

Antimicrobial Resistance Pattern Of *Klebsiella Pneumoniae* Isolated In A Tertiary Care Hospital

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Abstract:

Background: *Klebsiella pneumoniae* is a Gram-negative bacilli, non-motile, facultative anaerobe and capsulated producing characteristic lactose fermenting mucoid colonies on Mac Conkey agar. It is associated with both community-acquired as well as hospital-acquired infections, and is a known etiological agent of pneumonia, urinary tract infection, septicemia and various pyogenic infections. It is intrinsically resistant to ampicillin and ticarcillin and over the years, has become multi-drug resistant. Emergence of this resistance is in part due to indiscriminate empirical use of antibiotics. Hence it is important to have continuous monitoring of antibiotic resistance rate in *Klebsiella pneumoniae*.

Materials and Methods: This is a retrospective study which included 313 strains *Klebsiella pneumoniae* isolated from pus, urine, sputum, endotracheal secretions, blood and other samples. All the samples were aseptically collected and inoculated on to blood agar and Mac Conkey agar and in case of urine, on to cysteine lactose electrolyte deficient medium. Plates were incubated at 37°C for 24 hours. All the positive cultures with characteristic colony feature were further identified and confirmed with the help of standard biochemical tests. Antimicrobial susceptibility testing was performed as per CLSI guidelines. All age group and gender were included in the study, and *Klebsiella pneumoniae* isolated from stool was excluded.

Results: Of the 313 samples, 148 were from male patients and 165 from female patients, and most of the patients were in the age group of 21-40 years. Among these, 123 were isolated from pus samples, 112 from urine samples, 36 from sputum samples, 20 from endotracheal secretions, 15 from blood and 7 from other samples. Among the antibiotics tested, *Klebsiella pneumoniae* was found to be mostly susceptible to meropenem (94.7%), piperacillin-tazobactam (89.7%) followed by cefoxitin (77.5%) and cefepime (77.3%). Cefuroxime was found to be least susceptible (36.4%).

Conclusion: *Klebsiella pneumoniae* is being increasingly isolated from various samples and multi-drug-resistant strains have also been isolated. So, there is a need for an active antimicrobial stewardship program and training of physicians and other healthcare workers for controlling the drug resistance among bacteria in general.

Key Word: *Klebsiella pneumoniae*, multi-drug-resistant, Gram-negative bacilli

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I. Introduction

Klebsiella pneumoniae was first discovered by Carl Friedlander in 1882 from cases of patients who had died due to pneumonia. It belongs to the family Enterobacteriaceae, is Gram negative bacilli, non-motile, facultative anaerobe and capsulated producing characteristic lactose fermenting mucoid colonies on Mac Conkey agar.¹

It is associated with both community-acquired as well as hospital-acquired infections, responsible for pneumonia, urinary tract infection, septicemia and various pyogenic infections. It is intrinsically resistant to ampicillin and ticarcillin and over the years, has become multi-drug resistant. There has been a steady rise in *Klebsiella* producing extended spectrum beta lactamase (ESBL) and an increase in co-resistance to quinolone and aminoglycoside antibiotics has been seen in the last few years. These multi-drug resistant organisms cause considerable morbidity and mortality. Emergence of this resistance is significantly due to indiscriminate empirical use of antibiotics. Hence it is important to have continuous monitoring of antibiotic resistance rate in *Klebsiella pneumoniae*.²

There is low occurrence of *Klebsiella pneumoniae* in the community, hence treatment should follow the standard guidelines and once the infection is suspected or confirmed, treatment should be custom-made to suit the local antibiograms.

It is known to cause disease in immunocompromised hospitalized patients with neoplastic, cardiac, renal and chronic pulmonary diseases as well as in patients with diabetes mellitus.³

It can colonize multiple body sites like respiratory tract, gastrointestinal tract, skin and oral cavity.⁴

This study was undertaken with the aim to update the recent trends in *Klebsiella pneumoniae* isolated from various samples and to determine their resistance pattern. This will help in better selection of antibiotics and in efficient patient management when dealing with diseases caused by *Klebsiella pneumoniae*.

II. Material And Methods

This retrospective study was carried out in Department of Microbiology of a tertiary care hospital at Bhopal, Madhya Pradesh from June 2023 to November 2024. A total of 313 non repeat isolates of *Klebsiella pneumoniae* isolated during the period of study were included in the study.

Study Design: Retrospective study

Study Location: Department of Microbiology, People's College of Medical Sciences and Research Centre, People's University, Bhopal of a tertiary care hospital,

Study Duration: July 2022 to December 2023.

Sample size: 313

Sample size calculation: A total of 313 non repeat isolates of *Klebsiella pneumoniae* isolated from various samples, in the Department during the study period, were selected by convenience sampling method.

