Ministry of Health and Family Welfare
Government of India

Surveillance of Antimicrobial Consumption under National Antimicrobial Consumption Network (NAC-NET)

July 2023

National Programme on AMR Containment
National Centre for Disease Control (NCDC), Directorate General of Health Services

Antimicrobial Resistance Stewardship – Our Role, Our Responsibility
Judicious Use of Antimicrobials – Key to Contain AMR

सत्यमेव जयते

Preface

Antimicrobials play a crucial role in combating bacterial infections, but their inappropriate use, assists micro-organisms undergo genetic changes that enable them to resist the very drugs designed to eliminate them (Anti-microbial resistance or AMR). Consequently, previously successful treatments lose their effectiveness, resulting in increased rates of illness, loss of life, and escalated healthcare expense. In an era where antimicrobial resistance poses a significant threat to global health, a need for robust surveillance systems is imperative.

Estimating antimicrobial consumption is the crucial first step in addressing the global challenge of antimicrobial resistance. By understanding how antimicrobials are being used, targeted interventions can be developed to promote responsible use, improve prescribing practices, and preserve antimicrobial effectiveness.

India launched the National programme on AMR containment in the year 2013 and the National Action Plan on Antimicrobial Resistance in 2017. One of the strategic priorities has been to optimise the use of antimicrobials. To achieve this objective, National Centre for Disease Control co-ordinates antibiotic surveillance through National Antimicrobial Consumption Network (NAC-NET) comprising of 35 tertiary health care institutions.

Antimicrobial consumption data over five years (2017-2021) from 10 of these institutes has been compiled into this report. Through a comprehensive analysis of consumption patterns, we aim to highlight the amount and trends of antimicrobial usage, including the most commonly prescribed classes of antimicrobials and identify potential areas where interventions can be implemented. Understanding the actual consumption of antibiotics and other anti-microbials is the foundation to optimise their use.

We can use this data to develop policies that are grounded in evidence and aimed at encouraging responsible use of antimicrobials. This will help us preserve the effectiveness of existing medications and protect the health of future generations. I genuinely hope that this study will inspire all stakeholders generate a collective determination to combat antimicrobial resistance. By working together, we can guarantee that future generations enjoy extended and healthier lives.

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Abbreviations

AMR	Antimicrobial Resistance
ATC	Anatomical Therapeutic Chemical
AWaRe	Access, Watch, Reserve
Cap.	Capsule
DDD	Defined Daily Dose
g	Gram
GMC	Government Medical College
Inj.	Injection
mg	Milligram
NAC-NET	National Antibiotic Consumption-Network
NCDC	National Centre for Disease Control
SUs	Standard units
Tab.	Tablet
WHO	World Health Organisation

List of tables and figures

Executive summary

Antimicrobial resistance (AMR) is among the top ten public health threats according to WHO. One of the main drivers for the development of antibiotic resistance is excessive and inappropriate use of antibiotics. National Centre for Disease Control (NCDC) is the nodal agency for the National Programme on AMR containment in India. Surveillance of antibiotic usage is one of the key components of the national programme. To achieve this goal, NCDC established the National Antibiotic Consumption Network (NAC-NET). As part of this, the network sites compile the data on the antibiotics consumed in their respective health facilities and send it to NCDC.

This is the first report of the antibiotic consumption under the national programme on AMR containment which presents compiled and analysed antibiotic consumption data from ten NAC-NET sites over five years (2017-2021).

The total antibiotic consumption at the ten NAC-NET sites varied from 88.7 to 118.3 defined daily doses (DDD) per 100 bed days during the years 2017 to 2021. Classification of antibiotics as per the WHO AWaRe classification highlights that consumption of Watch group of antibiotics exceeded that of the Access group antibiotics in all years with proportions ranging from 52 to 73%. Tab. Amoxicillin and Clavulanic Acid 625mg (Access group), Tab. Azithromycin 500mg (Watch group), Tab. Cefixime 200mg (Watch group) and Inj. Ceftriaxone 1g (Watch group) were the most commonly used antibiotics over the years. Consumption of Reserve group of antibiotics ranged from 1 to 5%.

Background

Antibiotic resistance is one of the prominent threats to public health in the twenty-first century. AMR is a natural phenomenon as bacteria evolve and consequently the drugs used to treat infections become less effective. In 2019, 4.95 million deaths were estimated to be associated with bacterial AMR of which 1.27 million deaths were directly attributable to bacterial AMR (1). It is estimated that AMR will cause 10 million every year by 2050, becoming the number one cause of deaths globally (2). A major contributing factor to antibiotic resistance is overuse of antibiotics by humans, with approximately half or more of hospitals using antibiotics inappropriately (3–5).

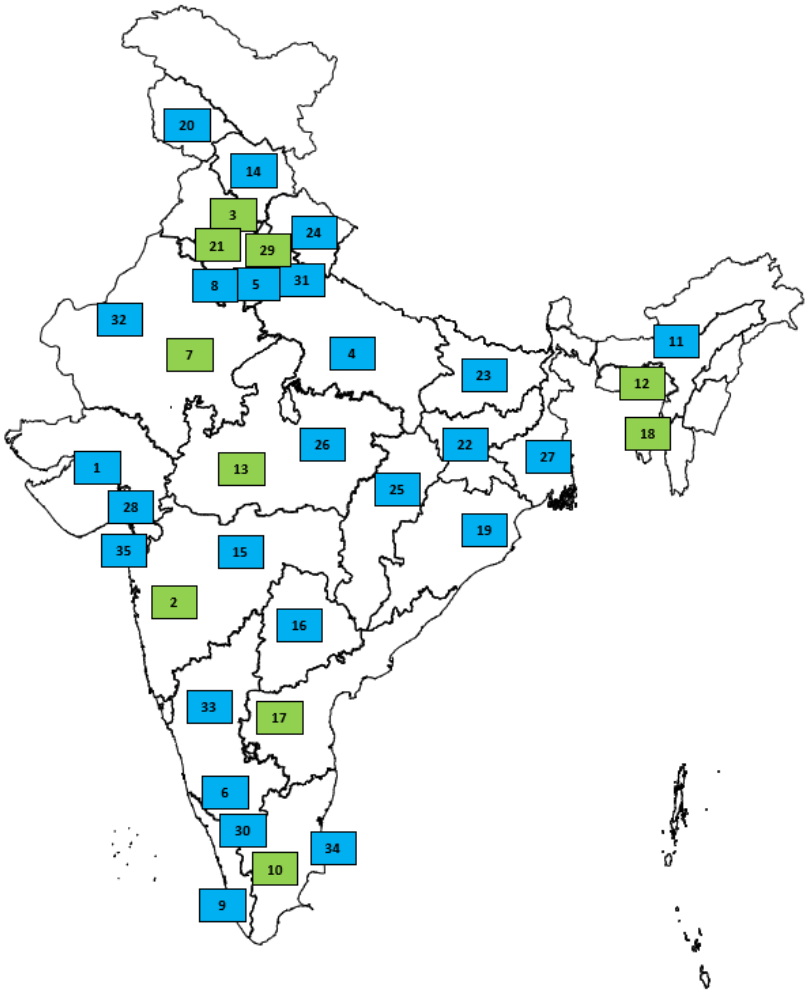
National Centre for Disease Control, New Delhi is the nodal agency for the National Programme on AMR Containment, which encourages rational antibiotic use (6). One of the priorities of this programme is to carry out surveillance of antibiotic usage in healthcare settings across India. Under the AMR programme, National Antibiotic Consumption-Network (NAC-NET) comprising of Government tertiary health care facilities was established across 24 States and 3 Union territories (UTs) in a phased manner (Fig. 1).

The global surveillance report for 2015 from 65 countries, does not include antibiotic consumption data from India. There are limited number of studies which assess the antibiotic consumption based on AWaRe classifications and Defined Daily Doses (DDD) in India (6). The purpose of this report is to collate the five-year (2017–2021) antibiotic consumption data from ten NAC-NET sites using the WHO Anatomical Therapeutic Chemical for Defined Daily Doses (ATC-DDD) methodology.

Antibiotic consumption data can be used to (7):

- recognize and detect changes in antibiotic exposure and use;
- develop interventions to address the identified problems;
- monitor the impact of interventions;
- ensure prescribing practices adhere to appropriate guidelines; and
- promote awareness of the adverse effects of inappropriate antibiotic use.

*Figure 1: Location of National Antibiotic Consumption Network (NAC-NET) sites**



	Phase I sites
1	BJMC, Ahmedabad
2	BJMC, Pune
3	GMC, Chandigarh
4	GMC, Kanpur
5	LHMC, Delhi
6	MMC & RI, Mysore
7	SMSMC, Jaipur
8	VMMC, Delhi

	Phase II sites
9	GMC, Trivandrum
10	KAPVGMC, Trichy
11	GMC, Guwahati
12	NEIGRIHMS, Shillong
13	MHMMC, Indore
14	IGMC, Shimla

	Phase III sites
15	GMC, Aurangabad
16	OMC, Hyderabad
17	GMC, Guntur
18	GMC, Agartala
19	SCBMC&H, Cuttack
20	GMC& H, Jammu

	Phase IV sites
21	PGIMS, Rohtak
22	RIMS, Ranchi
23	IGIMS, Patna
24	GMC, Haldwani
25	JLNMMC, Raipur

	Phase V sites
26	GMC, Bhopal
27	CSTM, Kolkata
28	GMERSMC&H, Valsad
29	LLRMMC, Meerut

	Phase VI sites
30	CMCH, Coimbatore
31	MAMC, Delhi
32	SPMC, Bikaner
33	KIMS, Hubballi
34	IGMC&RI, Puducherry
35	NAMOMERI, Silvassa

* Antibiotic consumption data from ten NAC-NET sites (marked in green) are included in this report.

Methodology

The antibiotic consumption data collection, compilation and report preparation was done as follows:

Selection of sites

The sites included in this report were the ones which had compiled the antibiotic consumption data for the years 2017 to 2021. The site list is provided in Fig. 1

Training

The pharmacists recruited under the programme undergo induction and refresher trainings. The trainings cover:

- Collection of antibiotic consumption data from the central stores/ pharmacy;
- Collection of bed occupancy data from the medical records department;
- Compilation of the data in the excel template provided by NCDC;
- Calculation of DDD and DDD/100-bed-days using the WHO AMC tool 2019 as per the WHO ATC-DDD methodology; and
- Analysis of the compiled data using trend graphs, AWaRe classification and top 5 antibiotics.

