

Original Article

A study of antibiotic prescribing pattern in the geriatrics department at a tertiary care hospital

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ABSTRACT

Objectives: The objectives of this study were as follows: (1) To study the antibiotics prescribed among the geriatric patients according to the World Health Organisation (WHO) access, watch and reserve (AWaRe) classification and WHO and national list of essential medicines (NLEM). (2) To categorise the prescribed antibiotics based on anatomic, therapeutic chemical (ATC) classification.

Materials and Method: The study was a prospective observational study conducted from July 2023 to June 2024 at JSS Hospital, Mysuru. It included a total of 200 prescriptions for geriatric inpatients. A descriptive statistical analysis of the data was done and indicated in tables and graphs as frequency and percentages.

Results: A total of 343 antibiotics were prescribed in 200 in-patient prescriptions (59% females and 41% males). Among them, 70.83% were listed in the WHO essential medicine list. Most frequently prescribed antibiotics were the third-generation cephalosporins (Cefoperazone + Sulbactam-30.90%). Further, the antibiotics were also grouped according to the WHO-AWaRe categorisation, 33.34% in access, 45.83% in watch and 8.33% in reserve groups, with 12.5% in the not recommended fixed dose combinations category.

Conclusion: Third-generation cephalosporins were the high-priority critically important antibiotics prescribed for specific indications. Irrational antibiotic utilisation can pose a risk of the development of antibiotic resistance. Regular effective antibiotic stewardship strategies and cautious utilisation of the reserve group of drugs can rationalise antibiotic utilisation and alleviate the antibiotic resistance and untoward adverse drug effects among the geriatric patients.

Keywords: Anti-bacterial agents, Antimicrobial resistance, WHO AWaRe antibiotic categorisation, Essential medicines list, Geriatrics

INTRODUCTION

Antibiotic utilisation in the geriatric population presents unique challenges, as elderly individuals often have multiple comorbidities and altered pharmacokinetics, which can influence both the effectiveness and safety of antibiotic treatments. Furthermore, inappropriate antibiotic use in this age group can lead to adverse outcomes, including antimicrobial resistance (AMR), drug interactions and increased hospitalisations.

Previous studies show that the elderly are highly susceptible to infections due to weakened immunity, compromised skin and mucosal barriers and age-related degenerative changes. The recent COVID-19 global pandemic has proved the vulnerability of the geriatric population all over the world toward infectious diseases.

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India is one of the countries in which there is an increase in the geriatric population due to improved life expectancy and decreased mortality.^[1] According to the Indian National Census 2021, India has 104 million elderly people aged above 60 years, which constitutes around 8.4% of the total population.^[2]

Common infections in the elderly include those of the urinary tract, lower respiratory tract and skin and soft-tissue infections. Antibiotics are a major group of prescription drugs used to treat various infectious diseases globally. However, the cure rate when treated with antibiotics is decreasing due to the development of AMR. The empirical use of the broad-spectrum antibiotics has resulted in the development of antibiotic resistance, drug interactions and unwanted adverse effects.^[3] In Geriatrics, prescription of antibiotics is a necessary prevalent practice, thus causing the emergence of highly resistant pathogens in the elderly, which include methicillin-resistant *Streptococcus aureus* (MRSA), vancomycin-resistant Enterococci and multidrug-resistant Gram-negative cocci.^[4]

The World Health Organisation (WHO) introduced the global AMR and use surveillance system (GLASS) in 2015 to standardise antibiotic consumption reporting and to support the global action plan on AMR. The national surveillance of antimicrobial consumption and use is the central element of the 'GLASS methodology for surveillance of national antimicrobial consumption', published in 2020. It is based on established international classification and categorisation systems, including the 'Access, watch and reserve' (AWaRe) categorisation and the anatomical therapeutic chemical classification (ATC)/defined daily dose system.^[5] For the rational treatment of AMR, implementation of an appropriate prescribing pattern and stewardship strategy is essential. In 2016, the WHO and the United National General Assembly urged the implementation of an anti-microbial stewardship programme (AMSP) globally and at the institutional level.^[6]

Inadequate prescribing pattern of antimicrobials leads to increased risk of developing AMR in the geriatric population. In this context, AMSP has emerged as a crucial intervention to optimise antibiotic prescribing, thereby promoting effective management of infections and mitigating the risks associated with overuse or misuse. Hence, it is essential to study the antibiotic prescribing pattern in this population. In this study, the antibiotics utilised in geriatric inpatients are grouped and according to the WHO AWaRe antibiotic categorisation, as well as the WHO-essential medicine list (EML) and ATC classification and also analysed for adherence of prescribed antibiotics to the hospital antibiotic policy.