Inclusion criteria:

1. All *Klebsiella pneumoniae* isolates
2. Any gender

Exclusion criteria:

1. Repeat isolates of *Klebsiella pneumoniae*
2. *Klebsiella pneumoniae* isolated from stool sample.

Procedure methodology

All the samples were aseptically collected and inoculated on to blood agar and Mac Conkey agar and in case of urine, on to cysteine lactose electrolyte deficient medium. Plates were incubated at 37°C for 24 hours. All the positive cultures with characteristic colony feature were further identified and confirmed with the help of standard biochemical tests.⁵

Antimicrobial susceptibility of all the isolates was performed by Kirby Bauer technique and the results interpreted as per CLSI guidelines 2022⁶. Briefly, the turbidity of the bacterial growth was compared with Mc Farland 0.5 standard and was spread on Mueller Hinton agar to give a lawn culture. Following antibiotics were tested – Amikacin (30 µg), Amoxycillin-clavulanic acid (20//10 µg), Cefepime (30 µg), Cotrimoxazole (1.25/23.75 µg), Cefuroxime (30 µg), Gentamicin (10 µg), Meropenem (10 µg), Ceftriaxone (30 µg), Ceftazidime (30 µg), Ciprofloxacin (5 µg), Cefoxitin (30 µg) and, in case of urine isolates, Norfloxacin (10 µg) and Nitrofurantoin (300 µg) were also included.

III. Result

A total of 313 non repeat isolates of *Klebsiella pneumoniae* isolated from different samples were included in the study. Of the 313 samples, 148 were from male patients and 165 from female patients, and most of the patients were in the age group of 21-40 years. (Table 1)

Among these, 123 were isolated from pus samples, 112 from urine samples, 36 from sputum samples, 20 from endotracheal secretions, 15 from blood and 7 from other samples. (Table 2).

Table 1: Showing age wise distribution.

Sample	<20 yrs	21-40 yrs	41-60 yrs	>61 yrs	Number (%)
Pus	22	58	28	15	123 (39.3)
Urine	21	53	26	12	112 (35.8)
Sputum	0	16	12	8	36 (11.5)
Endotracheal secretions	1	6	9	4	20 (6.4)
Blood	9	3	1	2	15 (4.8)
Other samples	0	5	1	1	07 (2.2)
Total	53	141	77	42	313

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Among these, 123 were isolated from pus samples, 112 from urine samples, 36 from sputum samples, 20 from endotracheal secretions, 15 from blood and 7 from other samples. (Table 2).

Table 2: Showing percentage of isolation from different samples and gender distribution.

Sample	Male	Female	Total Number (%)
Pus	76	47	123 (39.3)
Urine	29	83	112 (35.8)
Sputum	21	15	36 (11.5)
Endotracheal secretions	12	8	20 (6.4)
Blood	8	7	15 (4.8)
Other samples	2	5	07 (2.2)
Total	148	165	313

Among the antibiotics tested, *Klebsiella pneumoniae* was found to be mostly susceptible to meropenem (94.7%), piperacillin-tazobactam (89.7%) followed by cefoxitin (77.5%) and cefepime (77.3%). Cefuroxime was found to be least susceptible (36.4%). (Table 3)

Table 3: Showing percentage of susceptible and resistant isolates

Antibiotic	% susceptible	% resistant
Amikacin	67.7	32.3
Amoxycillin-clavulanic acid	38.7	61.3
Cefepime	77.3	22.7
Cotrimoxazole	55.7	44.3
Gentamicin	58.2	41.8
Cefuroxime	36.4	63.6
Meropenem	94.7	5.3
Ceftriaxone	46.9	53.1
Ceftazidime	59.3	40.7
Ciprofloxacin	60.5	39.5
Cefoxitin	77.5	22.5
Piperacillin-tazobactam	89.7	10.3
Norfloxacin	58.3	41.7
Nitrofurantoin	65	35.0

Many isolates were found to be multidrug resistant especially those that were isolated from pus and urine.