Inclusion criteria

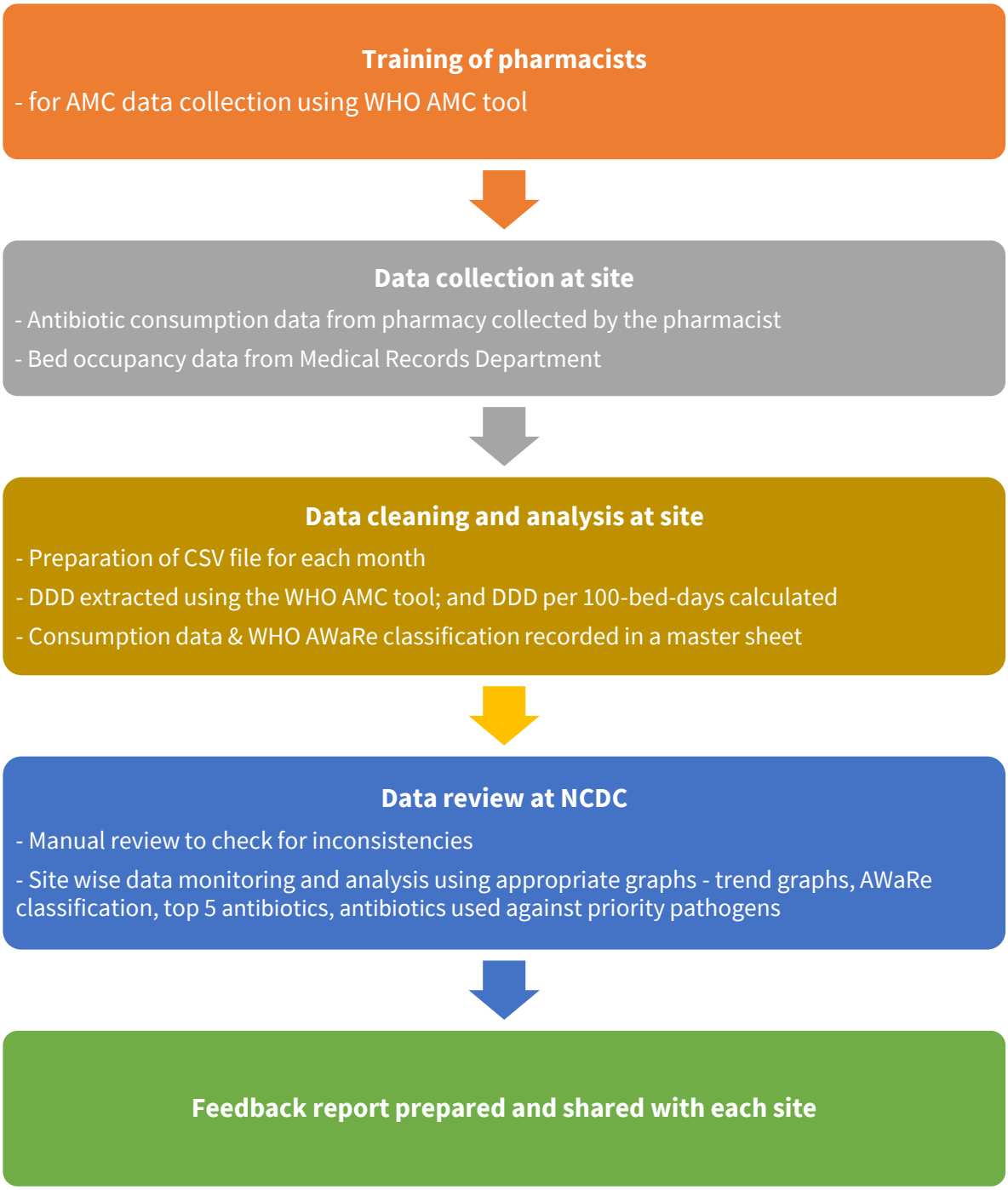
- Antibiotics consumed at the inpatient facilities of NAC-NET sites
- Antibiotics prescribed through oral and parenteral routes

Exclusion criteria

- Antibiotics prescribed in any other route ex. topical preparations, eye/ear drops, gel, and suppositories
- Other antibiotics like antifungal, antiviral, antitubercular, antiprotozoals

Antibiotics were classified in J01 and P01 groups under the WHO Anatomical Therapeutic Chemical (ATC) classification system. We reported consumption estimates in standard units (SUs) defined as the smallest dose of formulation like one tablet or capsule for oral solids, and one vial or ampoule for injectable antibiotics.

Figure 2: Mechanism of data collection and feedback to sites



Measures of antibiotic consumption

Antibiotic consumption was measured in Defined Daily Doses.

- Defined Daily Dose: The assumed average maintenance dose per day for a drug used for its main indication in adults (5). WHO AMC Tool 2019 v.1.9.0 was used to calculate DDDs of each volume of antibiotics.
- Bed occupancy: Bed occupancy rate for each month was calculated using the formula – Bed occupancy rate / Bed days = Occupied beds / Available beds,
- DDD/100-bed-days: This was calculated using the total number of beds for all sites and using the bed occupancy rate as 100%.

Data collection and analysis

At the site level, data collection is done by the pharmacist. The steps include:

- Consumption data is collected from the central drug store of the health facility.
- Bed occupancy data is sourced from the Medical Records Department.
- Consumption data is recorded in a master sheet along with their WHO AWaRe (Access-Watch-Reserve) classification.
- A CSV file is created using the following variables:
    - Name of the antibiotic
    - Pack size
    - Strength of the drug
    - ATC code
    - Route of administration
- After data entry, data was imported in WHO AMC Tool 2019 v.1.9.0, to calculate the DDD of each antibiotic.
- DDD/100-bed-days calculated month wise for each antibiotic and consolidated.

Overview at NCDC:

- Manual review of antibiotic consumption was done to check for inconsistencies.
- The sites were consulted for confirmation.
- Analysis of the data done using trend graphs based on AWaRe classification, antibiotics used against priority pathogens.
- Feedback document prepared for each site consisting of 5-year trend graphs, AWaRe classification, top-5 antibiotics and antibiotics used against priority pathogens
- Monthly data for ten sites compiled and consolidated for each year using MS-Excel.
- A new CSV file was prepared for each year for the consolidated consumption.
- After data entry, data was imported into WHO AMC Tool 2019 v.1.9.0, to calculate DDD of each antibiotic.
- DDD/100-bed-days was calculated month wise for each antibiotic and consolidated.
- Consolidated data was then analysed for the indicators mentioned below.

Indicators monitored

Antibiotic consumption is organized using the following key indicators:

- Annual consumption in terms of DDD/100-bed-days
- AWaRe classification of antibiotics
- List of top-10 antibiotics used
- Consumption of antibiotics against WHO priority pathogens
- Route of administration of antibiotics

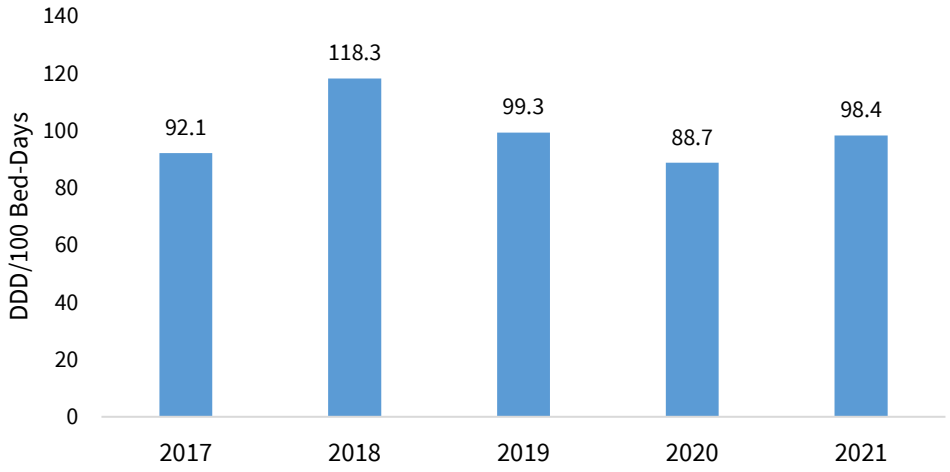
Results

Each of the NAC-NET sites had a different bed strength in the 5 years for which this analysis was done. A cumulative bed strength of each year for the 10 sites is given in Table 1.

Table 1: Year wise cumulative bed strength

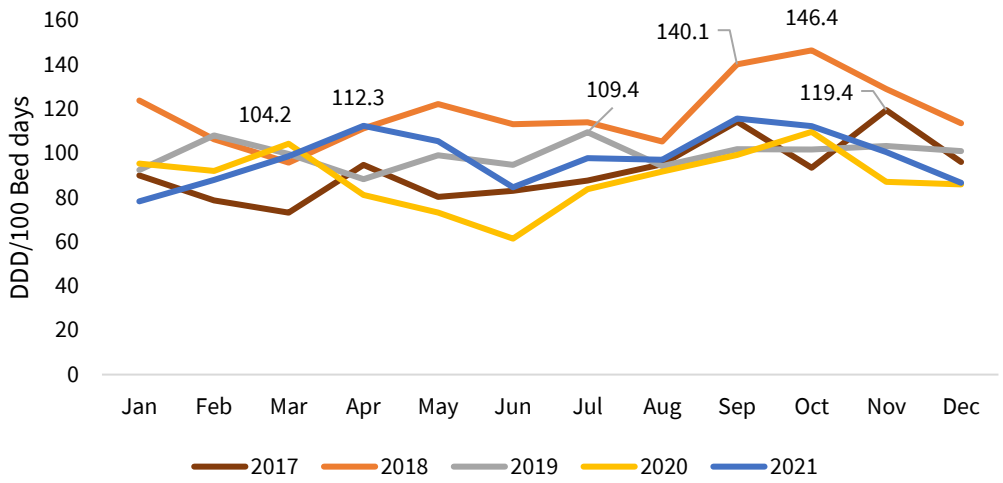
Year	Cumulative beds
2017	13838
2018	14088
2019	14889
2020	15168
2021	15532

Figure 3: Antibiotic consumption from 2017-2021



The antibiotic consumption across the ten sites ranged from 88.7 (2020) to 118.3 (2018) DDD/100-bed-days over the five years.

Figure 4: Trend of antibiotic consumption from 2017-2021



The trend of antibiotic consumption shows a surge in November 2017, September-October 2018, July 2019 and April 2021.

AWaRe classification of antibiotics

The antibiotics used in the hospitals are classified based on WHO AWaRe classification into three groups (8)

- Access group of antibiotics have activity against a wide range of commonly encountered susceptible pathogens while also showing lower resistance potential than antibiotics in the other groups
- Watch group of antibiotics have higher resistance potential and includes most of the highest priority agents
- Reserve group of antibiotics includes antibiotics and antibiotic classes that should be reserved for treatment of confirmed or suspected infections due to multi-drug-resistant organisms.

Figure 5: Consumption of antibiotics as per WHO AWaRe classification (2017-2021)

