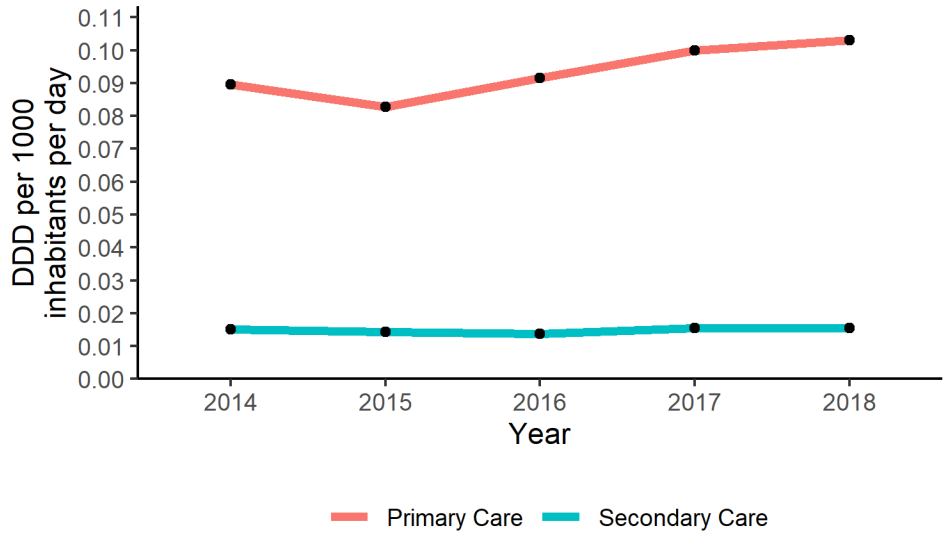


Figure 38: Consumption of colistin by prescriber location expressed per 1000 inhabitants per day, NI, 2014 -2018

The rate of colistin consumption remained stable from 2017 to 2018 at 0.1 DDD per 1000 inhabitants per day. Rates of consumption from 2017 to 2018 remained stable in both primary care (0.1 DDD per 1000 inhabitants per day) and secondary care (0.02 DDD per 1000 inhabitants per day) (Figure 38).