Study objectives

1. To evaluate the antibiotic prescribing pattern in the inpatient Geriatrics department of a tertiary care hospital
2. To categorise the antibiotics prescribed according to the WHO-ATC and WHO-Model EML 2023 guidelines
3. To assess the compliance of prescribed antibiotics with the hospital antibiotic guidelines.

MATERIALS AND METHODS

Study design

The study was a prospective observational study conducted at a tertiary hospital in Mysuru. The study was conducted from July 2023 to June 2024, which included a total of 200 prescriptions for geriatric inpatients.

Study participants

Inclusion criteria

- Patients of either gender above 60 years of age
- Patients admitted to the geriatric in-patient ward and treated with antibiotics.

Exclusion criteria

- Patients who are not able to communicate or give informed consent
- Patients on topical antibiotics, anti-retroviral, anti-helminthic, anti-malarial, anti-tuberculosis and anti-protozoal drugs
- Patients seriously/terminally ill are admitted to Intensive Care Units or referred to higher centres.

Study procedure

Informed consent was obtained before the patient data collection. Patients aged above 60 years from the Geriatrics inpatient department were included and followed up till discharge. Collected data included patient demographics (age and sex) and clinical information such as diagnosis, treatment and antibiotic specifics (generic name, dose, frequency and route). Culture sensitivity tests were analysed for bacterial growth in samples such as sputum, urine and blood. Only ATC 2022-classified antibiotics were included. Data were entered into Excel to calculate antibiotic usage frequency and categorise according to WHO-ATC, EML, National List of Essential Medicine (NLEM) and WHO-AWaRe classifications.

Statistical analysis

A descriptive statistical analysis of the data was done, and indicated it as frequency and percentage in tables and graphs.

RESULTS

Demographic features of geriatric population

A total of 200 cases were collected, of which 59.5% (119) subjects were male and 40.5% (81) were female. The study sample showed male predominance. Among the 200 patients, 62 patients (31%) were from the age group of 66 to 70 years and were the most frequent group in the study. Forty-nine patients (24.5%) were from the age group of 71 to 75 years, and 42 (21%) from the 76 to 80 years age group. Furthermore, 29 (14.5%) patients were from the 60 to 65 age group, and 18 (9%) were from the >80 age group.

Comorbidities and infection patterns

Among the 200 subjects, 158 of them were having other comorbidities. The study showed 18.35% with one comorbidity, 12.66% with two comorbidities and 68.99% with three or more comorbidities. Hypertension ($n = 51$, 80.58%) emerged as the most common comorbidity, followed by chronic obstructive pulmonary disease ($n = 42$, 66.36%), type 2 diabetes mellitus ($n = 32$, 61.62%), dementia ($n = 15$, 23.7%), type 2 renal failure ($n = 8$, 12.64%) and rheumatoid arthritis ($n = 3$, 4.74%) comorbidities were also observed, though to a lesser extent.

Among various infectious conditions treated, 38% were respiratory tract infections (RTIs), 16% were urinary tract infections (UTIs), followed by 13% each for skin and blood infections, followed by 11.5% other infections and 8.5% gastrointestinal tract infections (GIT-I).

Characteristics of antibiotics and their prescription

The antibiotic prescribing pattern indicated that among the 200 subjects, 99 (49.5%) of them were treated with single antibiotics, 63 (31.5%) were treated with two antibiotics and 38 (19%) of them were treated with three or more antibiotics.