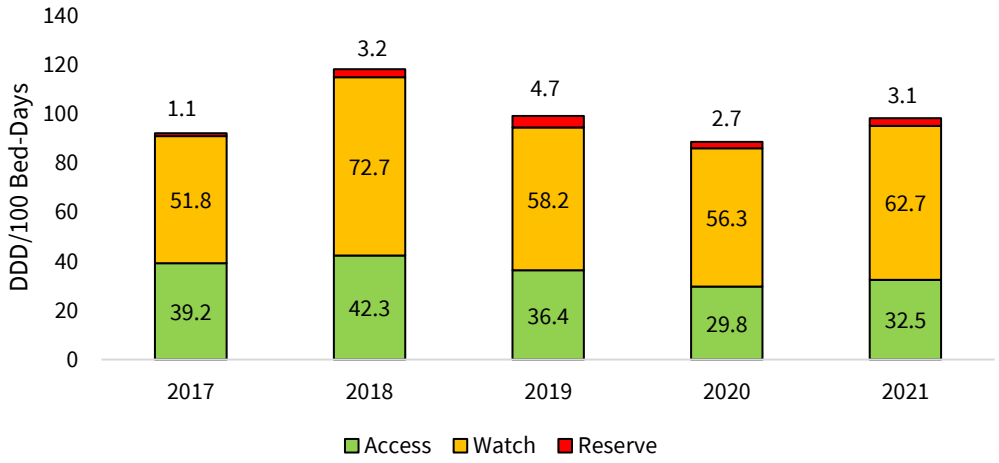
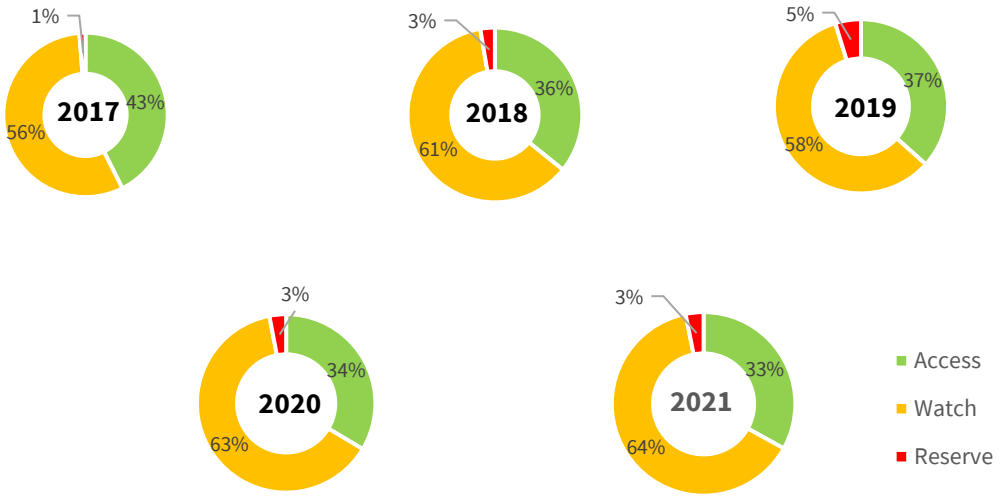
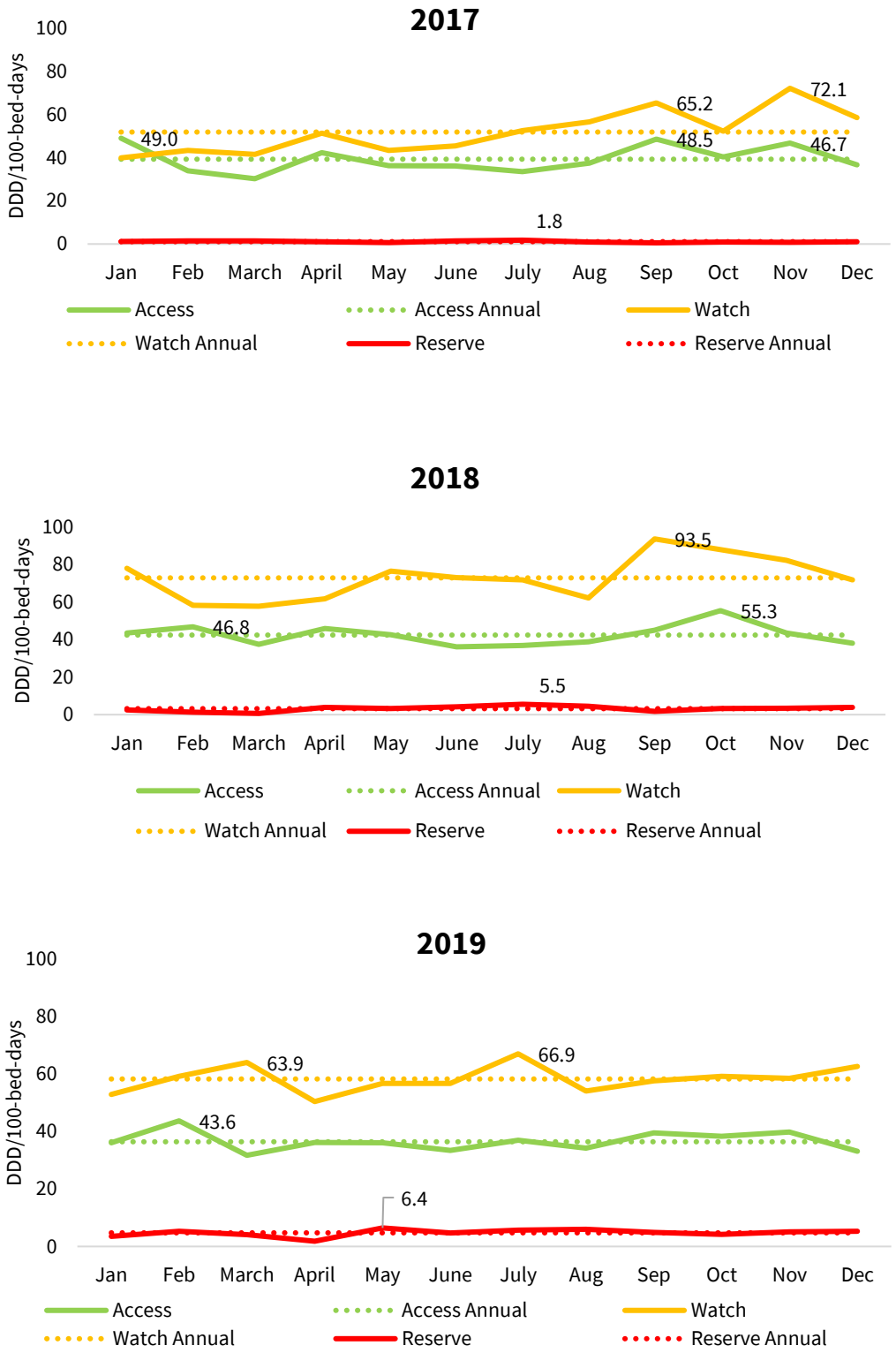


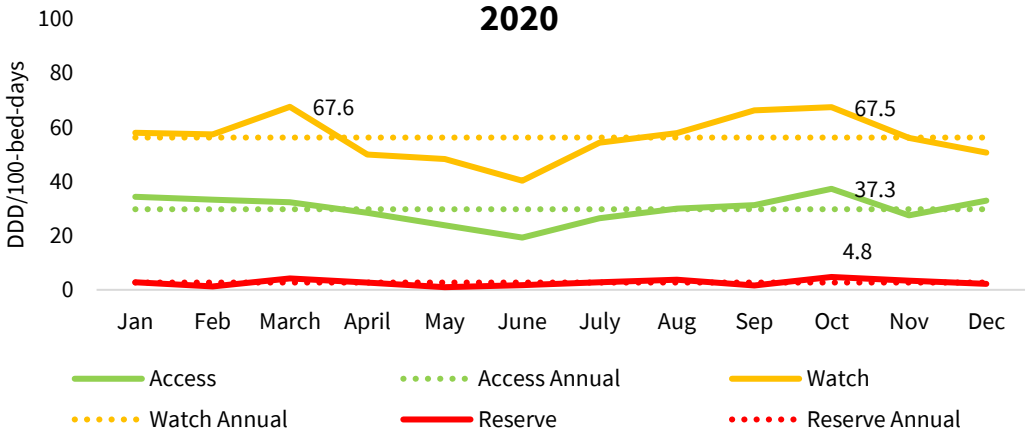
Figure 6: Proportion of antibiotic consumption based on WHO AWaRe classification (2017-2021)



Access group consumption ranged from 29.8 to 42.3 DDD per 100-bed-days with 2017 recording the highest proportion of Access group consumption at 43%. The Watch group consumption steadily increased from 51.8 to 72.7 DDD/100-bed-days with 2021 recording the highest proportion of Watch group consumption at 64%. Reserve group consumption ranged from 1.1 to 4.7 DDD/100-bed-days with the highest consumption seen in 2019.

Figure 7: Trend of antibiotic consumption as per WHO AWaRe classification (2017-2021)




2020
DDD/100-bed-days
100
80
60
40
20
0
67.6
67.5
37.3
4.8
Jan
Feb
March
April
May
June
July
Aug
Sep
Oct
Nov
Dec
Access
Access Annual
Watch
Watch Annual
Reserve
Reserve Annual

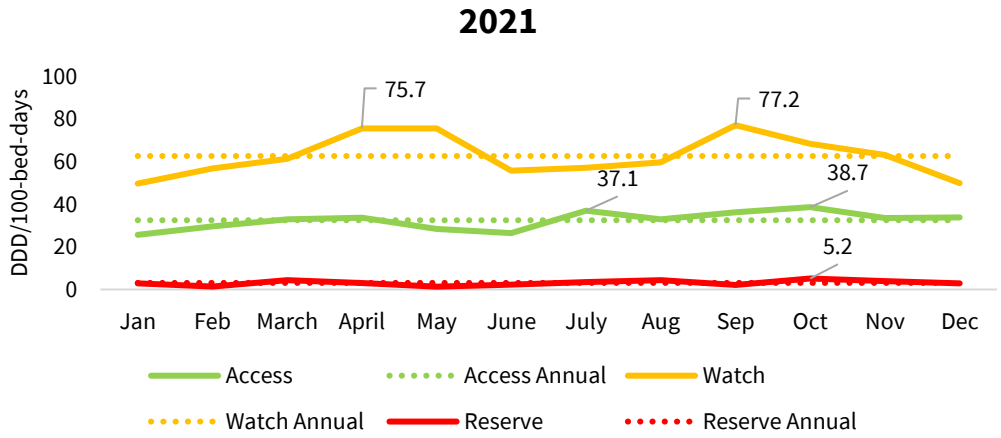
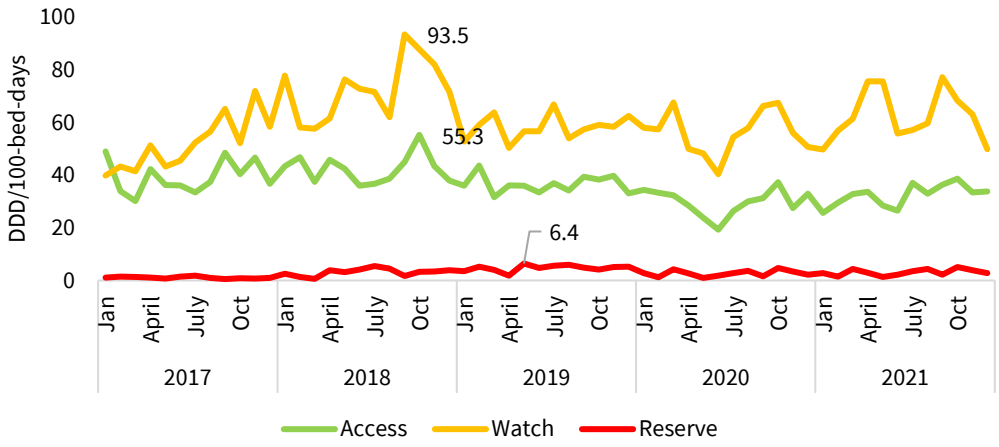
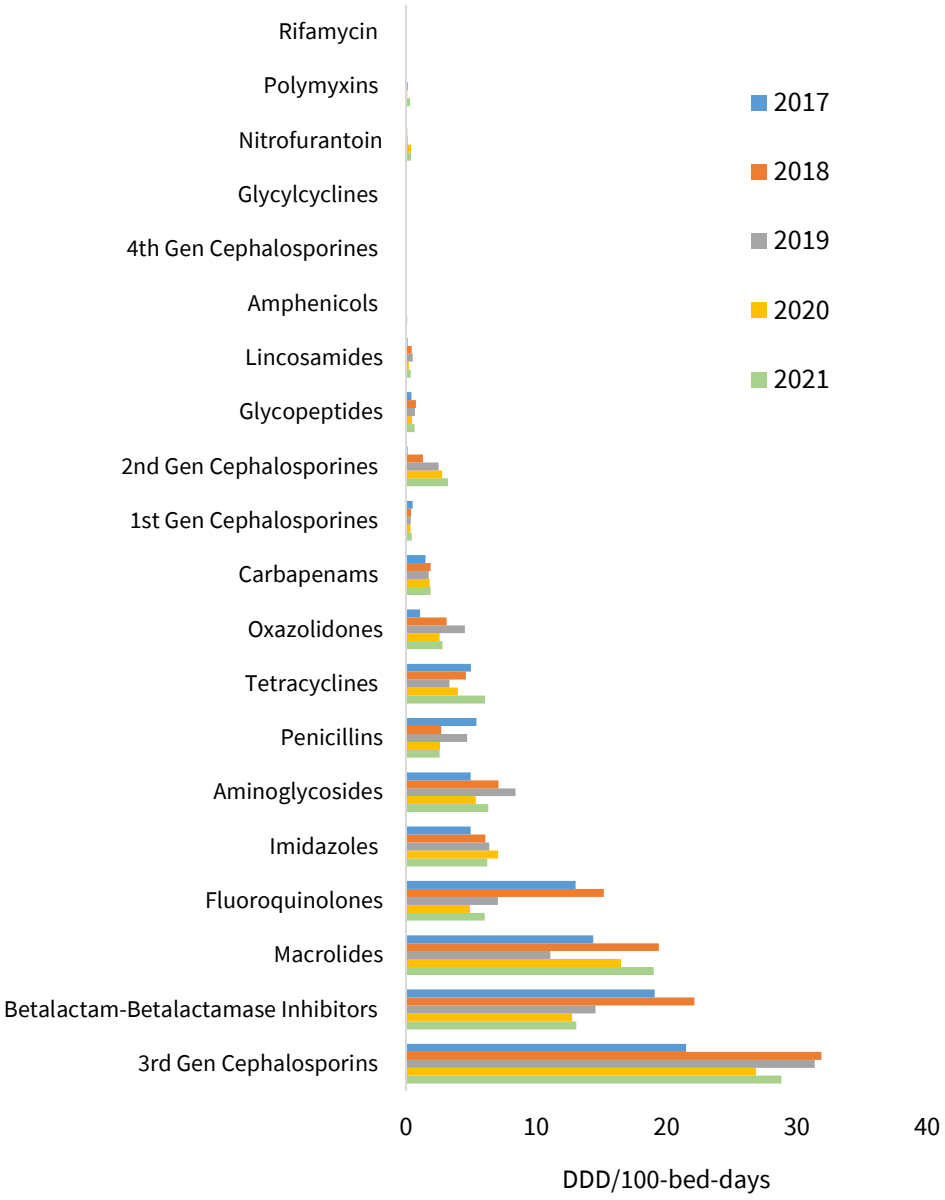