Antibiotic consumption by WHO AWaRe Category

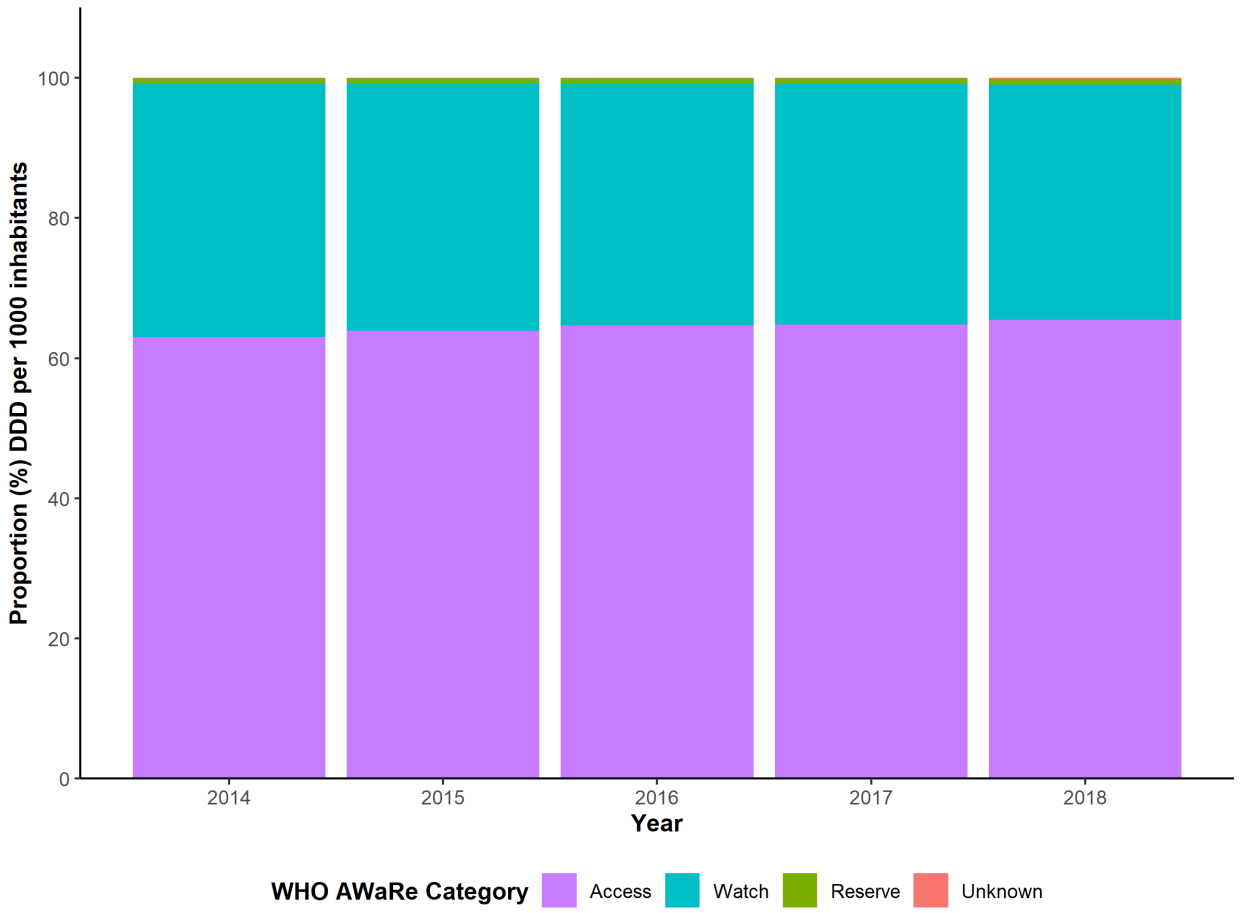


Figure 39: Proportion of DDDs per 1000 inhabitants by WHO AWaRe category, NI, 2014 -2018

The World Health Organization (WHO) classifies antibiotics into three stewardship groups- the AWaRe categories; Access, Watch and Reserve. Antibiotics in the Access group include antibiotics which can be utilised for a range of common susceptible pathogens and have a lower potential for resistance. The Watch group contains those which have an increased potential of resistance and should be used in a restricted manner and includes most high priority agents. The Reserve group contains antibiotics which are to be treated as 'last resort' when other treatments have failed or there are no alternatives available. This is the first year in which WHO AWaRe Categories have been included in this report.

The highest proportion of antibiotic consumption occurred within the Access category, which increased across the reporting period 2014 - 2018 (63.01 % to 65.49 %). The proportion of consumption accounted for by antibiotics from the Watch group has decreased

from 36.17% in 2014 to 33.56% in 2018. Consumption within the Reserve category has remained relatively stable between 2014 and 2018 (0.76% to 0.82%). Antibiotics which not assigned to any of the AWaRe categories- denoted here as 'unknown'- accounted for less than 1% of total consumption in each year between 2014 and 2018 (Figure 39).

