Profile of antibiotic consumption, sensitivity and resistance in an urban area of Andhra Pradesh, India

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INTRODUCTION Antibiotics are an important category of drugs in which indiscriminate use can affect the susceptibility patterns among infectious organisms, resulting in antibiotic resistance.

METHODS Data on antibiotic usage and susceptibility patterns were collected from public and private health centres in Vijayawada, Andhra Pradesh, India, through the use of questionnaires. The data collected were then coded, tabulated, computed and evaluated using statistical analysis.

RESULTS The consumption profile of the different categories of drugs used in public and private hospitals was as follows: nutrition and metabolism products 19.0%; gastrointestinal disorder-related drugs 18.5%; antibiotics 16.8%; anti-pyretics and anti-analgesics 20.6%. These drugs were found to be in high demand. Among the antibiotics, aminoglycosides (amikacin), quinolones (ofloxacin, ciprofloxacin), tetracyclines (doxycycline), penicillin (ampicillin) and sulphonamides (co-trimoxazole) were the most commonly prescribed drugs for antibiotic therapy. 46% of the culture laboratory reports were positive with the following organism profile: *Escherichia coli* (36%), *Klebsiella pneumoniae* (16%), *Staphylococcus aureus* (29%), *Enterocccus faecalis* (9%) and *Pseudomonas aeruginosa* (10%). In terms of the sensitivity profile of antibacterials, amikacin (66.9%) was the only antibiotic showing sensitivity patterns, while the majority of antibiotics, such as co-trimoxazole, nalidixic acid, amoxicillin, gentamycin and norfloxacin, had acquired a resistance rate of 55.1%–80.6%.

CONCLUSION The results of this study suggest that indiscriminate prescription and consumption of new broad-spectrum antibiotics against sensitive organisms results in the development of antimicrobial resistance. Therefore, there is an urgent need to curb the excessive use of antibiotics in local hospitals in order to control the trend of increasing antimicrobial resistance to antibiotics.

Keywords: antibiotics, drugs, indiscriminate prescription, resistance, sensitivity
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INTRODUCTION

In pharmacology, drugs are important substances used to treat and maintain irregular functions of the body that deviate from its regular activity. However, during the course of drug development, the efficacy and safety of drugs are often not adequately considered.[1,2] Various categories of drugs, such as analgesics, antibiotics and nutritional, gastrointestinal and hormonal drugs, are commonly prescribed to patients, with antibiotics being among the most frequently prescribed drugs. The misuse and overuse of antibiotics is widespread not only in developing countries but also in the developed world, and this inappropriate use of antibiotics has led to the rise in antimicrobial resistance. The emergence and spread of antimicrobial resistance is a complex problem that is driven by numerous interconnected factors such as under- or overuse of antimicrobials.[3]

A survey in the United States of America (USA) has found that 51% of patients with the common cold and upper respiratory tract infections (URTI) were prescribed with antibiotics, of which 20% were not absolutely required.[4] Furthermore, only 20%–25% of the antibiotics prescribed were based on the results of culture and sensitivity tests. In another survey conducted in the USA,[5] the proportion of broad-spectrum antibiotics prescribed was found to have increased from 41.0% in 1995–1996 to 76.8% in 2005–2006. The prescription procedure of antibiotics in Bangladesh is also less than ideal, as prior identification of the pathogen and its sensitivity to the drugs is rarely determined before the drug is prescribed.[6,7] Studies from the eastern part of the country have shown that inappropriate prescriptions arising from poor quality consultations due to time and money constraints have led to widespread misuse of broad-spectrum antibiotics.[8] In Nepal, a retrospective analysis of case records showed that in 26.2% of cases, the use of the antimicrobials was irrational.[9]

In India, several studies on the irrational use of antibiotics have been published. Over-prescription of antibiotics is widely reported in almost all parts of the country. Antibiotics (with analgesics) are included in nearly a quarter of all prescriptions.[10] The average frequency of antibiotics prescribed in Pune and its neighbouring areas was reported to be 43%.[11] Although antibiotic misuse and resistance is indirectly identified in these earlier studies, no substantial surveillance has previously been conducted in Vijayawada, India. The present