2021
DDD/100-bed-days
100
80
60
40
20
0
75.7
77.2
37.1
38.7
5.2
Jan
Feb
March
April
May
June
July
Aug
Sep
Oct
Nov
Dec
Access
Access Annual
Watch
Watch Annual
Reserve
Reserve Annual

Figure 8: Overall trend of antibiotic consumption as per WHO AWaRe classification (2017-2021)



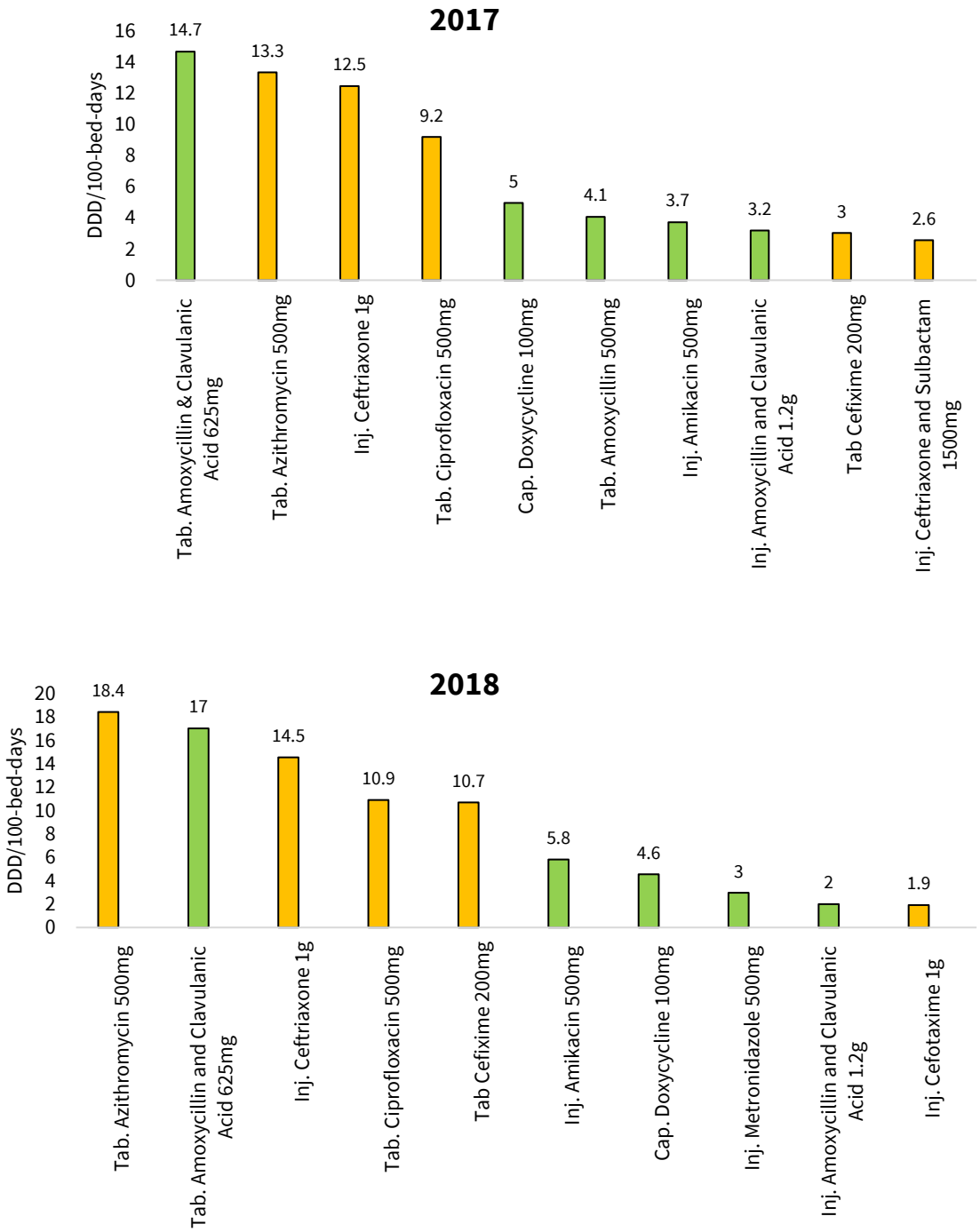
Consumption of Watch group antibiotics remained high in all five years, except in January 2017, when the Access group consumption exceeded that of Watch group. The highest consumption of Watch group antibiotics was seen in September 2018, and the highest consumption of Reserve group antibiotics was seen in May 2019.

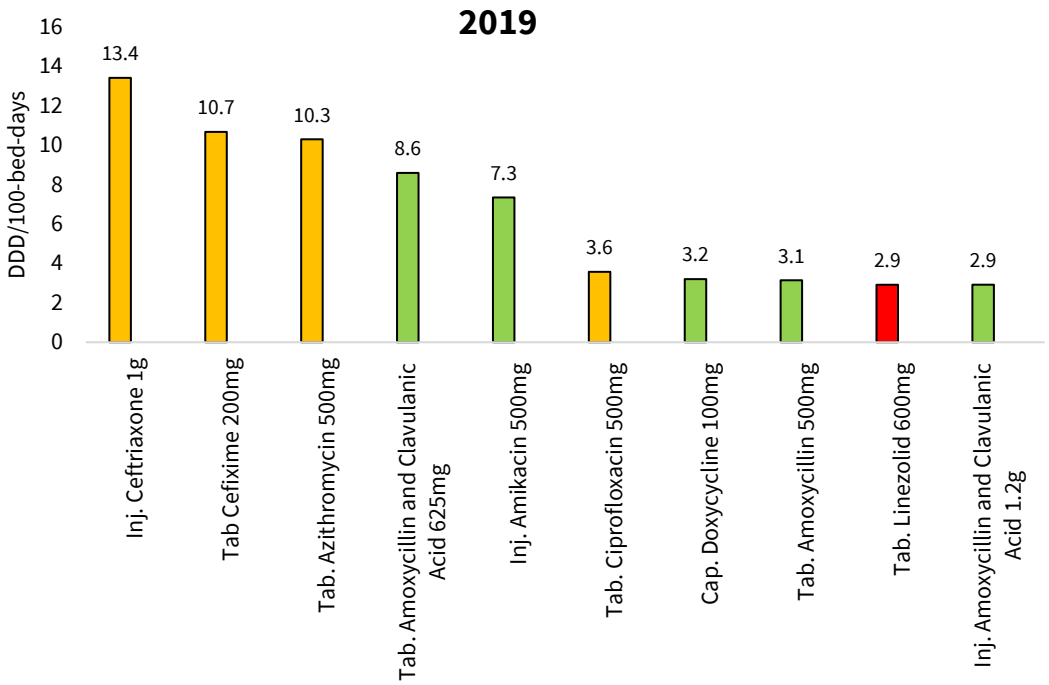
Figure 9: Year-wise consumption of various classes of antibiotics