Engagement activities

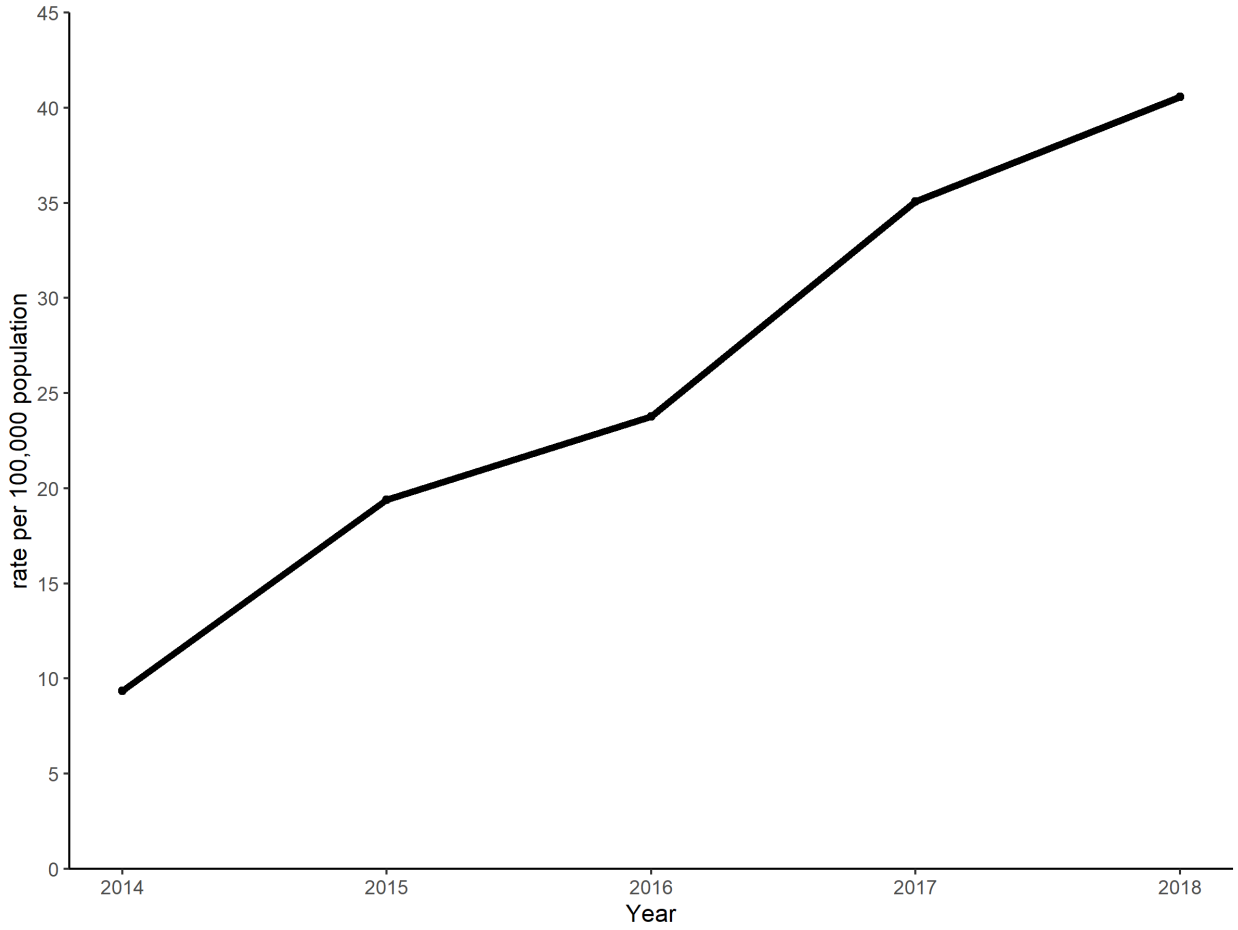
Public Engagement

The Public Health Agency (PHA) engaged in several communications projects during 2018 with the aim of sharing key messages surrounding antibiotic resistance with the public. These messages highlighted simple steps that individuals can make to keep antibiotics working and called the public to action by encouraging them to become 'Antibiotic Guardians'. Key messages were communicated using several methods including a mass media campaign and public engagement events. A focus was also made on educating children on microbes, how infections are spread and how this can be prevented.

Highlights of this work include the following:

- PHA ran a mass media campaign across Northern Ireland entitled 'Keep Antibiotics Working' during December 2018 which will continue into 2019. The evaluation of this will commence later in 2019 however preliminary findings have been positive and include increased campaign awareness, resonation of key messages and positive impact on intended behaviours amongst the public.
- Ongoing significant press and social media activity is planned and implemented specifically around World Antibiotic Awareness Week. These included an animation to inform the public on the threat of AMR, and the actions they can take to keep antibiotics working; videos of professionals including medics, pharmacists and scientists explaining the threat of AMR; and a series of antibiotic mythbusters. The issue was highlighted on news bulletins on several local radio stations.
- 100 primary and post-primary teachers in Northern Ireland have attended an e-Bug training workshop. This is a free NICE endorsed educational resource for classrooms that helps teachers educate their pupils on microbes, their spread, treatment and prevention of infection.

Antibiotic guardians



There were more than one hundred new antibiotic guardians registered in Northern Ireland during 2018. To the end of 2018 there was a total of 759 individuals registered as antibiotic guardians (41 individuals per 100,000 population).

Changing prescribing behaviour

Complementary to our public engagement and education campaigns is a programme of work to help change prescribing behaviour. Safely reducing antibiotic use is a complex challenge that will require an understanding of the capacity, opportunity and motivation of prescribers to decide when not to prescribe antibiotics.

Initiatives to reduce antimicrobial consumption during 2018 included:

- Publication in March 2018 of the results of a survey with GPs about the factors that influence their antibiotic prescribing decisions and with stakeholders about their current understanding of the problem and ideas for solutions (https://www.finance-ni.gov.uk/sites/default/files/publications/%5Bcurrent-domain%3Amachine-name%5D/antibiotic-prescribing-in-primary-care-final-version.pdf).
- TARGET toolkit workshops for GPs were delivered throughout Northern Ireland during the year.
- Collaborative work on a systematic review of behavioural science interventions for antimicrobial stewardship continued between the Innovation Lab and PHA.
- Evaluation of a pilot point-of-care CRP testing for respiratory infections in primary care was undertaken, with results due in 2019.

Future Work

Much of the current work undertaken will continue into 2019/20 and beyond. Engaging with the public to promote responsible use of antibiotics will remain a priority, as will endeavours to safely reduce the use of antibiotics. The following work is planned for delivery in 2019/20:

Surveillance and Epidemiological Work

- Continue to monitor the progress of the national ambition to reduce healthcare-associated Gram-negative bacteraemias and assess the impact on the burden of AMR in terms of the numbers of resistant infections.
- Further improve our understanding of the epidemiology and incidence of antibiotic-resistant infections with a view to improving their management and prevent onward transmission.
- Standardise the approach to investigation and treatment of suspected urinary tract infection in care homes in Northern Ireland.
- Continue to monitor trends in antibiotic prescribing across primary and secondary care and explore opportunities to improve benchmarking and quality improvement.
- Continue to develop, pilot and validate a tool to assess appropriateness of antibiotic prescriptions in acute hospitals and facilitate data collection and analysis of data
- Work closely with stakeholders to focus and further improve dental prescribing across Northern Ireland.