Table 4: Showing percentage of susceptible and resistant isolates

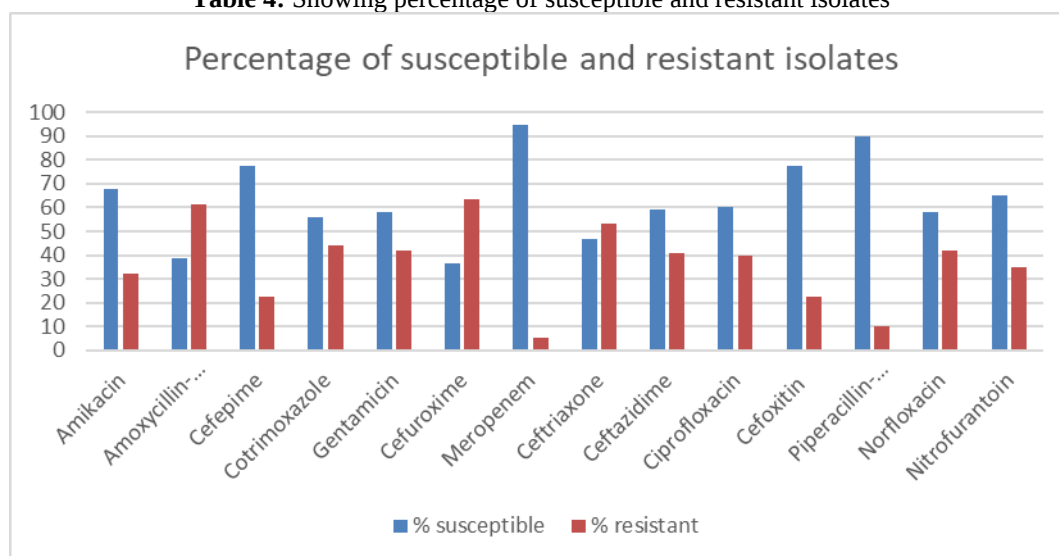


Table 4: Showing percentage of resistant isolates from different samples

Antibiotic	% resistant					
	Pus	Urine	Blood	Sputum	Endotracheal secretion	Others
Amikacin	31.8	28.3	50	10.5	44.4	28.6
Amoxycillin-clavulanic acid	56.1	56.7	85.7	42.1	55.6	71.4
Cefepime	33.4	21.7	28.6	15.8	22.2	14.3
Cotrimoxazole	50	53.3	57.8	31.6	44.4	28.6

Gentamicin	42.4	31.7	71.4	29	33.3	42.9
Cefuroxime	71.2	55	42.9	63.2	77.8	71.4
Meropenem	0	8.3	9.1	0	0	14.3
Ceftriaxone	62.1	31.7	50	36.8	66.7	71.4
Ceftazidime	50	20	42.9	26.3	33.3	71.4
Ciprofloxacin	45.5	-	21.4	29	44.4	57.1
Cefoxitin	34.7	19.8	27.5	17.3	21.9	13.8
Piperacillin-tazobactam	9.8	10.4	7.9	11.1	12.8	9.8
Norfloxacin	-	41.7	-	-	-	-
Nitrofurantoin	-	35	-	-	-	-

IV. Discussion:

Klebsiella pneumoniae is frequently isolated from different samples in hospital and community setting and is an important pathogen causing hospital associated infection. In the present study, 313 isolates were processed and gender wise distribution showed that the isolates were more from female patients (165) than from male (148) patients, the ratio is similar to study by Shireen Rana et al⁷, and this may be due to the fact that most of the urine samples were from female patients, possibly antenatal cases. (Table-4) Most of the samples were from the age group of 21 to 40 years. Klebsiella pneumoniae were mostly isolated from pus samples followed by urine sample as was observed by Gill MK et al and Madhavi S et al.^{8,9}

Klebsiella pneumoniae is showing increased resistance to commonly used antibiotics. This study shows higher level of resistance to cefuroxime, amoxycillin-clavulanic acid and ceftriaxone. Further, only 55.7% were sensitive to cotrimoxazole, 58.2% to gentamicin and 59.3% to ceftazidime.

The isolates were more sensitive to meropenem (94.7%), piperacillin-tazobactam (89.7%) followed by cefoxitin (77.5%) and cefepime (77.3%). This was similar to studies elsewhere.^{10, 11, 12}

In strains isolated from pus, sputum and endotracheal secretions, most were resistant to cefuroxime, ceftriaxone and amoxycillin-clavulanic acid. From urine and blood, strains were mostly resistant to amoxycillin-clavulanic acid and cotrimoxazole, but were susceptible to most other antibiotics. This was similar to studies elsewhere but not in concordance with studies by Gill MK et al² and Hafiz et al³. This study also showed that most strains were susceptible to meropenem as seen by Sunil Kumar et al¹¹.

Study by Amar Sunil Lobo et al have found Klebsiella to be resistant to Ciprofloxacin in 60.9% of the cases while our study shows a susceptibility rate of 60.5%.¹³ Similarly, in study by Rachana A. Bhavsar et al it was reported 85.2% susceptibility to Cotrimoxazole, while in our study it was 55.7%.¹⁴

There is a wide variation in the antibiogram of Klebsiella pneumoniae, which might be because of the geographical variation, usage pattern of antibiotics locally and pattern of the disease.¹⁵

Lot of morbidity and mortality could be avoided if the resistant antibiotic were replaced by sensitive antibiotics by proper testing of samples. The overuse as well as the misuse of antibiotics does not augur well for the future.

V. Conclusion

Klebsiella pneumoniae is being increasingly isolated from various samples and multi-drug resistant strains have also been isolated. So, there is a need for an active antimicrobial stewardship program and training of physicians and other healthcare workers for controlling the drug resistance among bacteria in general. Also, good infection control measure and cautious empirical prescription along with culture and sensitivity testing and consequent selection of antibiotic is of utmost importance. Also, the Microbiology department has to take initiative to prepare the antibiogram regularly which will help the clinician. Further studies in this geographical area are required with larger sample size.

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