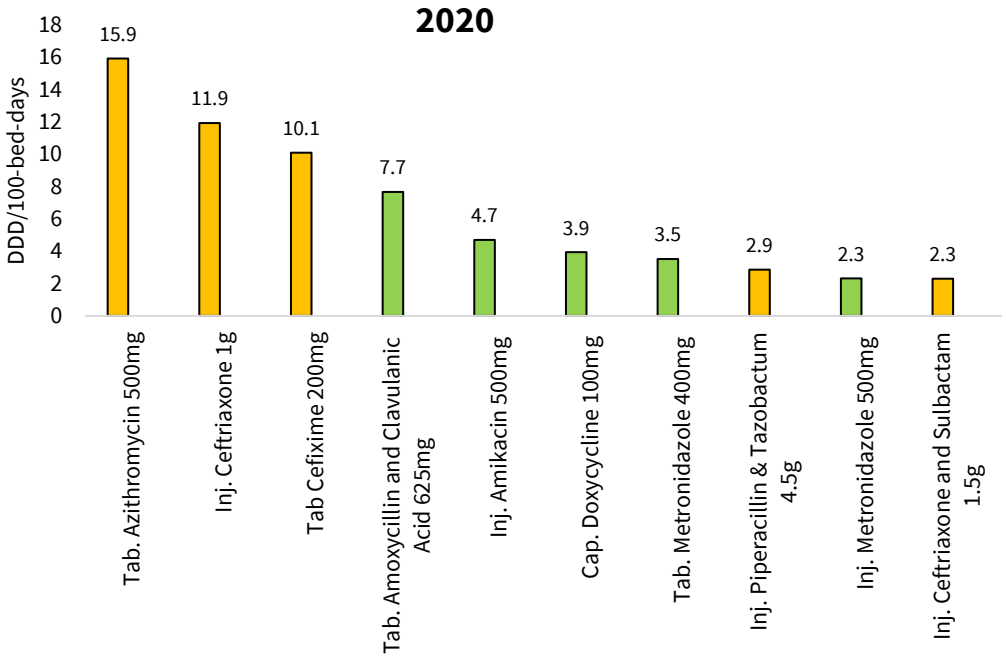


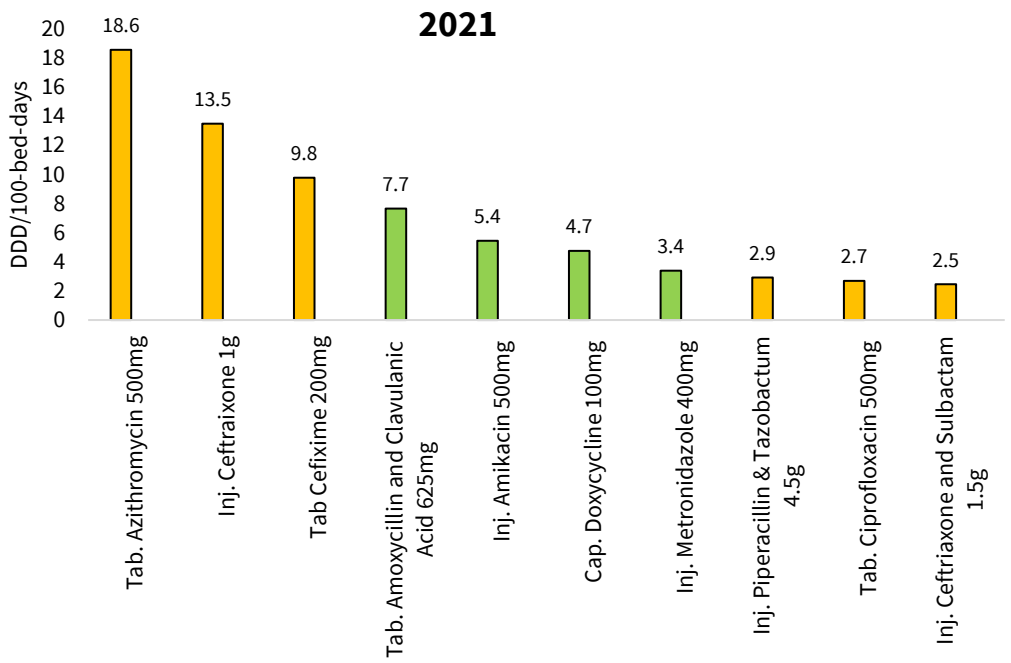
Third generation cephalosporins were the highest consumed class of antibiotics across the years followed by combinations of beta-lactams with beta-lactamase inhibitors.

Figure 10: Year wise top 10 antibiotics from 2017-2021




2019
DDD/100-bed-days
16
14
12
10
8
6
4
2
0
13.4
10.7
10.3
8.6
7.3
3.6
3.2
3.1
2.9
2.9
Inj. Ceftriaxone 1g
Tab Cefixime 200mg
Tab. Azithromycin 500mg
Tab. Amoxycillin and Clavulanic Acid 625mg
Inj. Amikacin 500mg
Tab. Ciprofloxacin 500mg
Cap. Doxycycline 100mg
Tab. Amoxycillin 500mg
Tab. Linezolid 600mg
Inj. Amoxycillin and Clavulanic Acid 1.2g

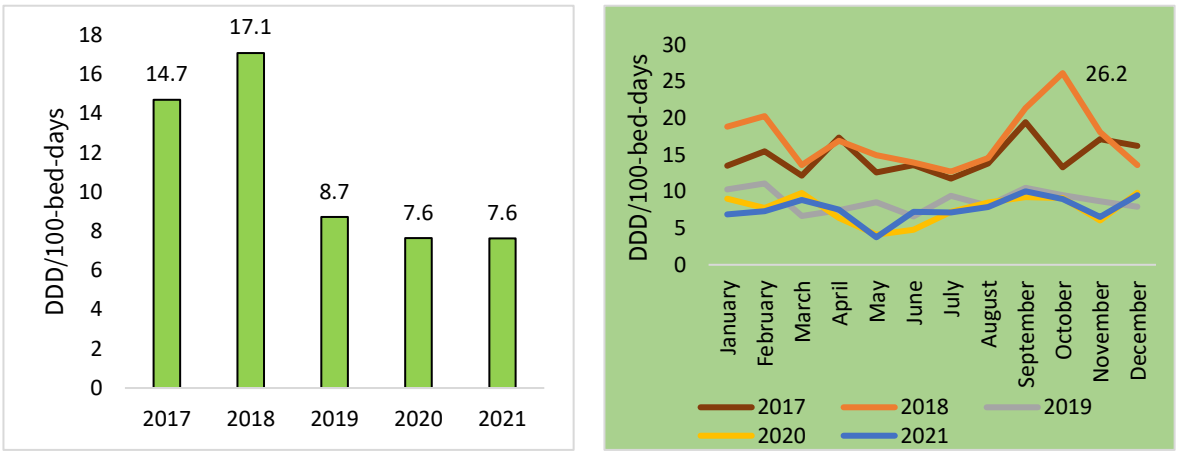

2020
DDD/100-bed-days
18
16
14
12
10
8
6
4
2
0
15.9
11.9
10.1
7.7
4.7
3.9
3.5
2.9
2.3
2.3
Tab. Azithromycin 500mg
Inj. Ceftriaxone 1g
Tab Cefixime 200mg
Tab. Amoxycillin and Clavulanic Acid 625mg
Inj. Amikacin 500mg
Cap. Doxycycline 100mg
Tab. Metronidazole 400mg
Inj. Piperacillin & Tazobactum 4.5g
Inj. Metronidazole 500mg
Inj. Ceftriaxone and Sulbactam 1.5g



Tab. Azithromycin 500mg, Inj. Ceftriaxone 1g, Inj. Amikacin 500mg, Tab. Amoxycillin and clavulanic acid 625mg, Cap. Doxycycline 100mg, and Tab. Cefixime 200mg were among the top ten antibiotics that were consumed across the ten sites in all five years.

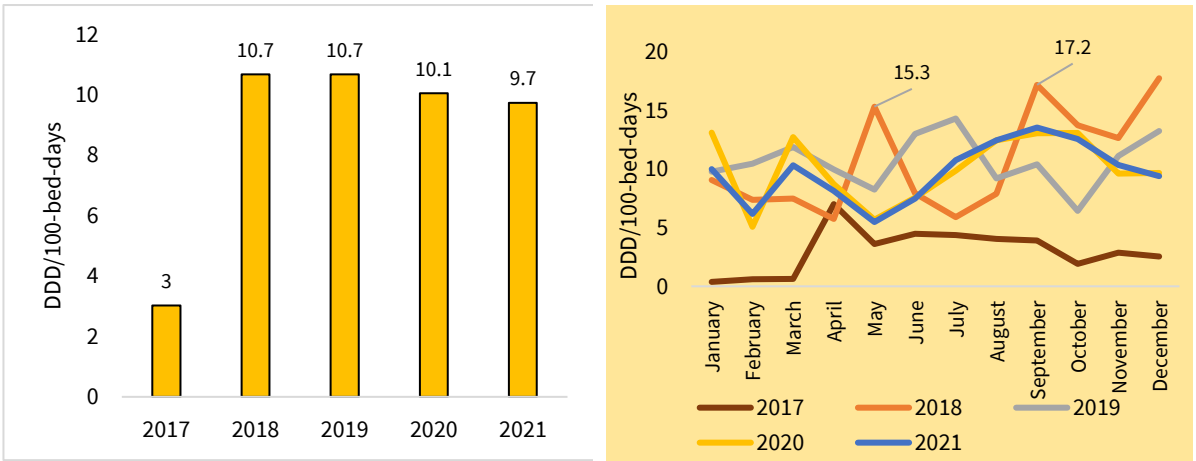
Year Wise consumption of Individual Antibiotics among top 10

Figure 11: Year wise consumption and trend of Tab. Amoxycillin and Clavulanic Acid (625mg)



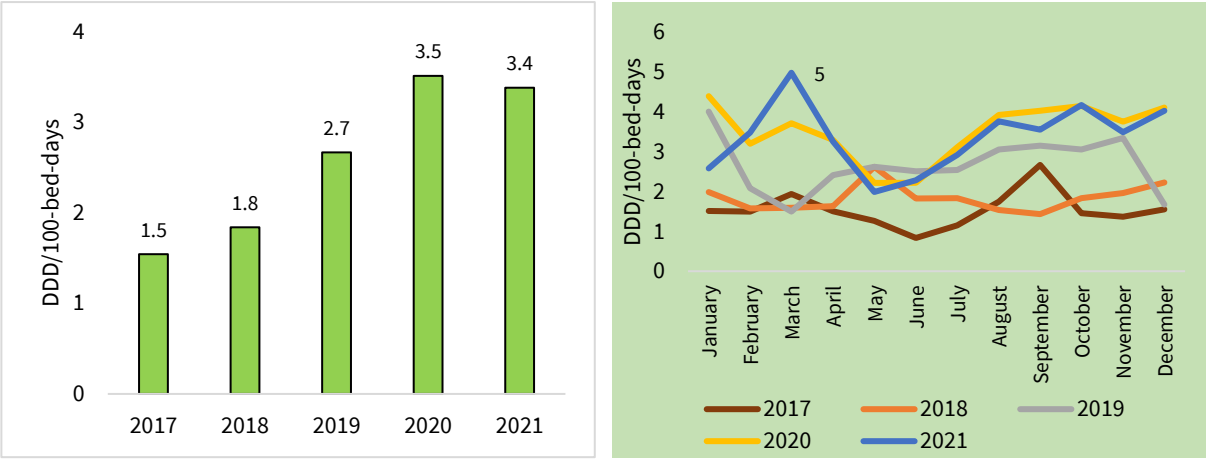
Consumption of Tab. Amoxycillin and Clavulanic Acid 625 mg ranges from 7.6 (2020 & 2021) to 17.1 (2018) DDD/100-bed-days. The consumption has decreased over the years. The highest consumption was seen in October 2018.

Figure 12: Year wise consumption and trend of Tab. Cefixime (200 mg)



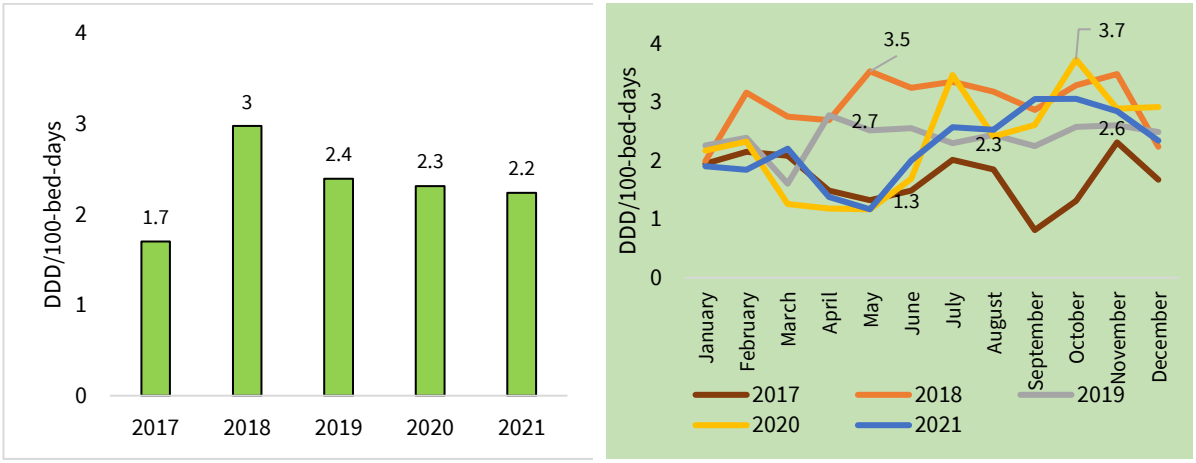
Consumption of Tab. Cefixime 200mg ranged from 3 DDD/100-bed-days in 2017 to 10.7 DDD/100-bed-days in 2018 & 2019. The consumption has remained constant over the last 4 years. The peak in consumption was seen in September 2018.