Engagement with the Public and HSC Colleagues

- PHA will continue to host a stand at the Balmoral Show. The stand will encourage the public to play their part in helping to keep antibiotics working. A range of interactive activities from e-Bug(http://www.e-bug.eu/) will be used to educate children about microbes, how they spread to others and what they can do to stop infections spreading. The stand will also be used to encourage members of the public to sign up to become antibiotic guardians.
- PHA will plan and facilitate an Infection Prevention and Control (IPC) study day and a HCAI (Healthcare Associated Infections) symposium to engage with colleagues across HSCNI to share best practice around reducing infections and antibiotic stewardship.

- PHA continue to engage in public awareness activities during the European Antibiotic Awareness Day (EEAD) and World Antibiotic Awareness Week (WAAW). Daily social media posts will be shared on PHA accounts (Facebook, Twitter, and Instagram) and partner organisations will be tagged so that resources can be shared on social media platforms. The social media posts will feature a range of existing content including animations, videos and myth-buster graphics.
- New video projects are also being planned for release. This includes a video to highlight the GP perspective regarding antibiotic prescribing and explain why a GP might not prescribe an antibiotic even if they are asked to. This will highlight key messages surrounding antibiotic resistance as well as common illnesses that usually do not require an antibiotic. similarly other videos will highlight simple steps that individuals can make to help keep antibiotics working. All communications materials will be uploaded to the PHA website to improve accessibility for partner organisations who may wish to download and use these resources for their own public facing media platforms.
- The PHA will continue to support HSCB Pharmacy colleagues to promote antibiotic guardianship by helping to organise and host stands on EAAD in PHA offices. Staff across Pharmacy and Health Protection will be available to speak to PHA employees about the key messages surrounding antibiotic resistance and correct antibiotic use. This opportunity will be used to encourage staff to become Antibiotic Guardians.
- Further E-Bug training workshops delivered to primary school teachers and other settings as appropriate.
- Public Health Agency in collaboration with Public Health England (PHE) will lead on the development of an Antibiotic Guardian badge programme for youth groups across the UK. This programme aims to educate children on how to prevent infections and to be more aware of antibiotics and antibiotic resistance. It includes interactive e-Bug activities and the development of a pledge to become an Antibiotic Guardian to protect antibiotics for the future. PHA plan to hold exploratory discussions with local youth organisations to raise awareness and interest in the badge in Northern Ireland.
- Lead and coordinate efforts in undergraduate and postgraduate training, continuing professional development, and staff training related to Antimicrobial Stewardship, Antimicrobial Resistance and IPC

Changing Prescribing Behaviour

- Work will continue on a study to understand the factors affecting primary care antibiotic prescribing.
- TARGET Toolkit workshops for healthcare staff will continue to be delivered during the year.
- Collaborative work on a systematic review of behavioural science interventions for antimicrobial stewardship will continue between the Innovation Lab and PHA.
- A pilot will be developed for implementation in Community Pharmacy looking at Point of Care testing in lower respiratory tract infection CRP as a means of reducing inappropriate GP presentations.
- GP practices will be visited and encouraged to address antibiotic prescribing as a key action point for 2019, as part of their annual meeting with a HSCB pharmacy adviser.
- Repeat of an intervention aimed at the top 20% antibiotic prescribing practices in NI, whereby each GP will receive a brief letter from the Chief Medical Officer highlighting the outlying nature of the practice and encouraging simple measures to counteract it.

Antimicrobial Stewardship Scale and Spread project

Regional work is underway to improve urinary tract infection (UTI) antimicrobial stewardship in nursing homes in the Northern Trust area. This work is one of four Regional Scale and Spread areas of work in NI's Health and Social Care Quality Improvement (HSCQI) network. Staff in three care homes in the Northern Trust area are working alongside four Antrim GP practices with the aim of reducing the GP practices' inappropriate antimicrobial prescribing by 10% for the care home residents. The project demonstrates collaboration from a range of stakeholders including the Public Health Agency, Northern Trust, and the Regulation and Quality Improvement Authority (RQIA) with support from the Institute for Healthcare Improvement (IHI). The project is using quality improvement science methodology with development of a nursing decision aid, checklist tool and measurement of GP prescribing activity.

Discussion

This is the third report of antimicrobial resistance and antimicrobial consumption in Northern Ireland. As with previous reports, we have aimed to keep the content generally comparable with the ESPAUR report for England [3]. In future reports, we aim to be able to access, analyse and report more detailed information about antimicrobial use and resistance in specific healthcare settings.