Culture sensitivity test and various samples collected for the test

The bacterial culture sensitivity test was done for 18% subjects before the empirical prescription of the antibiotic, and in rest 82% subjects, no culture sensitivity test was performed. Among them, 50% of the sample investigated were positive for various bacterial growth, and 50% were negative.

Among the 18 positive samples investigated, the following organisms were identified: *Staphylococcus* in two samples one each of pus and blood, *Escherichia coli* in eight samples which includes urine and blood, *Candida* in two samples-one each of urine and blood, *Klebsiella* in one sample of endotracheal fluid, Enterococci in four samples three of urine and one of pleural fluid and *Pseudomonas* in one sample of urine.

Antibiotic sensitivity testing revealed that *E. coli* isolates were sensitive to meropenem and tigecycline resistant to amoxicillin, ciprofloxacin and cotrimoxazole. *Staphylococcus* and Enterococci showed sensitivity to linezolid and resistance to amoxicillin, while *Klebsiella* was sensitive to tigecycline, meropenem and resistant to cephalosporins and amoxicillin. *Candida* isolates were susceptible to fluconazole. However, there was insufficient information available regarding the antibiotic sensitivity of the *Pseudomonas* isolate.

Among the various samples collected for the culture sensitivity test, 39.53% of the samples collected were urine ($n = 18$), 25.58% were blood ($n = 10$), 18.6% were sputum ($n = 8$), 6.98% were pus ($n = 3$), 4.65% were stool ($n = 2$) and rest 2.33% were from endotracheal secretion ($n = 1$) and pleural fluid ($n = 1$).

WHO core indicators

The WHO core indicators were analysed, and data regarding the average number of antibiotics per prescription, percentage of antibiotics prescribed from NLEM-2022 and WHO EML-2023 were tabulated [Table 1].

Among the 200 prescriptions examined, the total number of antibiotics prescribed was 343. The frequency of each class of antibiotics prescribed is demonstrated in the bar chart [Figure 1]. Cephalosporins were the most commonly prescribed, while nitrofurantoin, glycopeptides and sulphonamides were the least prescribed antibiotics.

Among the 343 antibiotics prescribed, 73, that is 21.28% were administered orally and about 170, that is 78.72% were administered intravenously.

Among the prescribed antibiotics, 206, that is 60% antibiotics, were single dose and 137, that is 40% were fixed dose combinations (FDC). The frequency of various FDC drugs prescribed is demonstrated in Figure 2.

The prescribed antibiotics were also categorised according to ATC classification and arranged as per the standard ATC code, that is, the pharmacological group of systemic antibiotics (J01) and the WHO-EML 2023 list and AWaRe categorisation [Table 2]. The frequency of different prescribed antibiotics based on AWaRe categorisation [Figure 3].

The data were then evaluated by the WHO quality indicators on the use of antibiotics [Table 3].

About 70.83 % of the antibiotics prescribed were listed in the WHO-EML 2023, while 29.17% of the antibiotics were not included in the WHO EML list.

The percentage of antibiotics that were included in the NLEM-2022 was about 76% while 24% were not listed in the NLEM-2022 list.

Table 1: WHO core indicators.

WHO core indicators	Percentage
Average number of antibiotics per prescription	1.66
% of antibiotics prescribed from NLEM-2022	76
% of antibiotics from WHO-EML 2023	70.83

WHO: World Health Organization, NLEM: National list of essential medicine, EML: Essential medicine list

Among the 200 prescriptions analysed, about 172 prescriptions were compliant with the antibiotic policy of the hospital and 28 were non-compliant with the hospital's antibiotic policy.

DISCUSSION

Antibiotics being prescribed inappropriately in hospital settings more often lead to a steady rise in multidrug-resistant organisms with associated increase in morbidity, mortality and healthcare costs. Antibiotic stewardship programme and internal antibiotic audits could assist in the prompt identification of any deviations or noncompliance and aid in rational therapy. Trends in resistance patterns of potential pathogens can also be identified and reported for future strategic measures. Frequent culture sensitivity investigations will also help with definitive therapy based on sensitivity patterns observed. The treating physicians can also provide timely inputs and justifications to further rationalise the prescriptions and prevent the emergence of resistant infections.^[7]

In the present study, 200 case sheets of patients admitted to the Geriatric in-patient wards of JSS Hospital were collected, which include patients' demographic details, diagnosis, antibiotics prescribed, culture report and sensitivity. Further compliance with the prescribed antibiotics was assessed.