Figure 13: Year wise consumption and trend of Tab. Metronidazole (400 mg)



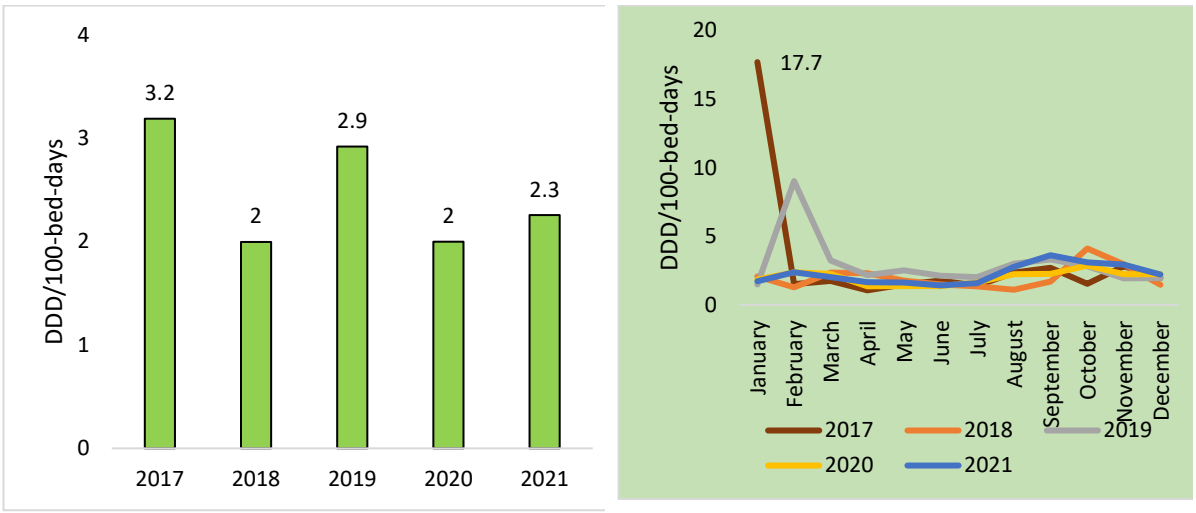
Annual consumption of Tab. Metronidazole 400mg ranged from 1.5 DDD/100-bed-days (2017) to 3.5 DDD/100-bed-days across five years. The highest consumption was seen in March 2021.

Figure 14: Year wise consumption and trend of Inj. Metronidazole (500mg)



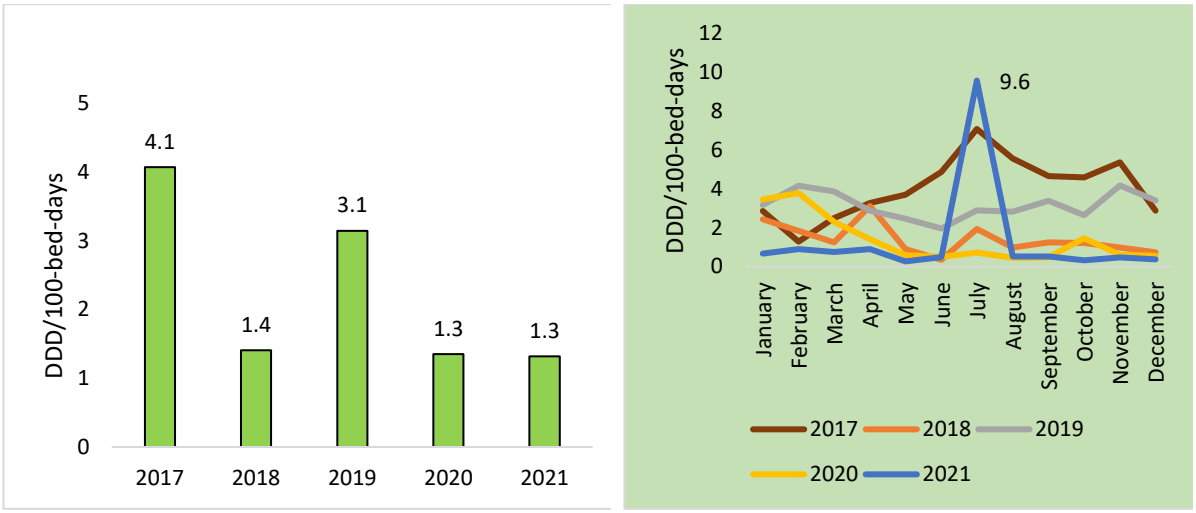
Annual consumption of Inj. Metronidazole 500mg ranged from 1.7 DDD/100-bed-days (2017) to 3 DDD/100-bed-days (2018) across five years. Highest consumption was noticed in October 2020.

Figure 15: Year wise consumption and trend of Inj. Amoxycillin and Clavulanic Acid (1.2g)



Annual consumption of Inj. Amoxycillin and Clavulanic Acid 1.2g ranged from 2 DDD/100-bed-days (2018 and 2020) to 3.2 DDD/100-bed-days (2017) across five years. Highest consumption was noticed in January 2017.

Figure 16: Year wise consumption and trend of Tab. Amoxycillin (500mg)

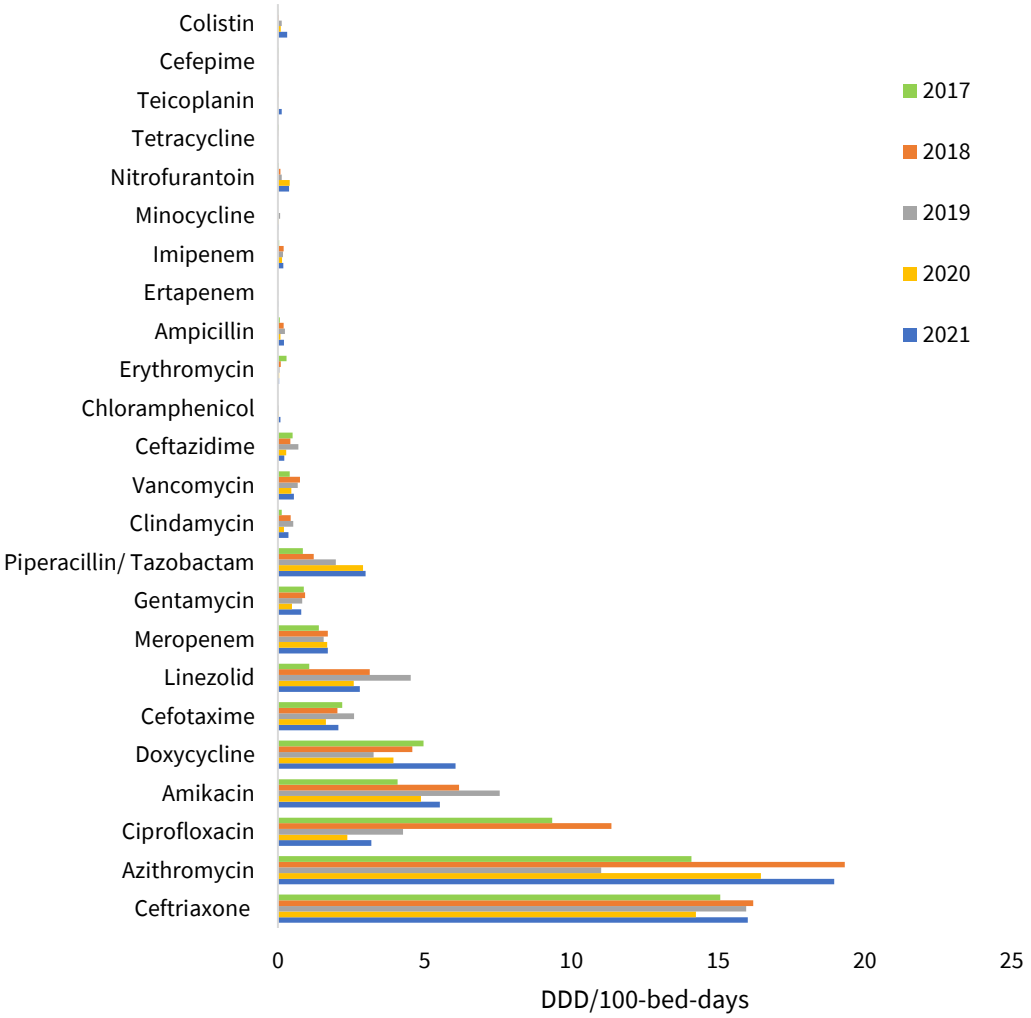


Annual consumption of Tab. Amoxycillin 500mg ranged from 1.3 DDD/100-bed-days (2020 and 2021) to 4.1 DDD/100-bed-days (2017) across five years. Highest consumption was noticed in July 2021.

Antibiotics against priority pathogens under National Programme on AMR Containment

Thirty antibiotics have been prioritised under the National Antibiotic Resistance Surveillance Network (NARS-NET) at NCDC against 6 priority pathogens. Fig. 17 depicts the commonly used antibiotics against priority pathogens across the ten sites for the years 2017 to 2021.

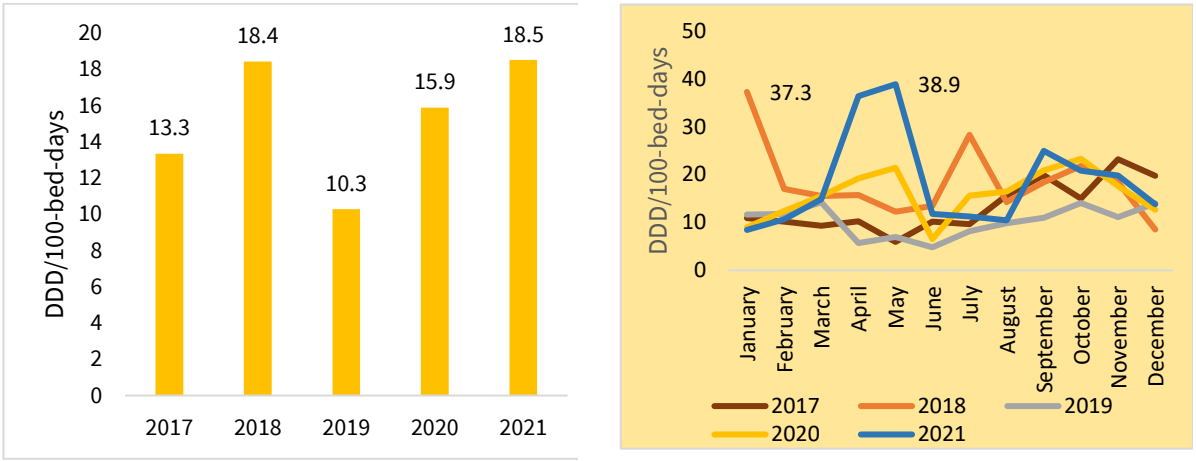
Figure 17: Year-wise consumption of antibiotics against priority pathogens



Majority of the antibiotics belonged to the Watch group. Ceftriaxone, Azithromycin, Ciprofloxacin were the top three antibiotics consumed against priority pathogens. Graphical representation of the most commonly consumed antibiotics against priority pathogens over the years along with monthly trends are shown below.

