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Original Research Article

Retrospective Study on Hospital-Acquired Infections and Antibiotic Sensitivity Patterns

Kalsariya Hitesh Babubhai[1], Jalondhara Sagar Nagjibhai[2], Nakum Rambhai Ranmalbhai[3]

[1]Post Intern, BJ Medical College and Hospital, Ahmedabad, Gujarat, India
[2]Post Intern, BJ Medical College and Hospital, Ahmedabad, Gujarat, India
[3]Post Intern, BJ Medical College and Hospital, Ahmedabad, Gujarat, India

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Corresponding Author: Nakum Rambhai Ranmalbhai
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Abstract:

Background: The likelihood of microbes resistant to antibiotics eventually rises. As a result, selecting the right antibiotics is crucial to ensuring effective treatment and avoiding long-term issues. A WHO preliminary survey found that 16% of doctors give antibiotics to patients who have non-specific fevers.

Objectives: In order to inform effective infection control and antibiotic stewardship practices, the study's objectives were to assess the antibiotic susceptibility and resistance profiles of the bacterial isolates and analyze the prevalence and trends of hospital-acquired infections in patients admitted to a tertiary care center.

Materials and Methods: It was a retrospective, observational study. The study was carried out at a tertiary care centre. The study data that was retrieved was for one year. Data from 186 participants were retrieved for the study. Regardless of age or gender, this study included patients who were hospitalized to the tertiary care facility throughout the one-year study period and who experienced hospital-acquired illnesses that were verified by positive bacterial culture.

Results: The most often isolated pathogen among the 186 culture-positive HAI patients examined was Escherichia coli (28.4%). Klebsiella pneumoniae came in second (22.6%). The third most frequent isolate was Pseudomonas aeruginosa (18.8%). Gram-positive isolates were largely composed of Staphylococcus aureus (14.0%), including potential MRSA.

Conclusion: Gram-negative bacteria accounted for the majority of hospital-acquired infections in this study, and they were highly resistant to many drugs. The majority of pathogens were still susceptible to the effects of nitrofurantoin, carbapenems, colistin, linezolid, and vancomycin.

Recommendations: Strict infection control, sensible antibiotic use informed by local antibiograms, and routine monitoring of resistance patterns should all be implemented in hospitals.

Keywords: Antibiotic Resistance, HAIs, Sensitivity, Specificity, Hospital-Acquired Infections.

Introduction

Antibiotics were first used in the 1940s. Millions of lives have been saved since. These, however, may result in adverse consequences resistance from antibiotics. Antibiotic resistance is a major global concern, but nowhere is the situation as dire as in India. Methicillin-resistant Staphylococcus aureus, vancomycin-resistant enterococcus, carbapenem-resistant Acinetobacter species, and drug-resistant candida species have all decreased in frequency, according to a report on antibiotic resistance published by the Centers for Disease Control and Prevention (CDC) in November 2019. Additionally, it showed a rising prevalence of drug-resistant Neisseria gonorrhoeae infections, multidrug-resistant Candida auris, and Enterobacterales that produce extended-spectrum beta-lactamases [1, 2].

The most often given medications are antibiotics, which are the mainstays used to treat a variety of infections. According to the national ambulatory medical care survey, they are the second most commonly prescribed medications [3].

India is one of the biggest consumers of antibiotics in the world, having consumed over 260 crore packs, or Rs. 15,000 crores, in 2016. Moreover, Goa (10.5), Delhi (9), Uttar Pradesh (7.2), Punjab (7.2), and Kerala (6.7) are the top antibiotic-consuming states in this concerning hierarchy, with daily usage rates exceeding the national average of almost 6 packets per 1000 people [4].

According to a recent study, up to 48% of Indians wish to switch doctors, and 53% of them take antibiotics without a prescription. A World Health

Organization (WHO) preliminary survey found that 16% of doctors give antibiotics to patients who have non-specific fevers [3].

The likelihood of microbes resistant to antibiotics eventually rises. As a result, selecting the right antibiotics is crucial to ensuring effective treatment and avoiding long-term issues [5]. The fast development of antibiotic resistance in harmful bacterial isolates is regarded as a major public health concern worldwide. Over the past few decades, multidrug-resistant Gram-negative bacterial strains, such as Acinetobacter baumannii, E. coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, and Gram-positive methicillin-resistant Staphylococcus aureus (MRSA), have been increasingly associated with pus infections in hospital settings due to widespread antibiotic misprescriptions and inadequate dosage regimens [6].

