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MHT-Based Screening of Carbapenem Resistance in *Klebsiella Pneumoniae*

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A B S T R A C T

Background: Klebsiella pneumoniae has emerged as a significant nosocomial pathogen, especially among critically ill patients in intensive care units (ICUs). The rising incidence of multi-drug resistant (MDR) strains, especially those resistant to carbapenems, poses a serious challenge to infection management.

Objectives: This study's objectives were to use the Modified Hodge Test to identify Klebsiella pneumoniae isolates that could produce carbapenemase, assess their pattern of antibiotic resistance, and highlight the importance of routine phenotypic detection techniques in labs with limited diagnostic resources.

Materials and Methods: A total of 15 K. pneumoniae isolates were collected from ICU patients at KLE's Dr. Prabhakar Kore Hospital & Medical Research Centre, Belagavi. Antimicrobial resistance patterns were determined by the disk diffusion technique following Clinical and Laboratory Standards Institute (CLSI) protocols, while carbapenemase activity was screened using the Modified Hodge Test.

Results: 12 (80%) of the 15 isolates tested positive for carbapenemase production by MHT, while 3 isolates maintained broad-spectrum sensitivity, while the other isolates displayed a variety of resistance profiles. The high percentage of MHT-positive result indicates a substantial presence of carbapenem-resistant strains in the clinical setting.

Conclusion: The high frequency of Klebsiella pneumoniae that produces carbapenemase emphasizes the urgent need of improved infection control protocols and frequent screening. Even though MHT has drawbacks, its affordability and simplicity of use make it useful tool for early detection in situations where access to molecular diagnostics is limited.

Keywords: *Klebsiella pneumoniae*, Carbapenemase, Antimicrobial resistance, Carbapenem-resistant Enterobacteriaceae, Multi-drug resistant (MDR), Phenotypic screening, *Klebsiella pneumoniae* Carbapenemase (KPC)

INTRODUCTION

An important pathogen that causes hospital-acquired infections is *Klebsiella pneumoniae*, particularly in patients with weakened immune system and those confined to critical care units. Since multi-drug resistant (MDR) strains of this Gram-negative bacterium are becoming more common, treating and controlling infections has become a global concern. Formerly, carbapenems have been the preferred antibiotics for treating infections brought on by *K. pneumoniae* that produces extended-spectrum beta-lactamases, as they are among the few substances that effectively combat these resistant organisms. The treatment of these infections is being jeopardized by rising reports of carbapenem resistance in recent years.

Klebsiella pneumoniae carbapenemase, a potent enzyme that deactivates carbapenem drugs, is the main cause of the advent of carbapenem-resistant *K. pneumoniae*, one of the most concerning discoveries. Resistance to carbapenem, nearly all kinds of antibiotics are known to cause resistance in Enterobacteriaceae, which severely restricts therapy options and impacts death and morbidity rates. A global public health emergency, the rising resistance problem transcends national and regional borders. Travelling abroad and participating in medical tourism might cause resistant strains to spread quickly between hospitals, communities, and even continents. In view of this, antimicrobial resistance is a global problem that necessitates careful antibiotic use, quick diagnostic methods, strict infection control protocols, and coordinated surveillance.

Given the expanding incidence of KPC-producing *K. pneumoniae* and treatment constraints, immediate action is required to put effective containment and prevention measures into place. The identification of isolates that produce KPC, their antibiotic resistance profiles, and the significance of precise diagnostic techniques in halting their spread are the main topics of our investigation [1,2]

MATERIALS AND METHODS

15 *Klebsiella pneumoniae* isolates were collected from patients who were admitted in ICU from KLE's Dr. Prabhakar Kore Hospital & Medical Research Centre, Belagavi.

Antimicrobial susceptibility pattern

Antibiotic susceptibility pattern of isolates was determined by performing Kirby- Bauer method (disk diffusion test) using Muller-Hinton agar according to guidelines of the CLSI.

