

Antimicrobial Resistance Patterns of Bacterial Isolates from Tertiary Care Hospital of North India

Abstract

Antimicrobial resistance is one of the serious health threats in the world and death due to it is projected to reach up to 10 million every year by 2050. In India, the government implemented a National Action Plan on Antimicrobial Resistance (NAP-AMR) intending to develop a laboratory-based AMR surveillance system, guidelines and practices to promote the awareness of the rational use of antibiotics in healthcare communities. In this plane, only five major hospitals are included which is not sufficient to provide the actual status of AMR. The present study focused on the AMR patterns analysis for bacteria isolated from the different health units in SSB heart and multispecialty hospital, Faridabad, Haryana. Clinically relevant samples such as pus & Body fluid, respiratory, urine and blood samples from the suspected patients were screened over a period of 5 months (February to June 2021) and AMR pattern analysis was carried out by using the disc diffusion method (Kirby–Bauer test) and interpretation was made by the guidelines of recent Clinical and Laboratory Standards Institute. In the present study, a total of 340 samples were analyzed for AMR out of which the maximum samples showed *Escherichia coli* as the most AMR resistant bacterial strain. Moreover, aminoglycosides with 55% sensitivity had resistance against maximum bacterial isolates from respiratory samples while fosfomycin had higher sensitivity i.e. 85% against bacterial strains isolated from urine samples. The present study concluded that regular susceptibility testing should be conducted with a defined interval to detect the current trend of resistance which helps clinicians in the effective infectious disease management and leads to reducing the burden of AMR.

Keywords: Antimicrobial resistance, antibiogram, National action plan on antimicrobial resistance, India, current status

1. Introduction

The World Health Organization (WHO) declared antimicrobial resistance (AMR) as one of the serious health threats at the global level [1]. In 2019, a total of 4.95 million casualties were associated with AMR out of which 1.27 million deaths occurred due to bacterial AMR in the world [2] and it is projected to reach up to 10 million deaths every year by 2050 [3]. At present, India faces a higher burden of AMR as compared to other nations which might be due to poor health services, inappropriate and uncontrolled sale of antibiotics use of antimicrobial agents against infectious diseases [4]. According to a governmental 'scoping report on antimicrobial resistance in India (2017), >70% of isolates of *Acinetobacter baumannii*, *Escherichia coli*, *Klebsiella pneumoniae*; 50% of all *Pseudomonas aeruginosa* were showed resistance against fluoroquinolones and third-generation cephalosporins while <35% *E. coli* and *P. aeruginosa* exhibited resistance to piperacillin-tazobactam combination. Additionally, an increasing rate of carbapenem resistance was found in 71% of isolates of *A. baumannii* which might be due to the regular use of colistin. Moreover, a total of 42.6% isolates of *Staphylococcus aureus* and 10.5% *Enterococcus faecium* were found resistant to methicillin and vancomycin, respectively. *Salmonella typhi* and *Shigella* species showed a 28

and 82% resistance rate for ciprofloxacin; 0.6 and 12% for ceftriaxone and 2.3 and 80% for co-trimoxazole, respectively. Approximately, 17- 75% of *Vibrio cholerae* exhibited resistance to tetracycline in India [5] and approximately 2 million deaths are estimated annually by 2050 [3].

In continuation with this, the Government of India launched a National Action Plan on Antimicrobial Resistance (NAP-AMR) intending to develop a laboratory-based AMR surveillance system, guidelines and practices to promote the awareness of the rational use of antibiotics in healthcare communities [6]. Among them, AMR surveillance is the most important strategy for evaluating the burden of AMR which helps in the development of new strategies for the treatment of microbial infections at regional, national and international levels. Previously, the Indian Council of Medical Research (ICMR) created an Antimicrobial Resistance Surveillance Network (AMRSN). In this surveillance network, only five major hospitals in India are included which is not sufficient to provide the actual status of AMR in hospitalized patients in tertiary care centers. However, there are only a few studies were reported to date on the impact of AMR in hospitalized adults [7]. These facts and figures advocated the urgent need to monitor and control the problem of AMR. The present study focused on the AMR patterns analysis for bacteria isolated from the different health units in SSB heart and multispecialty hospital, Faridabad, Haryana to establish a baseline for antibiotic prescribing in hospitals that can help in the evaluation of various national initiatives for the prevention of AMR.

2. Methods

In the present investigation patients enrolled from the out-patient as well as in-patient departments of different health units of the above-mentioned hospital. All clinically relevant samples such as pus & Body fluid, respiratory, urine and blood samples from the suspected patients were screened over a period of 5 months (February to June 2021) and submitted to the microbiology laboratory. These samples were then processed and identified the bacterial isolates by following standard operating procedures to evaluate the AMR pattern a antibiogram was also developed. The AMR pattern analysis was carried out by using the disc diffusion method (Kirby–Bauer test) and interpretation was made by the guidelines of the recent Clinical and Laboratory Standards Institute [8]. Antimicrobial agents namely cephalosporins, piperacillin, tazobactam, carbapenems, fosfomycin, nitrofurantoin, ertapenem, cotrimoxazole, vancomycin, linezolid, tigecycline, colistin, amphotericin B, capsosungin were subjected for AMR analysis. Vancomycin and colistin susceptibility in Gram-positive and Gram-negative isolates respectively was evaluated by methods described in CLSI guidelines.