Among 200 cases, 119, that is 59.5% were male patients and 81, that is 40.5% were female patients.

A prospective observational study by Senthilkumar *et al.*^[8] 2020 also showed a male dominance; a total of 206 geriatric patients were included, of which 132 (64.1%) were males and 74 (35.9%) were females. The average age of the elderly patients was 66.84 years. About 125 (60.7% of patients) and 1.9% of patients, respectively, were in the age group 60–65 years and over 80 years of age.^[8]

In the present study, majority of the patients, that is 62 (31%) were in the age group of 66–70, 49 (24.5%) of them in 71–75 years age group and 42 (21%) patients in 76–80 years age category, followed by 29 (14.5%) patients in 60–65 years age groups. The least of about 18 patients (9%) were from the age group >80 years.

A previous study conducted by Bhavshaikh *et al.* mentioned the prevalence of the same age group, that is, 60–91 years, and hence showed the improved life expectancy in India.^[9]

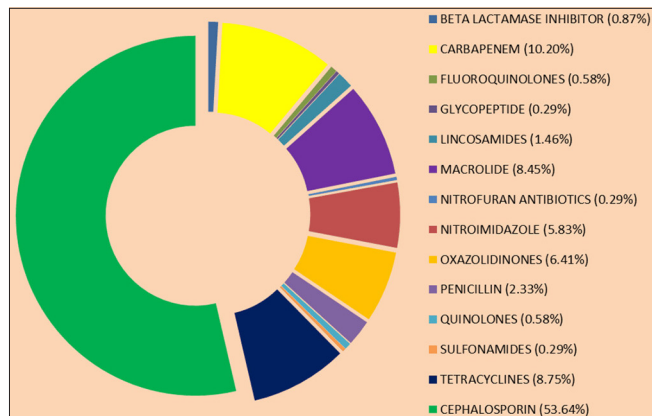


Figure 1: Pie-chart depicting the frequency of different classes of antibiotics prescribed.

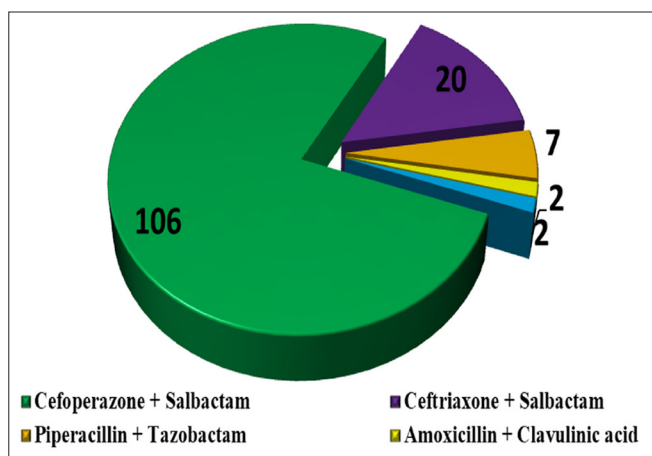


Figure 2: Pie-chart depicting the frequency of antibiotics prescribed in fixed dose combinations.

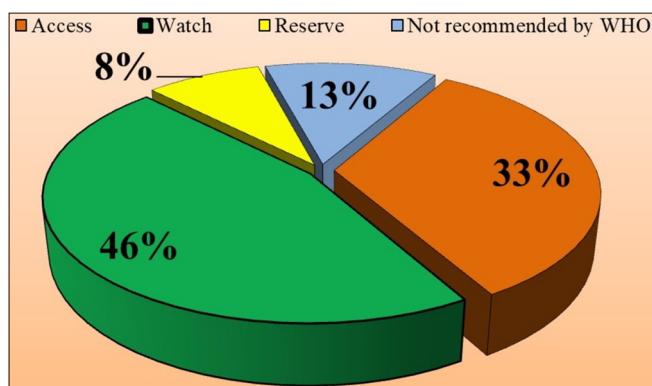


Figure 3: Pie-chart depicting the antibiotics prescribed (%) according to the World Health Organisation access, watch and reserve category.