Antimicrobial resistance

The focus for the antimicrobial resistance section was the organism-antibiotic combinations that were identified as part of the UK AMR strategy [8]. The data for this report has been extracted from the regional laboratory system. *Staphylococcus aureus* and Gram negative bloodstream infections including; *E.coli*, *K. pneumoniae* and *Pseudomonas sp.* are subject to mandatory surveillance.

E. coli and *K. pneumoniae* bloodstream infections have been targeted as part of the UK governments ambition to reduce healthcare-associated gram-negative bloodstream infections by 50% by 2020. In order to reduce the number of these infections, local teams will need timely information about the characteristics of the patients who are affected, the risk factors that contributed to the infection and which healthcare settings were responsible. In recognition of this, mandatory surveillance of gram-negative bloodstream infections was introduced in April 2018. These new data are an important source of business intelligence for Health and Social Care Trusts as they aim to improve the quality and safety of the care that they provide. The success of this new programme will require Trusts to take steps to implement new data collection arrangements quickly for the benefit of their patients.

During 2017 and 2018 the number of *E. coli*; *K. pneumoniae*, *Pseudomonas* and *Enterococcus* bacteremias have decreased. While *S. aureus*, *K. oxytoca* and *Acinetobacter* bacteremias have increased. *S. pneumoniae* remained stable over the annum.

Antimicrobial resistance in most of the selected organisms has remained relatively stable since 2009, with increases noted in both *E. coli* and *K. pneumoniae* resistance to co-amoxiclav and glycopeptide resistant enterococci. During 2017 to 2018 the number of *E. coli* and *K. pneumoniae* isolates non-suseptible to selected antibiotics has increased, while glycopeptide-resistant enterococci has remained stable. The number of Carbapenem-Producing Enterobacteriaceae (CPE) reported to the PHA have increased further in 2018 after declining from 2014-2016. This likely reflects the voluntary nature of reporting (case

ascertainment) as well as local developments in the ability to test for CPE. Comparable data for England is available in their 2018 ESPAUR report. While the proportion of isolates that are resistant to key antibiotics has not changed very much over time, the absolute number of resistant infections has increased because of the overall rising number of infections. As antimicrobial resistance is a transmissible global problem, PHA will continue to collaborate with Public Health England and the Scottish, Welsh and Irish public health organisations, to contribute to the European Antimicrobial Resistance Surveillance Network (EARS-Net) and the World Health Organisation's Global Antimicrobial Resistance Surveillance System (GLASS). This will ensure standardised information on antimicrobial resistance is available to inform comparisons and drive improvement.

Antibiotic consumption

It is important to note that in England, hospitals usually dispense outpatient medications, whereas in Northern Ireland these are usually prescribed by general practitioners at the request of secondary care specialists. A significant proportion of outpatient prescribing is therefore counted under primary care in Northern Ireland as opposed to secondary care in England. There is currently no way of separating these prescriptions from the rest of primary care prescribing in Northern Ireland. In England, outpatient prescribing accounts for 7.5% of secondary care antimicrobial prescribing [3].

Total antibiotic consumption in Northern Ireland has continued to decline in 2018 to 28.5 DDD per 1,000 inhabitants, after remaining largely unchanged between 2014 and 2016. Antibiotic consumption in primary care has decreased in recent years, meanwhile secondary care has fairly stable since 2014. Despite this, the rate of antimicrobial consumption in secondary care per admission and per occupied bed day has continued to steadily increase, perhaps suggesting that the case-mix of hospital inpatients has become more severe over time.

This relative stasis is in contrast with the situation in England, where antibiotic consumption has continued to fall, and was measured at 18.2 DDD per 1,000 inhabitants per day in 2018. By this measure, Northern Ireland's total antibiotic consumption is 57% higher than that of England. Penicillins, tetracyclines and macrolides were the most commonly prescribed antibiotics in both settings. There has been a slight increase in penicillin consumption in secondary care while tetracyclines have shown a slight increase over time in both settings, however macrolide consumption in primary care has slightly declined. The use of carbapenems, and meropenem in particular have also declined over time in Northern Ireland, which is an encouraging trend. Use of co-amoxiclav also fell further in 2018, and trimethoprim use fell slightly.

In general, however, comparison with antimicrobial use in England continues to highlight substantially higher use in Northern Ireland. Piperacillin/tazobactam consumption remained relatively stable in 2018 at 0.19 DDD per 1,000 inhabitants per day, which is more than three times the rate in England (0.069 DDD per 1,000 inhabitants per day). It should be noted however, the 2017 decrease in piperacillin/tazobactam use in England was partly due to an international supply shortage with an increase in the use of alternative antibiotics as a result. Piperacillin/tazobactam use in England increased by 6.4% between 2017 and 2018. The rate of cephalosporin use was steady at 0.51 DDD per 1,000 inhabitants per day, which is approximately 1.5 times the English rate of 0.32 DDD per 1,000 inhabitants

per day. The use of tetracyclines, particularly doxycycline, decreased slightly in 2018 in Northern Ireland to 7.36 DDD per 1,000 inhabitants per day, which was much higher than the English rate of 4.59 DDD per 1,000 inhabitants per day. The use of quinolones and macrolides has remained unchanged over the last 3 years in Northern Ireland, during which time macrolide use has decreased in England, but quinolone use has slightly increased.