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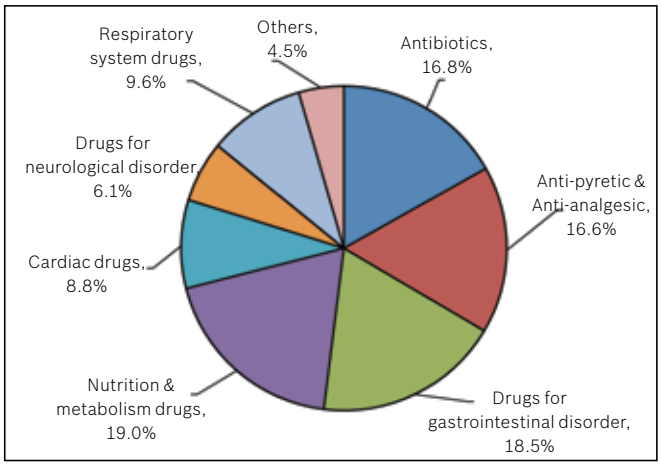

Fig. 1 Pie chart shows the distribution of various categories of drugs, with nutritional products, gastrointestinal drugs and antibiotics being the most highly procured therapeutic drugs.

study focused on the antibiotic prescription, sensitivity and resistance profiles of microorganisms in selected laboratories, hospitals, retail medical shops in both public and private hospitals in Vijayawada, Andhra Pradesh, India and around its vicinity.

METHODS

This was a retrospective study utilising questionnaires as the study instrument to collect data on therapeutic drug consumption and antibiotic susceptibility patterns in the city of Vijayawada. Data was derived from public and private health centres in a selected urban area. Information on antibiotic prescription profile was collected from consumers procuring drugs according to the doctor's prescriptions for a period of three months. Information on culture sensitivity profile was collected from both public (36%) and private (64%) diagnostic centres. Data was coded, tabulated, computed and evaluated using the Statistical Package for the Social Sciences version 14.6 (SPSS Inc, Chicago, IL, USA).

RESULTS

Data on 602 prescriptions of different categories of drugs and 1,424 culture sensitivity reports were collected, tabulated and then coded. A total of 1,912 drugs were purchased in the 602 prescriptions. The various categories of drugs included nutrition and metabolism products (19%), antibiotics (16.8%), anti-pyretics and anti-analgesics (16.6%), and medications for gastrointestinal disorders (18.5%), respiratory disorders (9.6%), cardiac conditions (8.8%), neurological disorders (6%) and other medical conditions (4.5%) (Fig. 1). The prescriptions written by private medical practitioners showed a preference for dispensing broad-spectrum antibiotics such as amikacin, ofloxacin, amoxicillin and gentamycin (Table I). Common illnesses for which antibiotics were prescribed included the common cold, cough, fever and abdominal problems.

The complete profile of antibiotics purchased is shown in Fig. 2. The most common antibiotics prescribed were amikacin (14.3%), doxycycline (13.2%), ofloxacin (13.2%), ampicillin (11.0%), co-trimoxazole (8.8%) and ciprofloxacin (8.8%). The prescriptions

Table I. Antibiotics procured with prescriptions from public and private hospitals.