The WHO prescribing indicators emphasise the importance of regular prescribing audits, thereby promoting rational prescribing among physicians. In this study of 200 cases, 343

Table 2: Depicts the classification of antibiotics based on ATC classification, EML 2023 and WHO-AWaRe category.

SL. No	Antibiotics	Antibiotic classification	ATC code	AWaRe category	Listed on EML 2023
1	Amoxicillin+Clavulanate	Beta lactamase inhibitor	J01CR02	Access	Yes
2	Amoxicillin	Penicillin	J01CA04	Access	Yes
3	Azithromycin	Macrolide	J01FA10	Watch	Yes
4	Cefotaxime	Third cephalosporin	J01DD01	Watch	Yes
5	Cefixime	Third cephalosporin	J01DD08	Watch	Yes
6	Ciprofloxacin+Tinidazole	Nitro imidazole	J01RA11	Not recommended by WHO	No
7	Cefoperazone	Third cephalosporin	J01DD12	Watch	No
8	Cefoperazone+Sulbactam	Third cephalosporin	J01DD62	Not recommended by WHO	No
9	Ceftriaxone	Third cephalosporin	J01DD04	Watch	Yes
10	Ceftriaxone+Sulbactam	Third cephalosporin	J01DD54	Not recommended by WHO	No
11	Ciprofloxacin	Fluoroquinolones	J01MA02	Watch	Yes
12	Clarithromycin	Macrolide	J01FA09	Watch	Yes
13	Clindamycin	Lincosamides	J01FF01	Access	Yes
14	Cotrimoxazole	Sulfonamides	J01EE01	Access	Yes
15	Doxycycline	Tetracycline's	J01AA02	Access	Yes
16	Levofloxacin	Quinolones	J01MA12	Watch	No
17	Linezolid	Oxazolidinone's	J01XX08	Reserve	Yes
18	Meropenam	Carbapenems	J01DH02	Watch	Yes
19	Metronidazole	Nitro imidazole	J01XD01	Access	Yes
20	Nitrofurantoin	Nitrofurantoin antibiotic	J01XE01	Access	Yes
21	Pipercillin+tazobactam	Penicillin	J01RA01	Watch	Yes
22	Vancomycin	Glycopeptides	J01XA01	Watch	Yes
23	Tetracycline	Tetracycline's	J01AA07	Access	No
24	Tigecycline	Tetracycline's	J01AA12	Reserve	No

ATC: Anatomical Therapeutic chemical, EML: Essential medicine list, WHO: World Health Organization, AWaRe: Access, watch and reserve

antibiotics were prescribed, averaging 1.6 per prescription, similar to findings by Senthilkumar *et al.* (1.57 per patient). Minimising drug numbers per prescription is crucial for reducing drug resistance and non-compliance.^[8] In contrast to previous study by Chandrasekhar *et al.* (i.e. monotherapy: 31.1%, 2 drugs: 40%, ≥3 drugs: 28.2%), in the present study, majority of the population was treated with single antibiotics (49.5%), followed by two antibiotics (31.5%) and 3/more antibiotics (19%).^[10]

Out of 343 antibiotics, cefoperazone + sulbactam was the most frequently prescribed antibiotic, about 106 times, that is 30.90%, followed by ceftriaxone (14.29%) – both are third-generation cephalosporins. The least prescribed antibiotics were amoxicillin from penicillin, cefixime from cephalosporin, co-trimoxazole, vancomycin, tetracycline, tigecycline and nitrofurantoin, each was about 1% of the total prescriptions. Overall data indicate that geriatric patients consumed more beta-lactam antibiotics, which include the third generation cephalosporin. More specifically, consumption of cefoperazone + sulbactam and

ceftriaxone was higher among the cephalosporins, similar to Chandrasekhar *et al.*^[10] Cephalosporins have remained a mainstay of therapy in hospitals due to their lower risk of hypersensitivity reaction, wide range of activity, lower cost, clinical efficacy and favourable tolerability profiles, which are the likely causes for their overuse.^[8]

Endocrine disorders, respiratory conditions, cardiovascular diseases and other conditions were among the common morbidities. About 158 geriatric patients had a history of other comorbidities. Among these, 109 patients had three or more comorbidities, and 29 of them had one comorbidity.