Colistin is an antibiotic of last resort that is used for multidrug-resistant infections and also as an inhaled therapy for people with cystic fibrosis. Colistin consumption in Northern Ireland has been steady since 2014, but rates are higher than in England (0.10 DDD per 1,000 inhabitants per day in 2018 in NI and 0.039 DDD per 1,000 inhabitants per day in 2018 in England).

This is the first year in which WHO AWaRe categories have been included in the report. The general trend of consumption across the categories is encouraging, with antibiotics from the Access category consistently accounting for approximately two thirds of total consumption per year between 2014 and 2018. This reflects the good work being carried out in local healthcare trusts and in general practice to promote appropriate use of antibiotics. Additionally, the proportion of consumption from the Access category has increased over time while usage from the Watch category has decreased, these are positive trends which will hopefully continue to reduce the risk of resistance.

The amount of antimicrobial use in Northern Ireland still however remains markedly higher than England. Understanding the reasons for the difference is a complex. Most antibiotics were prescribed in the primary care setting. In order to understand and address the factors that lead to antibiotic consumption, there is a need for further work to understand the behaviour of both prescribers and those who are being prescribed with a view to develop intervention. During 2018 the PHA collaborated with the Health and Social Care Board, the Innovation Lab at the Department of Finance and other primary care stakeholders to fill this information gap, producing a report of their findings. In the secondary care setting, investigating the reasons for differences is vastly more difficult because antimicrobial consumption is measured at ward level, not at patient level. Health and Social Care Northern Ireland has committed to developing a new electronic health care record ("Encompass"), which will ultimately include electronic prescribing, which will provide a rich source of information about the factors influencing antimicrobial consumption.

To engage with professionals and the public, the PHA is encouraging they sign up to the Antibiotic Guardian pledge. In 2018, 103 public and professionals successfully signed up to be Antibiotic Guardians. However, as public and professional interest in antimicrobial

resistance is increasing and with a number of projects in place for the coming year, it is hoped there will be further increase in the number of those who sign up.

Appendix 1: AMR surveillance categories

Table 14: Antibiotic names (trade and generic) and assigned surveillance group for the antimicrobial resistance data

Antibiotic surveillance group	Individual antibiotic name
3rd Generation Cephalosporin	cefotaxime
3rd Generation Cephalosporin	claforan
3rd Generation Cephalosporin	ceftazidime
3rd Generation Cephalosporin	fortum
3rd Generation Cephalosporin	cefpodoxime
3rd Generation Cephalosporin	ceftizoxime
3rd Generation Cephalosporin	ceftriaxone
Carbapenem	meronem
Carbapenem	meropenem
Carbapenem	imipenem
Carbapenem	ertapenem
Ciprofloxacin	ciprofloxacin
Ciprofloxacin	low level ciprofloxacin
Ciprofloxacin	ciproxin
Co-amoxiclav	co-amoxiclav
Co-amoxiclav	amoxicillin/clavulanate
Co-amoxiclav	augmentin
Colistin	colistin
Colistin	colomycin
Gentamicin	gentamicin
Gentamicin	lugacin
Gentamicin	cidomycin
Gentamicin	genticin
Gentamicin	garamycin
Gentamicin	high_level gentamicin
Glycopeptide	vancocin
Glycopeptide	vancomycin
Glycopeptide	teicoplanin
Macrolides	clarithromycin
Macrolides	erythromycin
Macrolides	azithromycin
Macrolides	erythrocin
Macrolides	erythromid
Methicillin	cefoxitin
Methicillin	flucloxacillin
Methicillin	floxapen
Methicillin	oxacillin
Methicillin	meticillin
Methicillin	celbenin
Methicillin	cloxacillin
Methicillin	orbenin

Table 14: Antibiotic names (trade and generic) and assigned surveillance group for the antimicrobial resistance data *(continued)*

Antibiotic surveillance group	Individual antibiotic name
Penicillin	apsin
Penicillin	benzylpenicillin
Penicillin	phenoxymethylpenicillin
Penicillin	penicillin
Penicillin	penidural
Piperacillin/Tazobactam	tazocin
Piperacillin/Tazobactam	piperacillin/tazobactam

Appendix 2: AMC data categories

Table 15: Antibiotic names, ATC codes and assigned surveillance group for the antimicrobial consumption data