Antibiotic	Public hospital (%)	Private hospital (%)
Quinolones		
Ofloxacin	2.9	19.6
Ciprofloxacin	14.3	5.4
Norfloxacin	11.4	1.8
Gatifloxacin	-	3.6
Levofloxacin	-	1.8
Penicillins		
Ampicillin	25.7	1.8
Amoxicillin	-	7.1
Penicillin	2.9	1.8
Piperacillin + tazobactum	-	5.4
Aminoglycosides		
Amikacin	-	23.2
Gentamycin	-	3.6
Tobramycin	-	1.8
Tetracyclines		
Doxycycline	17.1	10.7
Tetracycline	2.9	1.8
Sulphonamide		
Co-trimoxazole	22.9	-
Oxazolidinones		
Linezolid	-	7.1
Macrolides		
Clindamycin	-	3.6
3rd-generation cephalosporins		
Ceftriaxone	-	1.8

*Note: High usage of new broad-spectrum antibiotics is observed at private hospitals, with fewer antibiotics prescribed at public hospitals.

from private medical practitioners indicated that amikacin (23.2%), ofloxacin (19.6%), doxycycline (10.7%), amoxicillin (7.1%) and linezolid (7.1%) were the most frequently prescribed antibiotics for bacterial infections (Table I). However, in public hospitals, there was a preference for prescription of a limited number of antibiotics, mainly ampicillin (25.7%), co-trimoxazole (22.9%), doxycycline (17.1%), ciprofloxacin (14.3%) and norfloxacin (11.4%). Antibiotics such as amikacin, linezolid and piperacillin were frequently prescribed in combination with tazobactum by private medical practitioners, whereas these antibiotics were mainly prescribed in combination with ampicillin and co-trimoxazole at public hospitals, indicating a low preference for conventional or traditional antibiotics such as tetracycline. Other broad-spectrum antibiotics of choice prescribed by private medical practitioners included gatifloxacin, levofloxacin, tobramycin, gentamycin, clindamycin and ceftriaxone.

A total of 1,424 culture-sensitivity reports were collected from microbiological laboratories of both public and private health centres, of which the positive prevalence for infection was 40%–50%. Table II shows the culture-sensitivity results of the different samples tested. The biological samples tested for bacterial resistance and sensitivity patterns to antibiotics included urine, pus and blood. There were a large number of positive urine samples among the reports from private hospitals