3. Results

A total of 340 bacterial samples with AMR were recorded from different infection profiles out of which a total of 117 bacterial samples were drawn from urine followed by respiratory, blood and pus & body fluid samples i.e. 94, 70 and 60, respectively. *Escherichia coli* and *Pseudomonas aeruginosa* are the common AMR bacterial isolates in. Further, the maximum number of AMR *E. coli* were isolated from urine samplese while *P. aeruginosa* was recorded from respiratory samples (Table 1).

Table 1. Distribution of AMR bacterial isolates in different clinical samples (n = 340)

S. No.	Isolate Name	Type of sample				
		Respiratory	Urine	Pus and body fluids	Blood	Total
1	<i>Acinetobacter</i> spp	26	0	7	16	49
2	<i>Burkholderia cepacian</i>	1	0	0	0	1
3	<i>Candida</i> spp	0	0	0	5	5
4	<i>Citrobacter</i> spp	0	1	1	0	2
5	<i>Cryptococcus</i>	0	0	1	0	1
6	<i>Delftia</i> spp	0	0	0	1	1
7	<i>Enterobacter aerogenes</i>	0	0	4	4	8
8	<i>Enterobacter</i> spp	2	1	0	0	3
9	<i>Enterococcus Faecium</i>	0	0	0	2	2
10	<i>Enterococcus</i> spp	0	5	2	0	7
11	<i>Escherichia coli</i>	12	84	16	12	124
12	<i>Klebsiella pnuemoniae</i>	0	0	10	7	17
13	<i>Klebsiella</i> spp	23	15	0	0	38
14	<i>Morganella morgani</i>	0	1	0	0	1
15	<i>Proteus</i> spp	0	1	0	0	1
16	<i>Providencia</i> spp	0	0	0	1	1
17	<i>Pseudomonas aeruginosa</i>	21	7	6	5	39
18	<i>Salmonella</i> spp	0	0	0	12	12
19	<i>Serratia marcescens</i>	3	1	0	0	4
20	<i>Staphylococcus aureus</i>	3	1	13	0	17
21	<i>Staphyococcus</i> coagulase negative	0	0	0	4	4
22	<i>Stenotrophomonas maltophila</i>	2	0	0	0	2
23	<i>Stenotrophomonas</i> spp	0	0	0	1	1
Total		93	117	60	70	340

Respiratory sample analysis revealed that *Acinetobacter* spp (26 in number) was the predominant AMR bacterial isolate followed by the *Klebsiella* spp (23) and *Pseudomonas aeruginosa* (21). Moreover, most of the isolates showed resistance against aminoglycosides with 55% sensitivity while cephalosporins and fluoroquinolones showed sensitivity of 36 and 22%, respectively. In addition, piperacillin tazobactam and carbapenems have same sensitivity i.e. 30% (Fig. 1).

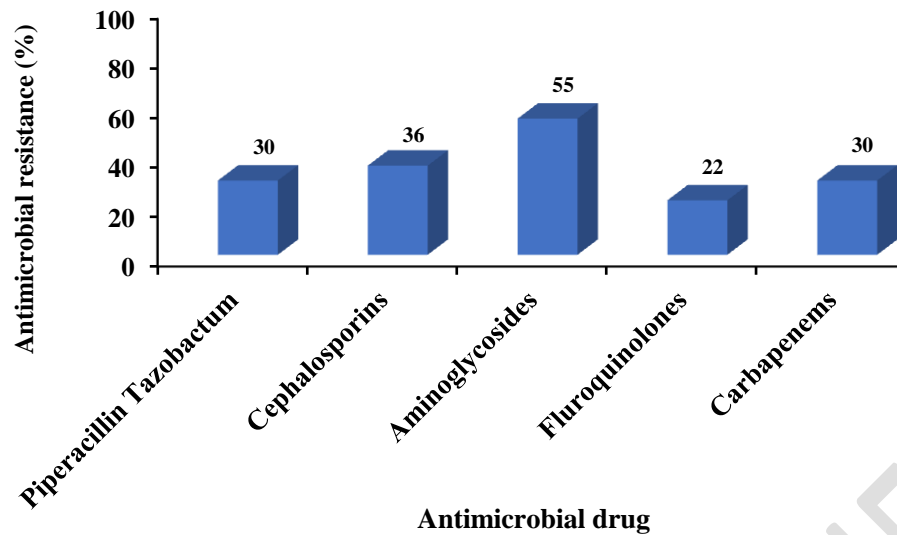


Fig. 1. AMR pattern analysis of bacterial isolates in respiratory samples.