Antibiotic surveillance group	Individual antibiotic name	ATC codes
Aminoglycosides	tobramycin	J01GB01
Aminoglycosides	gentamicin	J01GB03
Aminoglycosides	neomycin	J01GB05
Aminoglycosides	amikacin	J01GB06
Anti-Clostridium difficile agents	vancomycin	A07AA09
Anti-Clostridium difficile agents	fidaxomicin	A07AA12
Anti-Clostridium difficile agents	metronidazole	G01AF01
Anti-Clostridium difficile agents	metronidazole	P01AB01
Anti-folate agents	trimethoprim	J01EA01
Anti-folate agents	sulfapyridine	J01EB04
Anti-folate agents	sulfadiazine	J01EC02
Anti-folate agents	sulphamethoxypyridazine	J01ED05
Anti-folate agents	co-trimoxazole	J01EE01
Anti-folate agents	nitrofurantoin	J01XE01
Anti-folate agents	methenamine	J01XX05
Anti-tuberculous drugs	streptomycin	J01GA01
Carbapenems	meropenem	J01DH02
Carbapenems	ertapenem	J01DH03
Carbapenems	imipenem with cilastatin	J01DH51
Cephalosporins	cefalexin	J01DB01
Cephalosporins	cefazolin	J01DB04
Cephalosporins	cefadroxil	J01DB05
Cephalosporins	cefradine	J01DB09
Cephalosporins	cefoxitin	J01DC01
Cephalosporins	cefuroxime	J01DC02
Cephalosporins	cefaclor	J01DC04
Cephalosporins	cefotaxime	J01DD01
Cephalosporins	ceftazidime	J01DD02
Cephalosporins	ceftriaxone	J01DD04
Cephalosporins	cefixime	J01DD08
Cephalosporins	cefpodoxime	J01DD13
Cephalosporins	ceftazidime_with_avibactam	J01DD52
Cephalosporins	ceftaroline	J01DI02
Glycopeptides and Daptomycin	vancomycin	J01XA01
Glycopeptides and Daptomycin	teicoplanin	J01XA02
Glycopeptides and Daptomycin	dalbavancin	J01XA04
Glycopeptides and Daptomycin	daptomycin	J01XX09
Lincosamides	clindamycin	J01FF01
Macrolides	erythromycin	J01FA01
Macrolides	clarithromycin	J01FA09
Macrolides	azithromycin	J01FA10

Table 15: Antibiotic names, ATC codes and assigned surveillance group for the antimicrobial consumption data *(continued)*

Antibiotic surveillance group	Individual antibiotic name	ATC codes
Macrolides	telithromycin	J01FA15
Monobactams	aztreonam	J01DF01
Nitroimidazoles	metronidazole	J01XD01
Nitroimidazoles	tinidazole	P01AB02
Other antibiotics	chloramphenicol	J01BA01
Other antibiotics	quinupristin	J01FG02
Other antibiotics	colistin	J01XB01
Other antibiotics	fucidic_acid	J01XC01
Other antibiotics	fosfomycin	J01XX01
Oxazolidinones	linezolid	J01XX08
Oxazolidinones	tedizolid	J01XX11
Penicillins	ampicillin	J01CA01
Penicillins	amoxicillin	J01CA04
Penicillins	pivmecillinam	J01CA08
Penicillins	temocillin	J01CA17
Penicillins	co-fluampicil	J01CA51
Penicillins	benzylpenicillin	J01CE01
Penicillins	phenoxymethylpenicillin	J01CE02
Penicillins	benzathine-benzylpenicillin	J01CE08
Penicillins	procaine	J01CE09
Penicillins	flucloxacillin	J01CF05
Penicillins	co-fluampicil	J01CR50
Penicillins with beta lactamase inhibitors	co-amoxiclav	J01CR02
Penicillins with beta lactamase inhibitors	ticarcillin with clavulanic_acid	J01CR03
Penicillins with beta lactamase inhibitors	piperacillin/tazobactam	J01CR05
Quinolones	ofloxacin	J01MA01
Quinolones	ciprofloxacin	J01MA02
Quinolones	norfloxacin	J01MA06
Quinolones	levofloxacin	J01MA12
Quinolones	moxifloxacin	J01MA14
Tetracyclines and related drugs	doxycycline	J01AA02
Tetracyclines and related drugs	lymecycline	J01AA04
Tetracyclines and related drugs	oxytetracycline	J01AA06
Tetracyclines and related drugs	tetracycline	J01AA07
Tetracyclines and related drugs	minocycline	J01AA08
Tetracyclines and related drugs	tigecycline	J01AA12