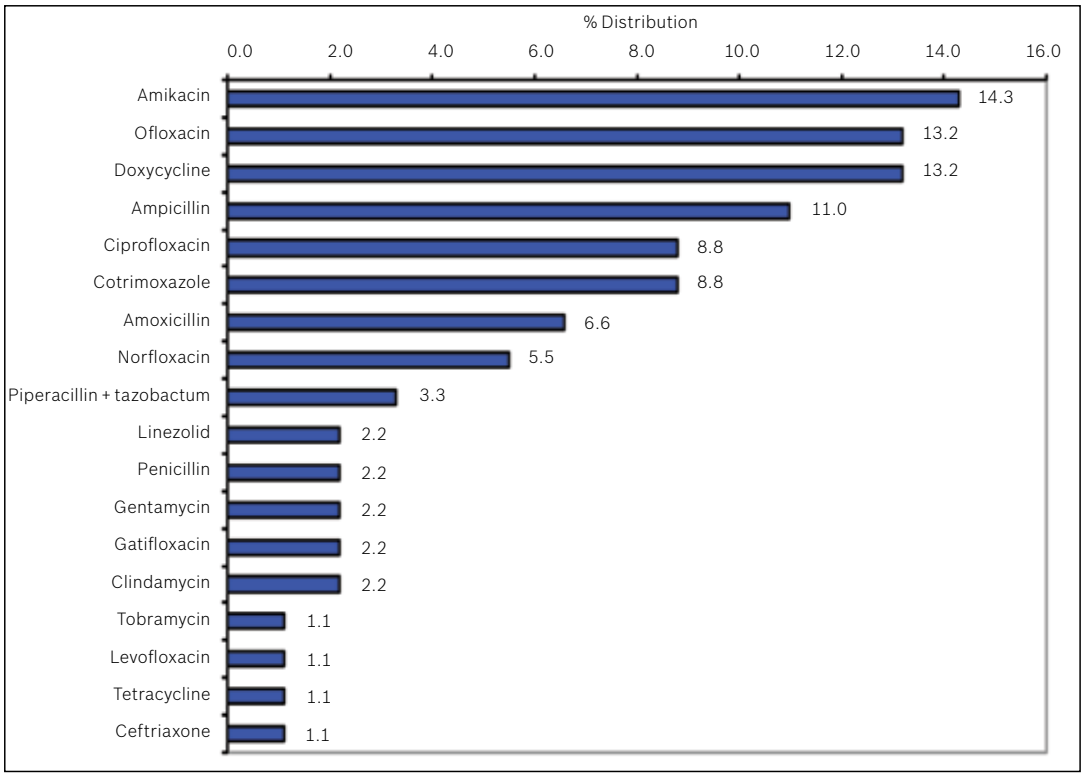

Fig. 2 Bar graph shows percentage distribution of the commonly prescribed antibiotics at public and private health centres. Distribution of new broad-spectrum antibiotics such as ceftriaxone, linezolid, levofloxacin and piperacillin + tazobactum combination is observed.

Table II. Profile of culture-sensitive reports.

Biological sample (n = 1,424)	Public laboratory (n = 513)		Private laboratory (n = 911)	
	Positive (n = 256)	Negative (n = 257)	Positive (n = 393)	Negative (n = 518)
Urine (n = 547)	14.1	20.2	54.2	47.5
Stool (n = 124)	7.4	17.1	7.9	5.8
Blood (n = 220)	7.8	15.6	7.1	25.5
Sputum (n = 141)	13.3	9.7	7.4	10.2
Throat swab (n = 28)	1.6	0.0	4.1	1.5
Pus (n = 364)	55.9	37.4	19.3	9.5

Note: Positive culture-sensitivity reports of pus samples are higher at public hospitals, while private hospitals have higher positive reports of urine sample, indicating the susceptibility patterns. Data is presented in percent.

(54%) as compared to only 14% from public hospitals. However, the number of positive pus samples found in public hospitals was noted to be as high as that from private hospitals. The prevalence of positive throat swabs was marginally higher in public hospitals.

Bacteriological findings in the biological samples included *Escherichia* (*E.*) *coli* (36%), followed by *Klebsiella* (*K.*) *pneumoniae* (16%), *Staphylococcus* (*S.*) *aureus* (29%), *Enterococcus* (*E.*) *faecalis* (9%) and *Pseudomonas* (*P.*) *aeruginosa* (10%) (Fig.3). The profile of the organisms suggested that the commonly present organisms in urine infection were *E. coli* (56.6%), *K. pneumoniae* (54.1%) and *E. faecalis* (52.6%), while *P. aeruginosa* (67.7%) and *S. aureus* (52.3%) were more commonly isolated from pus samples. However, *E. faecalis* (12.3%) and *S. aureus* (10.2%) were the more prevalent organisms in blood samples (Fig. 3). The sensitivity and resistance profiles of the different antibiotics are shown in Fig. 4. Antibiotic resistance for broad-spectrum antibiotics was 60%–80%, with 80.6% for co-trimoxazole, 78.9% for nalidixic

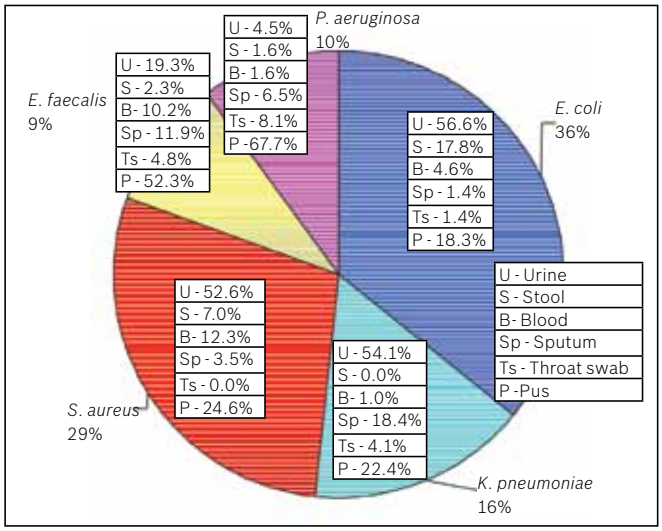

Fig. 3 Pie chart shows the profile of organisms in positive biological samples and the individual organism profile in the biological samples collected from culture-sensitivity reports.