In urine sample analysis *Escherichia coli* (84 in number) was found the dominated AMR bacterial isolates followed by the *Klebsiella* spp (15) and *Pseudomonas aeruginosa* (7). Additionally, fosfomycin had higher drug sensitivity i.e. 85% as compared to nitrofurantoin (77%) and ertapenem (73%) while fluoroquinolones and cephalosporins had only 22% drug sensitivity during the study period (Fig. 2).

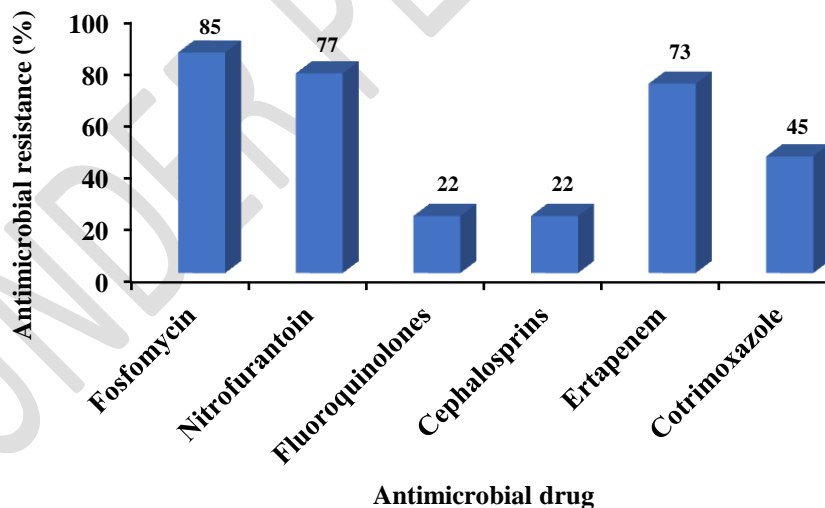


Fig. 2. AMR pattern analysis of bacterial isolates in urine samples.

The AMR pattern analysis of pus and body fluid samples revealed that *E. coli* (16) had higher sensitivity followed by *Staphylococcus aureus* (13), *Klebsiella pneumoniae* (10) and *Pseudomonas aeruginosa* (6). The maximum resistance i.e. 58.8% was shown by *S. aureus* against methicillin and described as the methicillin-resistant *Staphylococcus aureus* (MRSA).

Furthermore, in the case of blood sample analysis 16 *Acinetobacter* spp, 12 *Salmonella* spp & *E. coli*, 7 *Klebsiella pneumoniae* and 5 *Pseudomonas aeruginosa* were recorded as the AMR sensitive bacterial isolates. In terms of AMR, a total of 3.16 per 100 admissions multidrug-resistant organisms rate was observed which is a serious concern in infectious disease management.

Antibiogram showed that cephalosporins, especially from the third generation, had less sensitivity as compared to another drug of choice while in symptomatic urinary tract infections fluoroquinolones can also be used as an alternative to cephalosporins as it showed a similar AMR pattern. Further, fluoroquinolones also showed less sensitivity against respiratory isolates.

4. Discussion

The burden of antimicrobial resistance is very high in developing countries such as India which is due to the number of factors such as the high burden of disease, poor health setups, insufficient diagnostic support, and lack of data AMR related data that helps in the proper estimation of drug resistance can be accomplished [3, 9]. Due to the difference in geographical as well as climatic conditions in India present study might be shown the different spectrum of bacterial isolates from the western countries [10, 11]. In this study, *E. coli* and *P. aeruginosa* were found as the predominates bacterial isolates in all types of clinical samples and a similar observation was also reported in several studies [12-15].

The present study revealed that the aminoglycoside group of antimicrobial agents which contain gentamicin, amikacin, and tobramycin showed sensitivity against *Pseudomonas* spp forms the respiratory sample. A similar observation was also recorded from tertiary care hospitals in India [16, 17]. It also exhibited resistance against *Klebsiella* spp and a similar result was also published for urine samples in India [18]. According to Bashir et al, resistance to aminoglycoside drugs could be an emerging condition for its prescription to Urinary tract infection (UTI) patients [19]. *E. coli* and *K. pneumoniae* were also exhibit resistance against cephalosporins which correlated with the previous study from Tamil Nadu [20]. Further, Multidrug resistance *Salmonell* spp was also found in the present study and a similar result was also published in *S. typhi* from India which is also a serious health concern for the treatment of typhoid fever in children [21].

5. Conclusion

The present study gives a brief highlight on the AMR pattern in the North part of India and also provide insight on the appropriate prescription of antibiotic against pathogenic microorganisms. It finally concluded that the regular susceptibility testing should be conducted with a defined interval to detect the current trend of resistance which helps clinicians in the effective infectious disease management and leads to reducing the burden of AMR. Additionally, a rational approach to drug prescription is urgently required to combat this health concern.

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