The infection pattern of present study showed that 38% patients had RTIs which was the most common infection among the geriatric population, followed by 16% UTI, 13% combined skin or blood infections, 11.5% had other type of acute infections such as dengue fever, viral fever and typhoid fever and 8.5% had GI infections which corresponded with the Bist *et al.* study conducted in Karnataka.^[11]

According to the WHO quality indicators, the pharmacological group was used to analyse the consumption data. The usage

Table 3: The percentage of the WHO quality indicators on the use of antibiotics.

WHO quality indicators on the use of antibiotics	Percentage
Total number of beta-lactam (J01CR) antibiotics used as a % of all antibiotics	0.87
Total number of cephalosporin's (J01D) % of total antibiotic use	53.64
Total number of quinolones (J01MA) as a % of total antibiotic utilization	8.45
Total number of macrolides (J01F) as a % of total antibiotic use	9.04
Total number of penicillin (J01C) as a % of total antibiotic use	2.33
Total number of combination penicillin (J01CR) as a % of total antibiotic use	0.87
Total number of tetracycline (J01A) % of total antibiotic use	8.75
Total number of carbapenems (J01DH) % of total antibiotic use	7.29
Total number of other antibacterial (J01MA) as a % of total antibiotic utilization	23.91
WHO: World Health Organisation	

of 'J01D cephalosporin' was the most prevalent by 53.64%, followed by 23.91% J01MA (other antibiotics), 9.04% macrolides (J01F) and 8.75% Tetracycline's (J01A), 8.45% quinolones (J01MA), 7.29% carbapenems (J01DH), 2.33% penicillin's (J01C) and 0.87% of combination penicillin (J01CR). The least prescribed antibiotic was penicillin and combination penicillins. When considering the overall data, beta-lactam antibiotics, especially third-generation cephalosporins, were consumed more by geriatric patients, which also corresponds to a previous study by Senthilkumar *et al.* 2020.^[8]

Ceftriaxone was found to be highly consumed for the prophylaxis and treatment of RTIs, found to be more prevalent in this study than in other previous studies by John *et al.* and Baktygul *et al.*^[12,13] The top 10 most consumed antibiotics were cefoperazone + sulbactam, ceftriaxone, meropenam, doxycycline, linezolid and ceftriaxone + sulbactam.

The most commonly identified infections among the geriatric population in the study were RTIs ($n = 76$), followed by UTIs ($n = 32$), skin infections ($n = 26$) and bloodstream infections ($n = 26$). GI infections were the least frequently reported ($n = 17$).

AMR is a growing global health crisis. Antibiotic resistance has steadily increased in the past few years to many commonly used antibiotics in the healthcare settings and livestock systems.^[14]

Increasing antibiotic resistance is also noted in various commonly used infections such as UTIs, hospital-acquired

infections, sepsis, sexually transmitted infections, respiratory infections and diarrhoea, necessitating prompt measures to tackle the same.

The WHO fact sheet highlights the range of AMR to common infections. Globally, there is an alarming rise in the resistance against antibiotics commonly used for common bacterial infections such as hospital-acquired infections, UTIs, diarrhoea, sepsis and STDs.^[15] The WHO fact sheet highlights the range of AMR to common infections. Resistance to ciprofloxacin is rapidly emerging in common bacteria such as *E. coli* and *Klebsiella pneumoniae*. Severe infections caused by *K. pneumoniae* have been reported to be resistant to even last-resort treatment of carbapenem antibiotics. Similarly, resistance to colistin, the only effective antibiotic against carbapenem-resistant *Enterobacteriaceae*, has been reported in several countries.^[16]