Appendix 3: Testing data

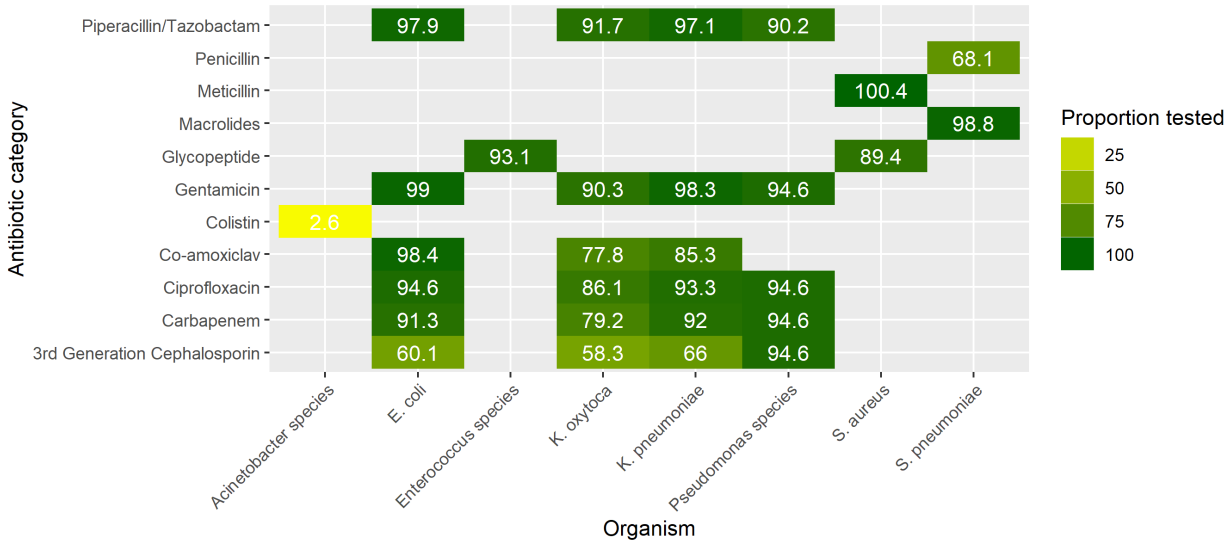


Figure 40: The proportion of key bacteraemias where selected antibiotic susceptibility results were reported to the PHA

Appendix 4: Drug/bug combinations monitored

Bacteria	Antibiotics
Escherichia coli	Third-generation cephalosporins, carbapenems, co-amoxiclav, ciprofloxacin, gentamicin, piperacillin/tazobactam
Klebsiella pneumoniae	Third-generation cephalosporins, carbapenems, co-amoxiclav, ciprofloxacin, gentamicin, piperacillin/tazobactam
Pseudomonas species	Third-generation cephalosporins, carbapenems, ciprofloxacin, gentamicin, piperacillin/tazobactam
Staphylococcus aureus	Glycopeptide, meticillin
Enterococcus species	Glycopeptide
Streptococcus pneumoniae	Macrolides, penicillin
Acinetobacter species	Colistin

References

1 Department of Health Social Services and Public Safety Northern Ireland. Strategy for Tackling Antimicrobial Resistance (STAR) 2012-2017. 2012. https://www.health-ni.gov.uk/sites/default/files/publications/dhssps/star-doc.pdf

2 Department of Health. Tackling antimicrobial resistance 2019-2024 The UK's five-year national action plan. 2019.

3 Public Health England. English surveillance programme for antimicrobial utilisation and resistance (ESPAUR). 2019;1–143.

4 Grayson M. *Kucers' The Use of Antibiotics Sixth Edition: A Clinical Review of Antibacterial, Antifungal and Antiviral Drugs*. London:: Hodder Arnold 2010.

5 Bignell C, Fitzgerald M. UK national guideline for the management of gonorrhoea in adults, 2011. *International Journal of STD and AIDS* 2011;**22**:541–7. doi:10.1258/ijsa.2011.011267

6 Spiteri G, Cole M, Unemo M *et al.* The European Gonococcal Antimicrobial Surveillance Programme (Euro-GASP)-a sentinel approach in the European Union (EU)/European Economic Area (EEA). *Sexually Transmitted Infections* 2013;**89 suppl 4**:iv 16–8. doi:10.1136/sextrans-2013-051117

7 Eurogasp. European Gonococcal Antimicrobial Surveillance Programme (Euro-GASP). https://www.ecdc.europa.eu/en/about-us/partnerships-and-networks/disease-and-laboratory-networks/euro-gasp

8 Department of Health. UK Five Year Antimicrobial Resistance Strategy 2013 to 2018. 2013. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment%7B/_%7Ddata/file/244058/20130902%7B/_%7DUK%7B/_%7D5%7B/_%7Dyear%7B/_%7DAMR%7B/_%7Dstrategy.pdf

HSC Public Health Agency

Public Health Agency
12-22 Linenhall Street, Belfast BT2 8BS.
Tel: 0300 555 0114 (local rate).
www.publichealth.hscni.net

Find us on:

10/20