The Hidden Threat of Carbapenemases in Hospital Effluents

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ABSTRACT

Introduction: It is well-known that resistant Gram-negative bacteria may be found in hospitals' wastes. *Klebsiella pneumoniae* is considered the most medically significant organism within the Klebsiella species. It produces a thick capsule layer of extracellular polysaccharides, which helps protect the bacterial cells from being cleared by the host's innate immune system during infection. Infections caused by Klebsiella pneumoniae carbapenemases (KPC) are quickly rising to the top of the list of infectious diseases resistant to many drugs. Septicemia, UTIs, pneumoniae, and infections of the soft tissues are among the many hospital-acquired diseases caused by this bacterium, which is especially common in patients with impaired immune systems. There have been several outbreaks of this bacterium in hospitals because healthcare personnel's and patients' hands serve as reservoirs for its transmission.

A rise in cases of Klebsiella pneumoniae that is resistant to several drugs or that produces extended-spectrum beta-lactamase (ESBL) has been seen in recent years. Therefore, prevention through strict infection control guidelines, effective hand washing, proper wastewater treatment, appropriate disposal, use of antibacterial agents, and affordable, non-toxic, and highly effective antibiotics is crucial to combat the multidrug resistance of this rapidly increasing organism. Significant pathogenic bacteria, including *Klebsiella pneumoniae*, have been isolated from various hospital wastewater samples in Karachi, Pakistan. Additionally, other gram-negative organisms were also observed in healthcare waste.

Objectives: This research aimed to examine hospital effluent for carbapenemase-producing *Klebsiella pneumoniae* and the factors that influence their resistance. The primary aim of research is detecting the bla_{KPC} gene in carbapenem-resistant *Klebsiella pneumoniae* is to identify and understand the presence of *Klebsiella pneumoniae* carbapenemase (KPC).

Methodology: This research was performed step by step, i.e., intially collected the waste water sample after that isolation, identification and biochemical tests were performed for the confirmation of isolated organisms. Antimicrobial susceptibility testing of carbapenems antibiotic was performed by agar well diffusion assay to confirmed the resistance pattern of organisms. DNA extraction of isolated resistant organisms was performed by manual method and PCR assay performed for the detection of bla_{KPC} gene. Finally, agarose gel electrophoresis used to confirm the detection of the bla_{KPC} gene by visualizing the characteristic bands. (Englen & Kelley, 2000).

Result: Approximately 100 samples were collected, among these 25 were other than Klebsiella species and 35 were Klebsiella species. Whereas, 40 were *klebsiella pneumoniae* strains were isolated, after confirmation by PCR and band detection by agarose gel electrophoresis, thirty- three samples were found to carry the bla_{KPC} gene.

Key Findings:

- Identification of key resistance genes like KPC, NDM, OXA-48, and CTX-M has improved our ability to detect and monitor resistant strains.
- Surveillance studies have guided infection control policies in healthcare settings.
- Discovery of novel drug combinations and β-lactamase inhibitors (e.g., avibactam, vaborbactam) to treat carbapenem-resistant *K. pneumoniae*.

- Research has clarified the role of biofilms in chronic infections and resistance.

Conclusion: The present research showed that bla_{KPC} gene was very important for the regulation and production of carbapenemase enzymes which assisted in increasing anti-microbial resistance. The alarming global spread of resistance among pathogenic bacteria against life-saving antimicrobial drugs severely threatens public health. The continuous flow of resistance among deadly bacteria against anti-microbial drugs is becoming a threatening condition worldwide. The pattern of antibiotic resistance can occasionally be different; therefore, immediate assessment is mandatory for infection command.

Keywords: KPC, Extracellular Polysaccharides, ESBL, blaKPC, PCR, wastewater, Antibiotic Resistance.

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