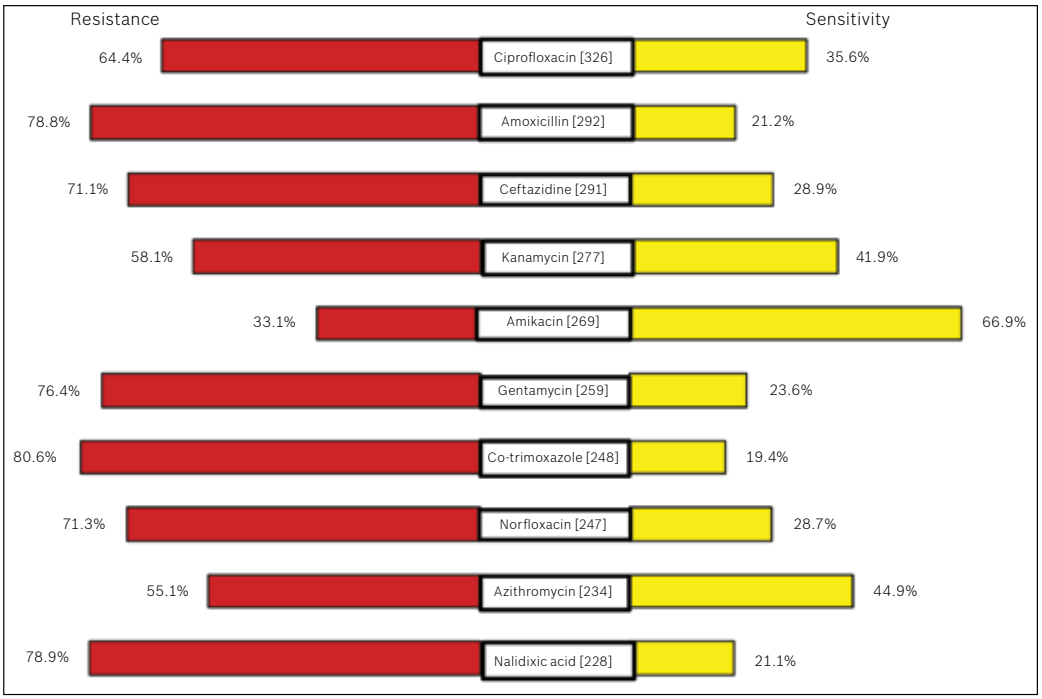

Fig. 4 Graph shows the resistance and sensitivity patterns of antibiotics. With the exception of amikacin, all the other antibiotics show antibiotic resistance patterns. The numbers in parenthesis represent frequency.

acid, 78.8% for amoxicillin, 76.4% for gentamycin and 71.1% for ceftazidime. Antibiotics such as amikacin (66.9%), azithromycin (44.9%), kanamycin (41.9%), ciprofloxacin (35.6%) and ceftazidime (28.9%) showed a sensitivity pattern.

DISCUSSION

The present study was undertaken with the intention to document the usage of different categories of drugs, paying particular attention to antibiotics, as it constituted one of the major categories of drugs. Nutritional supplements, analgesics, gastrointestinal drugs and antibiotics were found to be the most commonly used drugs. A study conducted at two health centres in Pondicherry, India, found that vitamins, antibiotics, analgesics and antihistamines accounted for up to 80% of the total drugs prescribed;[12] this finding is almost similar to that of our study. Nutritional supplements were ranked first in usage among the different categories of drugs, and other studies have shown similar findings.[13]