MDR organisms are of particular concern. MDR bacteria have developed resistance to one or more of the antibiotics used to treat them. Multi-drug resistance in an organism may develop when antibiotics are not used properly. MDR strains can also arise as a result of a biological mechanism.^[17]

Serious infections and mortalities are noted in about 64% of people infected with MRSA infections than those with drug-sensitive species. Mortality due to various drug-resistant strains such as *Pseudomonas aeruginosa* and *Neisseria gonorrhoeae*, which alone account for about 11% of hospital-acquired bacterial infections, is steadily increasing.^[18]

Various strains of *N. gonorrhoeae* have shown resistance to common antibiotics such as sulphonamides, penicillin, tetracyclines, macrolides, fluoroquinolones and early-generation cephalosporins. At present, ceftriaxone is the only available empiric monotherapy for treating gonorrhoea.^[19]

The WHO's 2023 updated essential medicines list (EML) introduced the AWaRe classification for antibiotics to combat the crisis of increasing antibiotic resistance. In this study, Access antibiotics comprised 33.33% and watch antibiotics 45.83% of use, diverging significantly from the WHO standards, mirroring findings from Senthilkumar *et al.*'s prior research.^[8] According to the WHO, access to antibiotics should comprise over 60% of total antibiotic use due to their lower resistance risk. However, in this study, access use was below target, while watch antibiotics exceeded 40% and reserve antibiotic usage was minimal. This deviation suggests a reliance on higher-resistance antibiotics, contrary to the WHO standards, with 12.5% of antibiotics used not recommended for geriatric care. In addition, unclassified antibiotics in the WHO-EML highlight gaps needing review. The study reveals significant discrepancies between current prescribing patterns and WHO-recommended antibiotic use, underscoring the need for stricter antibiotic policies and awareness in geriatric care.

CONCLUSION

The present study aimed to analyse antibiotic prescribing patterns among geriatric patients and also assess the prescription adherence to institutional antibiotic policy.

RTIs were the most common diagnosis. Cefoperazone + Sulbactam and Ceftriaxone, both third-generation cephalosporins, were the most frequently used antibiotics. Cephalosporins, macrolides and carbapenems were the primary classes prescribed.

The study also assessed prescription adherence to institutional antibiotic policy, finding that 86% of prescriptions were rational and aligned with guidelines. However, only 36 out of 200 cases had a culture sensitivity test before antibiotic prescription, while 164 cases were prescribed antibiotics without such testing. This lack of diagnostic testing can increase antibiotic resistance risk among elderly patients, impacting morbidity, mortality, costs and quality of life.

Antibiotics were also classified based on the WHO's EML and the AWaRe categorisation. According to the WHO guidelines, 'Reserve' antibiotics should be used only when other options are exhausted, while 'Access' antibiotics are recommended for the 25 most common indications. This study found a deviation from WHO standards: 33.33% of prescribed antibiotics fell into the access category, while 45.83% were in the watch category. To address this misalignment, strict monitoring is essential to reduce irrational antibiotic use in the elderly, which can be achieved by reinforcing WHO guidelines.

To mitigate resistance, it is recommended that physicians reduce the use of broad-spectrum antibiotics in favour of narrow-spectrum alternatives, guided by strict antibiotic policies and treatment guidelines. Educational programs are needed to encourage rational prescribing, particularly in geriatric care, where caution is warranted with potentially inappropriate medications, and adverse reactions should be promptly identified.

The study also advocates for a shift from empirical therapy to definitive therapy by encouraging the prescription of culture sensitivity tests before antibiotic administration. This approach would help prevent antibiotic resistance and improve life quality for geriatric patients.

There is an increasing requirement for newer antibiotics for the treatment of multidrug-resistant infections caused by resistant bacteria. However, pharmaceutical companies have been driven out of antibacterial research and development due to the high cost of clinical trials, new regulatory uncertainties and a low economic return. Hence, rather than relying solely on the discovery of new antibacterial agents, efforts should be directed toward strategies or treatment alternatives to avoid the emergence or spread of resistance in microbes.

Ethical approval: The research/study was approved by the Institutional Review Board at JSS Medical College, approval number JSS/MC/PG/50/2022-23, dated 25th May 2022.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent.

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