In order to inform effective infection control and antibiotic stewardship practices, the study's objectives were to assess the antibiotic susceptibility and resistance profiles of the bacterial isolates and analyze the prevalence and trends of hospital-acquired infections in patients admitted to a tertiary care center.

Methodology

Study Design: The study was a retrospective, observational.

Study Settings: It was carried out at a tertiary care centre. The study data that was retrieved was for one year.

Study Population: Data of 186 participants were retrieved for the study. Regardless of age or gender, this study included patients who were hospitalized to the tertiary care facility throughout the one-year study period and who experienced hospital-acquired illnesses that were verified by positive bacterial culture. These patients' medical records included all clinical and microbiological information. Exclusion criteria were non-bacterial illnesses, duplicate isolates from the same infection episode, inadequate records, prior antibiotic medication influencing culture findings, and community-acquired infections.

Data Collection: The medical records and microbiological lab reports of patients who satisfied the inclusion requirements were used to gather data in the past. Records were kept of the patient's demographics, medical history, comorbidities, infection type and site, and length of hospital stay. From culture reports, microbiological information was taken out, such as the kind of bacterial isolate and patterns of antibiotic susceptibility.

Study Procedure: Comorbidities, infection site, length of hospital stays, and other pertinent clinical and demographic data were documented. Bacterial isolates and their patterns of antibiotic susceptibility were identified by analyzing microbiological data from blood, urine, wound swabs, or other specimens. Multidrug resistance was identified for both Gram-positive and Gram-negative species, and antibiotic resistance was classified according to accepted standards.

Statistical Analysis: The statistical analysis was conducted using SPSS version 26.0. Microsoft Excel was used to originally enter the data. The information has been displayed as mean±SD or as the number of participants (n) with percentages (%).

For statistical analysis, the independent t-test was employed. A p-value of less than 0.05 was considered to be statistically significant.

Results

The age range of 41–60 years old accounted for 82 participants (44.1%) of HAIs, while the group of 21–40 years old accounted for 49 participants (26.3%). Of the study population, 22.0% (n = 41) were participants who were over 60. Just 7.5% of the population was under 20 years old (14). The age distribution of research participants is displayed in Figure 1.

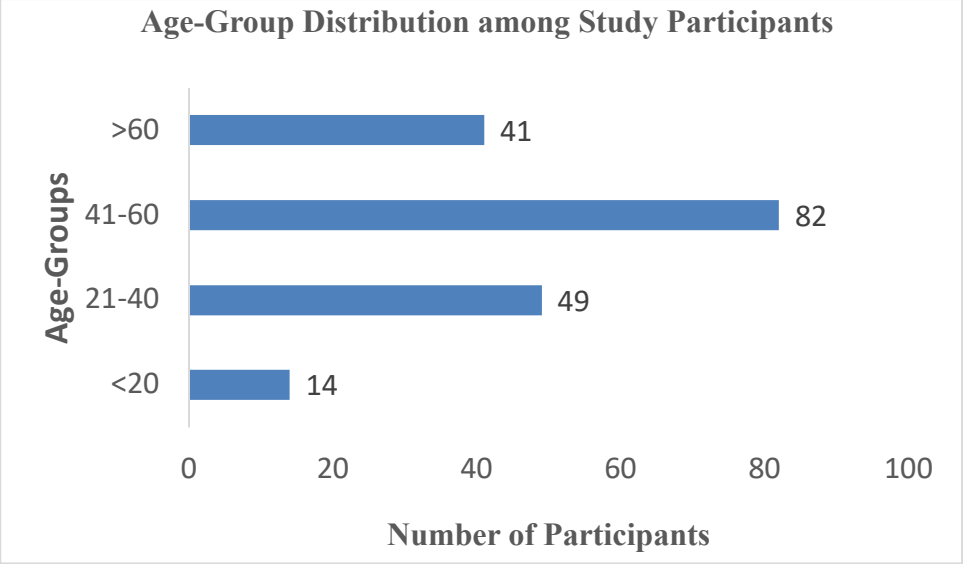

Figure 1: Distribution of age-groups among Study Participants

Among all participants, 71 participants were female, while 115 participants were male. Figure 2 shows gender distribution among study participants.