The irrational use of antibiotics is documented in all parts of the world. In line with the reports from other countries, we also observed that antibacterial was one of the favourite medications used. Common illnesses such as cough, cold and fever often drive patients to retail outlets to purchase antibiotics, and antibiotic use for the common cold has been reported to be as high as 83.1%.[14] The present study observed a high usage of broad-spectrum and newer antibiotics. A study conducted in Nigeria found that ampicillin, chloramphenicol and tetracycline were the most commonly prescribed antibiotics.[15] Similarly, another study conducted in a major city confirmed the high usage of broad-spectrum antibiotics such as chloramphenicol, but found that about 70% of patients had bought only less than one day's supply of these antibiotics.[16] The usage of broad-spectrum antibiotics in such irregular dosage schedules results in development of resistant strains, indirectly increasing the need for more potent new antibiotics.[17]

One important observation in our study was the significant difference in the prescription profiles between physicians in public and private practice. Prescription of the new categories of broad-spectrum antibiotics was limited in the public sector, whereas private practitioners had a preference for prescribing these antibiotics. This difference is likely attributed to the shortage or unavailability of these new antibiotics in public hospitals, thus limiting their use. Similarly, a surveillance study from Delhi reported that prescription of the fluoroquinolone group of drugs was considerably higher than that of any other antibiotic class,[18] which corresponds to our findings. In Malaysia, ampicillin, cloxacillin, penicillin, gentamycin, erythromycin and co-trimoxazole were the commonly prescribed antibiotics, as found in a survey.[19]

Another important observation was that more positive urine samples were noted in the culture-sensitivity reports from the private sector, whereas more positive pus samples were found in the reports from the public sector. If we consider the resistance profile with reference to urine samples, the majority of antibiotics (such as co-trimoxazole, amoxicillin, gentamycin, ciprofloxacin, norfloxacin) have become resistant. This resistance has been increasing considerably and is primarily due to the excessive and unnecessary use of antibiotics for non-therapeutic complaints. Studies have observed that ampicillin was prescribed by 90% of doctors, but less than 50% of these doctors could indicate correctly the resistance rates of *E. coli* and *K. pneumoniae* to this antibiotic.[19] The top antibiotic-resistant drugs include ampicillin, penicillin, co-trimoxazole and gentamycin. It has also

been shown that 80% of antibiotics were prescribed without the benefit of laboratory reports.[20] A study in Tamil Nadu[21] reported that the three most commonly prescribed antimicrobials were amoxicillin (20.5%), ciprofloxacin (17.6%) and co-trimoxazole (10.5%). About 42% of the medical practitioners requested for culture-sensitivity tests for only 10% of the cases, and barely 10% of them requested for culture-sensitivity tests in more than 50% of the cases.[21]

In a study conducted in Bangalore, the most commonly prescribed antibiotics were found to be norfloxacin, ciprofloxacin, cephalexin, co-trimoxazole and amikacin, although resistance to co-trimoxazole and penicillins as well as high resistance to fluoroquinolone were observed at the same time.[22] A 2007 summary report showed that ciprofloxacin, gentamycin, co-trimoxazole, ceftazidime were resistant to Gram-negative and Gram-positive organisms.[23] Other studies have also revealed that in the majority of cases, prescription of antibiotics was empirically directed to the site of infection and the availability of culture facilities was lagging behind in Indian hospitals, leading to rampant empirical use of antibiotics.[24,25] Unfortunately, even when laboratory facilities are available, culture-sensitivity tests were seldom requested by physicians.[26]

Thus, it can be concluded that neither public nor private practitioners refer to culture-sensitivity reports, as a high-resistant pattern is found among most antibiotics prescribed, which would be a major reason for prolonging antibiotic therapy, thus leading to a further increase in costs. The results of the present study showed that irrational antibiotic prescription and procurement (knowingly or unknowingly) has resulted in undesirable health issues. Hence, it is imperative to curb the excessive use of antibiotics in both the public and private health sectors. The tracking of prescription, consumption and resistant patterns of antibiotics at regular intervals is an immediate and urgent need, so as to control the trends of increasing antimicrobial resistance to antibiotics, which would eventually enable physicians to prescribe antibiotics rationally.

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