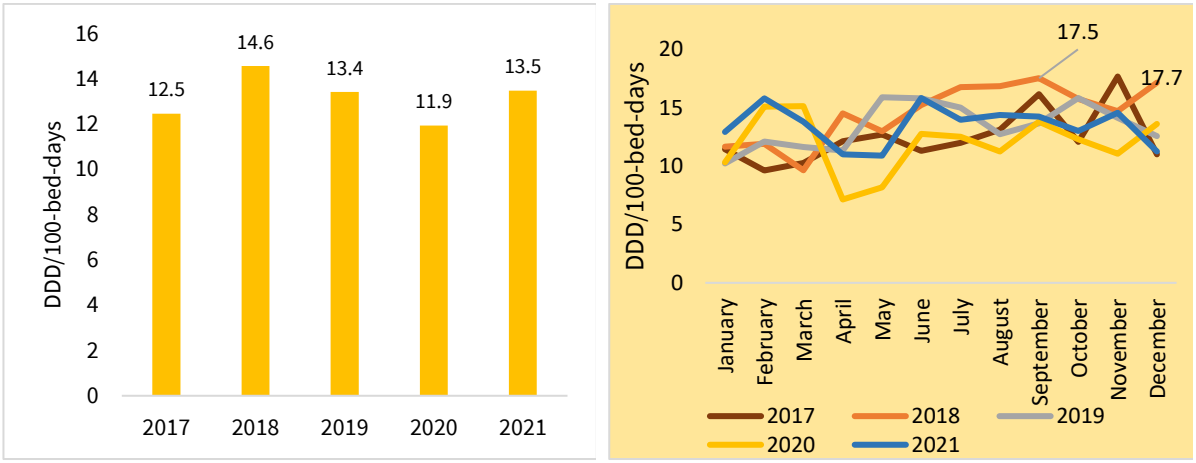
Antibiotics against priority pathogens: The top antibiotics used from 2017 to 2021

Figure 18: Year wise consumption and trend of Tab. Azithromycin (500 mg)



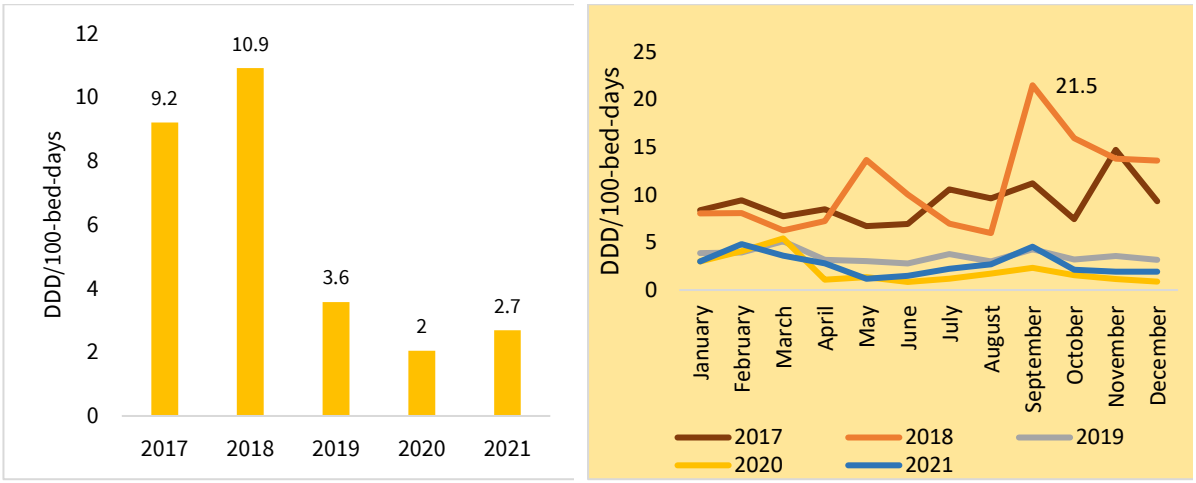
Consumption of Tab. Azithromycin ranged from 10.3 in 2019 to 18.5 DDD/100-bed-days in 2021. The consumption has been increasing over the years, and highest consumption was seen in May 2021.

Figure 19: Year wise consumption and trend of Inj. Ceftriaxone (1 g)



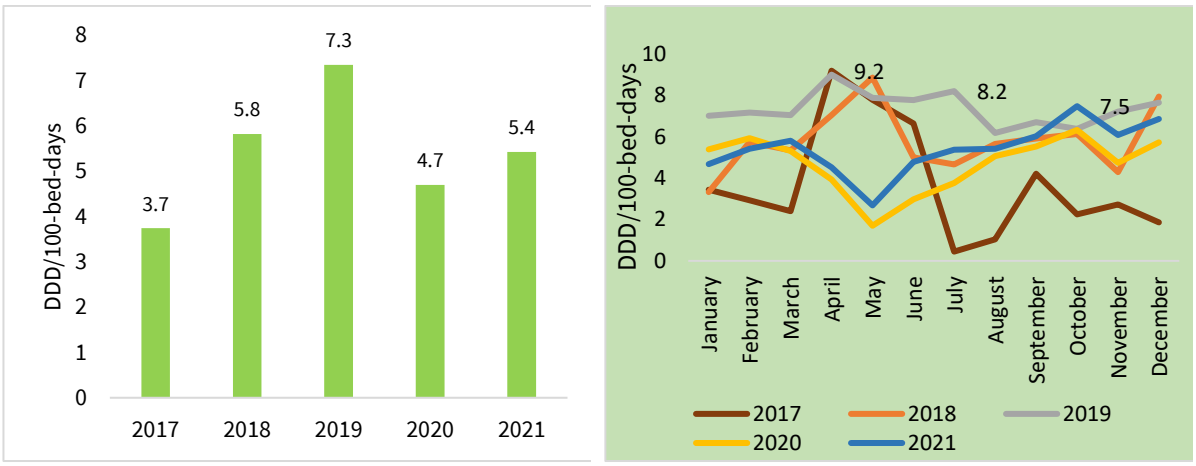
Consumption of Inj. Ceftriaxone 1g has been constant in all the five years ranging from 11.9 DDD/100-bed-days in 2020 to 14.6 DDD/100-bed-days in 2018. The highest consumption was observed in September 2018.

Figure 20: Year wise consumption and trend of Tab. Ciprofloxacin (500 mg)



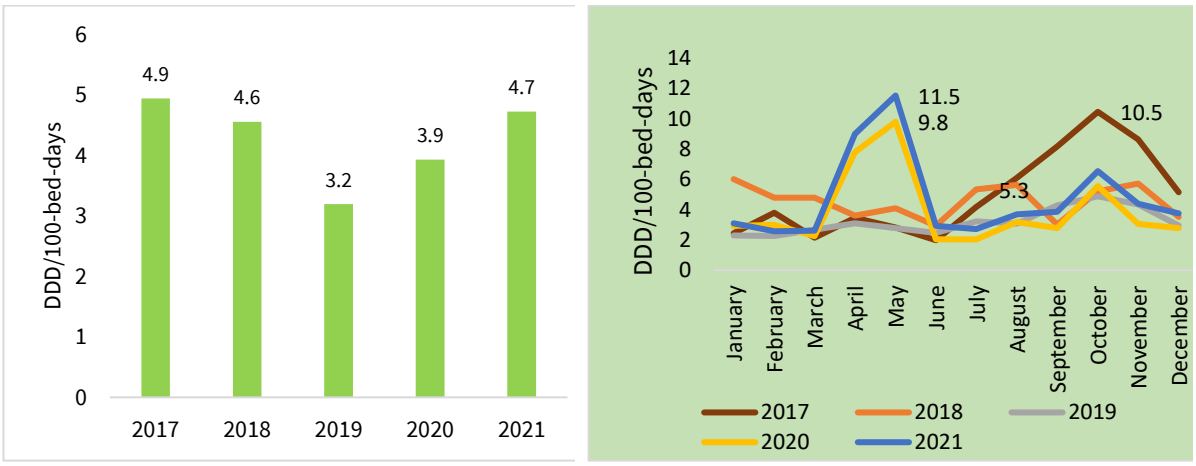
Consumption of Tab. Ciprofloxacin 500mg ranged from 2 DDD/100-bed-days in 2020 to 10.9 DDD/100-bed-days. The consumption has decreased over the years from 2017 to 2021. The peak in consumption was observed in September 2018.

Figure 21: Year wise consumption and trend of Inj. Amikacin (500 mg)



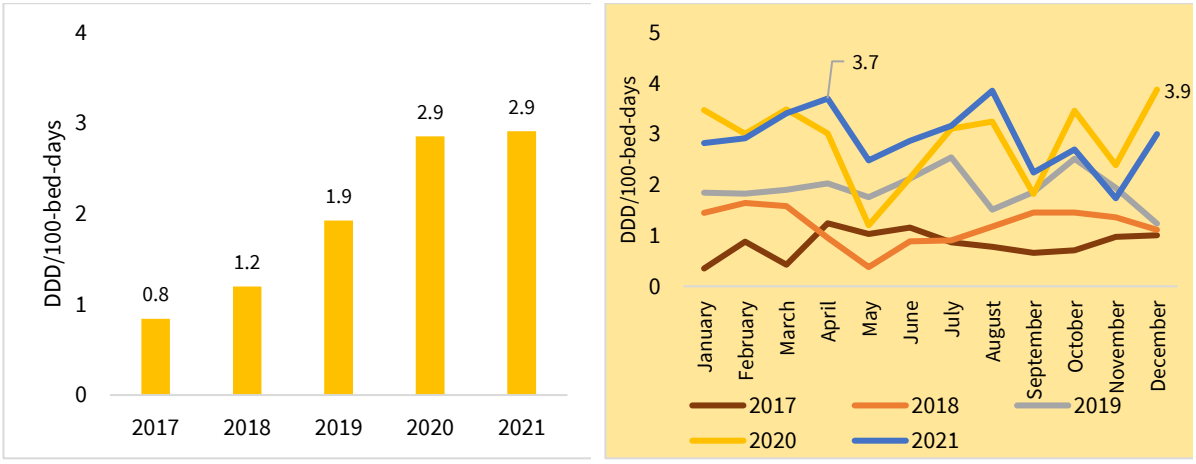
Consumption of Inj. Amikacin 500mg ranged from 3.7 in 2017 to 7.4 DDD/100-bed-days in 2019. The peak in consumption was observed in April 2019.

Figure 22: Year wise consumption and trend of Cap. Doxycycline (100 mg)



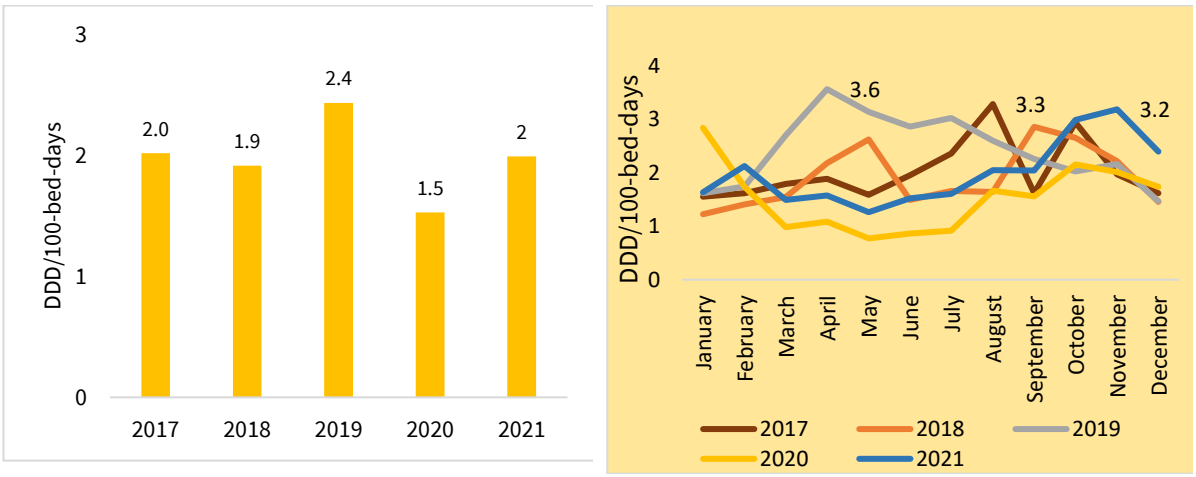
Consumption of Cap. Doxycycline ranged from 3.2 DDD/100-bed-days in 2019 to 4.9 DDD/100-bed-days in 2017. The highest consumption was seen in May 2021 and October 2017.