Modified Hodge Test:

The Modified Hodge Test was carried out following Clinical and Laboratory Standards Institute (CLSI) guidelines**.** Four to five well separated colonies of *Escherichia coli* ATCC 25318 were used to make a 0.5 McFarland Standard suspension broth. Using a sterile swab, Mueller-Hinton Agar plate was inoculated as for routine disk diffusion test. An Imipenem disk was put in the centre of the plate, leaving toom to streak the test organism from edge of disk to edge of plate. Selection of three to five colonies of test organisms grown overnight on a blood agar were picked with a swab. From the disk's edge to the plate's edge, straight line should be streaked. Touching the disk with swab should be avoided. The streak should have a minimum length of 20 to 25 mm. The plate was incubated overnight at 35^0C in ambient air for 16 to 24 hours. An area of enhanced growth of the *E. coli* at the intersection of the streak and the zone of inhibition was observed.

RESULTS

To determine whether carbapenemase synthesis exists, the Modified Hodge Test (MHT) was performed on a total of 15 clinical isolates of *Klebsiella pneumoniae*. 12 isolates (80%) of those tested were positive MHT results, which are indicative of carbapenemase enzyme activity. Three isolates were found to be sensitive to a wide spectrum of antibiotics, including piperacillin-tazobactam, ciprofloxacin, ceftriaxone, amikacin, meropenem, imipenem, and tetracycline, as determined by antimicrobial susceptibility tests. This may indicate that those bacteria lack resistance mechanisms. 2 isolates exhibited gentamicin and aztreonam sensitivity. Given the clinical relevance of carbapenems as last-resort antibiotics, the high percentage of MHT-positive isolates suggests a significant prevalence of carbapenemase synthesis among *K. pneumoniae* strains within the study. These results emphasize the necessity for robust antibiotic stewardship and infection control measures, in addition to the likelihood of carbapenem-resistant Enterobacteriaceae spreading inside the healthcare environment**.**

DISCUSSION

In the current study, 80% of the *Klebsiella pneumoniae* isolates demonstrated carbapenemase production as indicated by Modified Hodge Test (MHT) positivity, reflecting a notably high level of phenotypic resistance. This prevalence exceeds rates reported in previous Indian surveillance efforts, including a multicenter investigation that identified 35.9% MHT positivity among *Enterobacteriaceae*, with *Klebsiella* species contributing to around 30% of those cases. The findings align with data from Deshpande et al., where 91.6% of carbapenem-resistant *Enterobacteriaceae* tested positive by MHT, reinforcing the relevance of this method for initial screening. Despite its limitations—such as reduced sensitivity in detecting metallo-β-lactamases and the potential for false positives in non-fermenting organisms or ESBL-producing strains—MHT remains a valuable tool, particularly in settings with limited access to molecular diagnostics. Its affordability, ease of implementation, and compatibility with standard microbiological workflows support its role as a frontline diagnostic method. The high proportion of carbapenemase-producing isolates identified in this study underscores the urgent need for comprehensive resistance monitoring, especially in healthcare facilities facing a high burden of multidrug-resistant pathogens. To improve diagnostic accuracy, phenotypic methods like MHT should ideally be complemented with molecular assays or inhibitor-based tests. Moreover, reinforcing antimicrobial stewardship and implementing strict infection control protocols are essential steps to contain the spread of carbapenem-resistant *K. pneumoniae* in clinical environments.

CONCLSION

As part of antimicrobial resistance surveillance, the results highlight the significance of routine phenotypic screening for carbapenemase production. The discrepancy between MHT positive and phenotypic susceptibility, however, points to the necessity of further molecular diagnostic methods in order to precisely confirm resistance mechanisms. In order to assure adequate antibiotic therapy, avoid treatment failures, and prevent the emergence of resistant organisms, it is imperative that resistant strains be identified promptly.

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