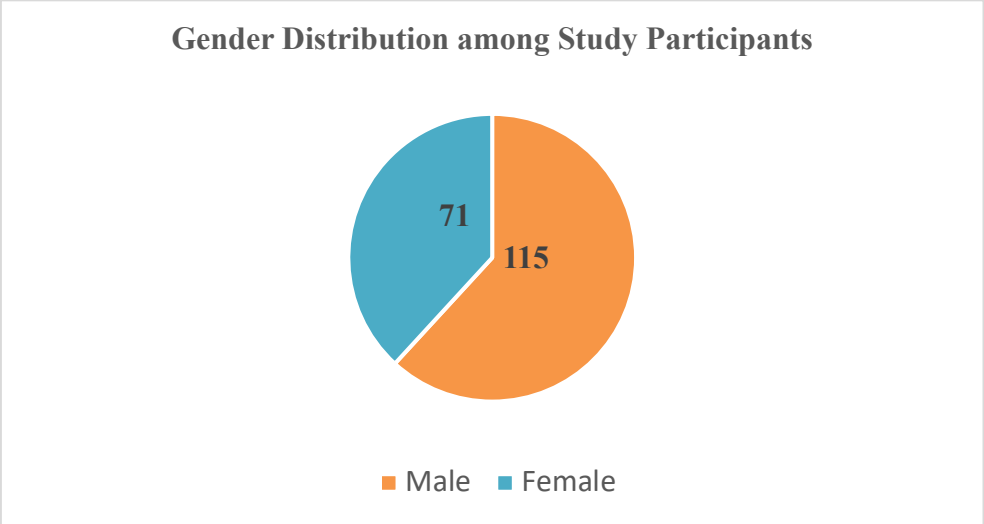

Figure 2: Distribution of Gender among Study Participants

The most often isolated pathogen among the 186 culture-positive HAI patients examined was Escherichia coli (28.4%). Klebsiella pneumoniae came in second (22.6%). The third most frequent isolate was Pseudomonas aeruginosa (18.8%). Gram-positive isolates were largely composed of Staphylococcus aureus (14.0%), including potential MRSA. The distribution of bacterial isolates among research participants is shown in Table 1.

Table 1: Distribution of Bacterial Isolates among Study Participants

Bacterial Isolate	Frequency (n)	Percentage (%)
E. coli	53	28.4
K. pneumoniae	42	22.6
P. aeruginosa	35	18.8
S. aureus	26	14.0
A. baumannii	19	10.2
Others	11	5.9

Widespread β-lactam and fluoroquinolone resistance was indicated by the high resistance to Ceftriaxone (68%) and Ciprofloxacin (64%), which were observed in E. coli. Nitrofurantoin, however, maintained its high sensitivity (84%), indicating that it is still a useful first-line treatment for E. coli

infections of the urinary tract. In Klebsiella pneumoniae, resistance to Cefotaxime (71%) was markedly high, consistent with ESBL-producing strains. Although developing carbapenem resistance (28%) is alarming, meropenem maintained good efficacy (72% sensitivity). Colistin has a sensitivity of 92% and a p-value of less than 0.001, making it the most effective antibiotic. Patterns of antibiotic sensitivity and resistance are detailed in Table 2.

Table 2: Antibiotic Resistance and Sensitivity Patterns

Organism	Antibiotic	Resistant (%)	Sensitive (%)	p-value
E. coli (n=53)	Ceftriaxone	68	32	**0.002**
	Ciprofloxacin	64	36	**0.009**
	Nitrofurantoin	16	84	**0.001**
K. pneumoniae (n=42)	Cefotaxime	71	29	**<0.001**
	Meropenem	28	72	**0.022**
	Colistin	8	92	**<0.001**
P. aeruginosa (n=35)	Ceftazidime	65	35	**0.011**
	Amikacin	24	76	**0.001**
	Colistin	6	94	**<0.001**
S. aureus (n=26)	Methicillin	42	58	**0.041**
	Linezolid	4	96	**<0.001**
	Vancomycin	6	94	**<0.001**
A. baumannii (n=19)	Cephalosporins	88	12	**<0.001**
	Carbapenems	52	48	**0.015**
	Colistin	10	90	**<0.001**

With a p-value of 0.006, it was determined that the MDR rate of Gram-negative bacteria was significantly greater (53.7%) than that of Gram-positive organisms (35.1%). Gram positive and gram-negative isolates' resistance is compared in Table 3.