Figure 23: Year wise consumption and trend of Inj. Piperacillin and Tazobactam (4.5 g)



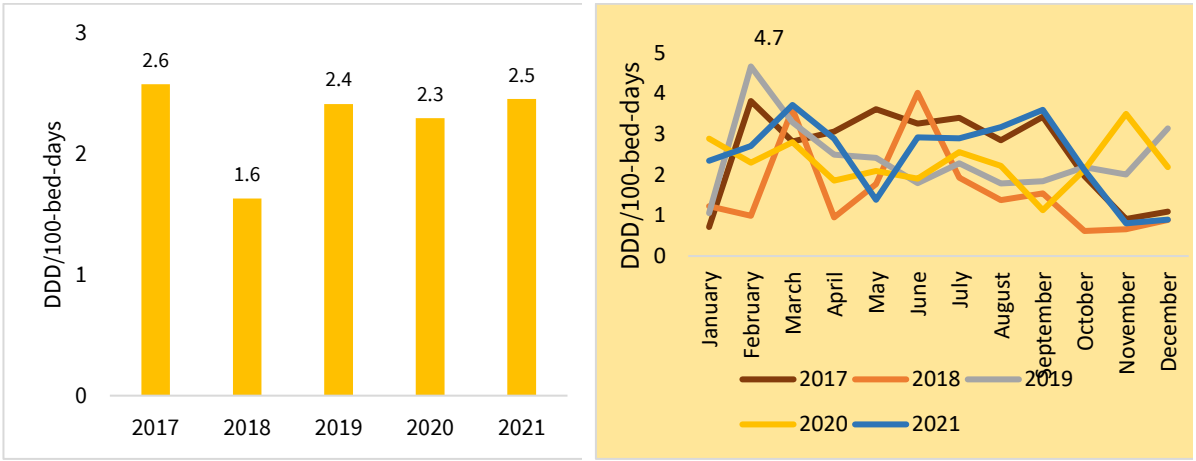
Consumption Inj. Piperacillin and Tazobactam 4.5 g has seen a steady rise. The consumption ranges from 0.8 DDD/100-bed-days in 2017 to 2.9 DDD/100-bed-days in 2021. The highest consumption was seen in April 2021.

Figure 24: Year wise consumption and trend of Inj. Cefotaxime (1 g)



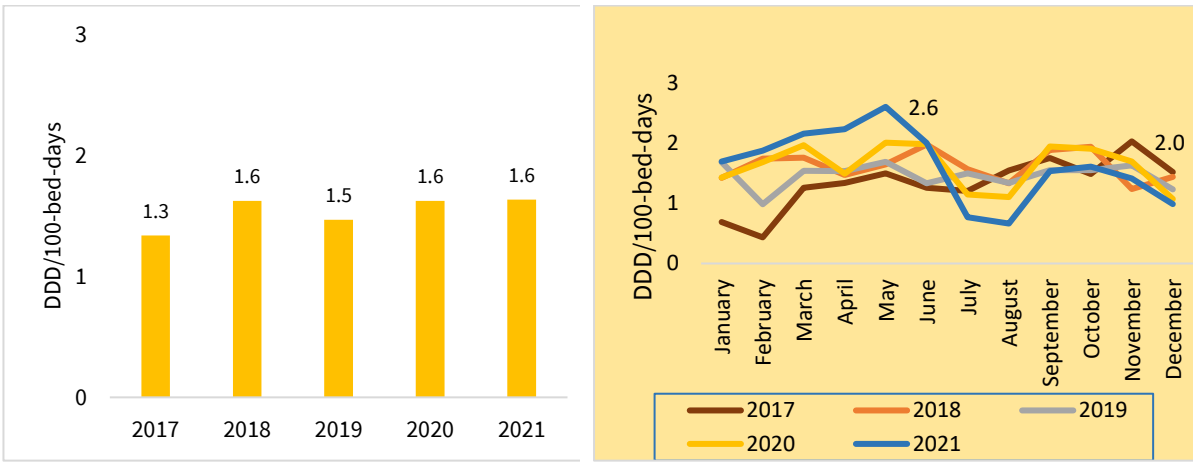
Consumption on Inj. Cefotaxime 1g ranged from 1.5 DDD/100-bed-days in 2020 to 2.4 DDD/100-bed-days in 2019. The peak in consumption was seen in April 2019.

Figure 25: Year wise consumption and trend of Inj. Ceftriaxone and Sulbactam (1.5 g)



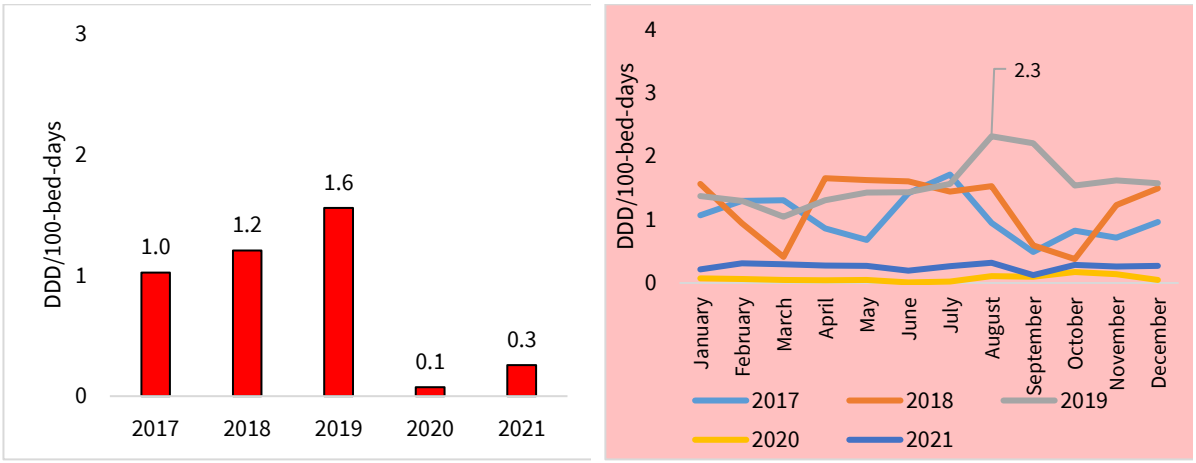
Consumption on Inj. Ceftriaxone Sulbactam 1.5g ranged from 1.6 DDD/100-bed-days in 2018 to 2.6 DDD/100-bed-days in 2017. The highest consumption was observed in February 2019.

Figure 26: Year wise consumption and trend of Inj. Meropenem (1 g)



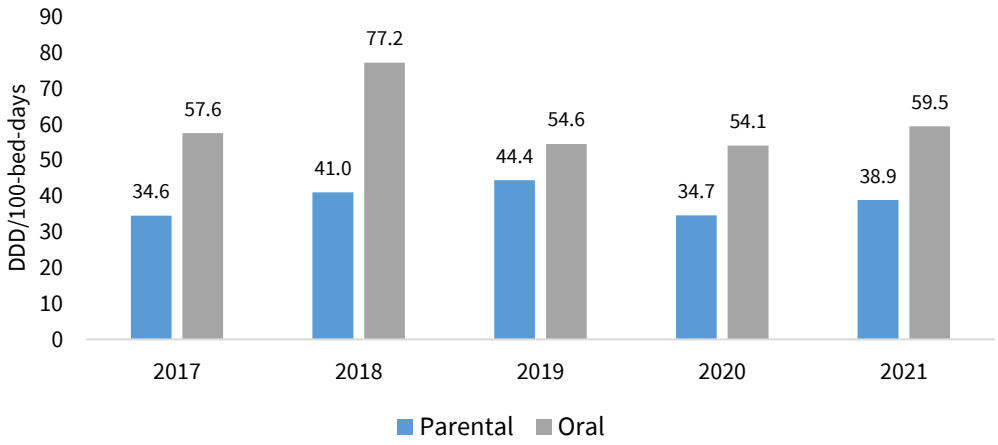
Consumption of Inj. Meropenem 1g, ranged from 1.3 DDD/100-bed-days in 2017 to 1.6 DDD/100-bed-days in 2021. The highest consumption was seen in May 2021. The consumption has been steady at similar levels in the five years across ten sites.

Figure 27: Year wise consumption and trend of Inj. Linezolid (600 mg)



Consumption of Inj. Linezolid 600mg ranged from 0.07 in 2020 to 1.6 DDD/100-bed-days in 2017. The peak in consumption was seen in August 2019.

Figure 28: Route of Administration of antibiotics used across 2017- 2021



It is observed that each year the proportion of oral antibiotics are consumed more than parenteral antibiotics.

Discussion

We observed that consumption of antibiotics ranged from 88.7 (2020) to 118.3 (2018) DDD/100-bed-days. Watch group of antibiotics were consumed more than the access group antibiotics in all the five years ranging from 51.8 to 72.7 DDD/100-bed-days with 2021 recording the highest proportion of Watch group consumption at 64%. Access group consumption ranged from 29.8 to 42.3 DDD per 100-bed-days with 2017 recording the highest proportion of Access group consumption at 43%. WHO recommends that, at the country-level, at least 60% of total antibiotic consumption to be from the Access group of antibiotics (8). The top 10 antibiotics consumed across the 10 sites include, Tab. Amoxycillin and clavulanic acid (625mg), Tab. Azithromycin (500mg), Inj. Ceftriaxone (1g), Cap. Doxycycline (100 mg), Tab. Cefixime (200 mg) and Inj. Amikacin (500 mg). Third generation cephalosporins were the highest consumed class of antibiotics across the years followed by combinations of beta-lactams and beta-lactamase inhibitors. Reserve group antibiotics should be treated as 'last resort' options, however, the use of colistin, linezolid, and aztreonam in these sites is a matter of concern. Use of last resort antibiotics (Reserve group) such as colistin, linezolid and aztreonam was between 1-5% of overall consumption which raises concerns and hence requires strengthening of local antibiotic stewardship practices in these sites. As the use of Reserve group antibiotics is a last resort it is imperative to keep the consumption of this group of antibiotics to a minimum. It is also relevant to note that consumption data has been sourced from the pharmacy of the hospital and did not include any out-of-pocket purchase of antibiotics by the patients.

Limitations

The consumption data compiled in this report is from the hospital pharmacy which only caters to in-patients of the hospital. Any antibiotics prescribed to the patients that were purchased from other sources is not included, including antibiotics prescribed to outpatients.

Conclusion

Analysis of antibiotic consumption trends from different sites over the years presents an interesting picture of the pattern and overall usage of antibiotics. Linking consumption data with antibiotic resistance will lead to a better understanding of the AMR issues in these facilities. Continued monitoring of the usage of Watch and Reserve group antibiotics will support antibiotic stewardship practices. Surveillance of antibiotic consumption and use at the hospital level is an important tool in our fight against antibiotic resistance.

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