Table 3: Comparison of Resistance Between Gram-Positive and Gram-Negative Isolates

Category	Total Isolates	MDR (%)	P-value
Gram-negative (n=149)	149	53.7	**0.006**
Gram-positive (n=37)	37	35.1	

Discussion

Particularly at tertiary care facilities where patients are extremely sick and undergo invasive procedures, HAIs for being reason of morbidity and mortality. The age group aged 41–60 years had the highest incidence of HAIs (44.1%) in this investigation of 186 culture-positive cases, followed by those aged 21–40 years (26.3%) and those aged >60 years (22%). This pattern is consistent with earlier research showing that comorbidities, immunosenescence, and longer hospital stays make middle-aged and older patients more vulnerable [7, 8]. 61.8% of infections were among male participants, which is in line with earlier findings that suggested a somewhat greater prevalence of HAI in men, possibly as a result of underlying medical problems and health-seeking behavior [9].

The majority of pathogens were gram-negative bacteria, with the most frequent isolates being Escherichia coli (28.4%), Klebsiella pneumoniae (22.6%), and Pseudomonas aeruginosa (18.8%). Of the isolates, 14% were gram-positive bacteria, primarily Staphylococcus aureus, and a sizable fraction were methicillin-resistant (MRSA). Gram-negative organisms are more commonly linked to bloodstream infections, ventilator-associated pneumonia, and urinary tract infections, which is in line with both national and international trends [10, 11].

Gram-negative isolates exhibited substantial levels of antibiotic resistance, according to antibiotic susceptibility patterns. Nitrofurantoin remained extremely effective (84%), supporting its ongoing use as a first-line treatment for urinary infections, but E. coli demonstrated significant resistance to Ceftriaxone (68%) and Ciprofloxacin (64%), showing widespread β-lactam and fluoroquinolone resistance. Cefotaxime resistance in K. pneumoniae was 71%, which is in line with the frequency of strains that produce extended-spectrum beta-lactamases (ESBLs). Although rising carbapenem resistance (28%) is alarming, meropenem maintained its 72% effectiveness. Colistin's 92% effectiveness rate demonstrated its use as a last-resort antibiotic [12, 13].

Methicillin-resistant S. aureus made up 42% of the Gram-positive isolates, highlighting the ongoing problem of MRSA in hospital settings. According to current recommendations for treating resistant Gram-positive infections, vancomycin and linezolid

both maintained high activity (96% and 94% sensitivity, respectively) [14].

Gram-negative bacteria had a considerably higher total multidrug resistance (MDR) rate (53.7%) than Gram-positive bacteria (35.1%, p=0.006), highlighting the critical need for strict infection control protocols and antimicrobial stewardship initiatives. These results emphasize how crucial local antibiograms are for directing empirical treatment, cutting down on needless antibiotic use, and stopping the spread of resistant pathogens [1, 6].

Conclusion

Gram-negative bacteria accounted for the majority of hospital-acquired infections in this study, and they were highly resistant to many drugs. The majority of pathogens were still susceptible to the effects of nitrofurantoin, carbapenems, colistin, linezolid, and vancomycin. In order to prevent the spread of resistant organisms, the results highlight the necessity of stringent infection control, prudent antibiotic usage, and routine surveillance.

Limitations: It might not be possible to generalize the results of this study to a larger population because it was carried out in a single urban tertiary care facility. Furthermore, the study's sample size was insufficient for extrapolating results and drawing inferences.

Recommendations: Strict infection control, sensible antibiotic use informed by local antibiograms, and routine monitoring of resistance patterns should all be implemented in hospitals. To lower infections and enhance patient outcomes, ongoing staff training on antimicrobial stewardship and HAI prevention is crucial.

List of Abbreviations

WHO- World Health Organization

HAIs- Hospital-Acquired Infections

MRSA- Methicillin-Resistant Staphylococcus aureus

MDR- Multidrug Resistance

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