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# The Epidemiology of *Klebsiella Pneumoniae*: A Review

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**ABSTRACT**

In alcohol and diabetes mellitus patient populations, *Klebsiella pneumoniae* is associated with pneumonia. Usually, the bacterium colonizes the human oropharynx and GI mucosal surfaces. *Klebsiella pneumoniae* has been extensively studied and a beta-lactamase that induces antibiotic beta-lactam ring hydrolysis has been shown to develop. Human beings represent *K. pneumoniae* as the main reservoir.

Relationship between multidrug resistance and epidemiological study of *K. pneumoniae* in hospital environment.There are (5%-38%) of individuals in the population have the organism in their stomach and (1%-6%) in the nasopharynx.Additional research on resistance and survival mechanisms for *K. pneumoniae* can inform infection prevention and control strategies to decrease *K. pneumoniae* transmission.

*Klebsiella pneumoniae* was an urgently defined threat in the rise of multi-drug-resistant hospitals and hyper virulent strains. The appearance of these hazardous isolates and their global distribution has left very few therapeutic options to clinicians and determined one of the essential strains of nosocomial infections.

**Keywords:** Enterobacteriaceae,*Klebsiella pneumoniae*, virulence factors

## Introduction

In alcohol and diabetes mellitus patient populations, *Klebsiella pneumoniae*is associated with pneumonia (Siu *et al.*,2012). Usually, the bacterium colonizes the human oropharynx and GI mucosal surfaces (Nadasy*et al.*,2007). The bacterium can be shown high levels of virulence and antibiotic resistance once it reaches the body (Lenchenko*et al.*,2020). *K. pneumoniae* is also the world's most common cause of hospital-acquired pneumonia thatdetermined between(3% to 8%) of all bacterial infections (Yu*et*

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*al.*,2020).*Klebsiella pneumoniae* is a gram-negative, encapsulate, and nonmobile bacterium in the Enterobacteriaceae family (Walker *et al.*,2020). A wide variety of factors contributing to infection and antibiotic resistance include bacterium virulence (Zhang *et al.*,2020). The organism's polysaccharide capsule is the most important virulence factor and can prevent the host organism from developing opsonophagocytosis and bacterium eradication (Sun *et al.*,2020).To date, 77 capsules were studied, and those without capsules are often less virulent for *Klebsiella* species. Lipopolysaccharides coating the external surface of gram-negative bacteria is a second virulence factor (Ma *et al.*,2020). Lipopolysaccharide sensation releases an inflamed cascade to the host organism and has proved to be a significant culprit in septic and septic sequelae(Anand *et al.*,2020). The organism can bind itself to host cells via a particular virulence factor, fimbriae. Another virulence factor used by the organism for hosts is siderophores (Rodrigues *et al.*,2020). To enable the spread of the contaminating organism, siderophores obtain iron from their host (Liu *et al.*,2020).*Klebsiella pneumoniae* is one of the bacteria with a high antibiotic resistance rate secondary to changes in the core genome of the cell (Ruan*et al.*,2020). Fleming first discovered resistance in gram-negative species to beta-lactam antibiotics in 1929. From then on, *K. pneumoniae* has been extensively studied and a beta-lactamase that induces antibiotic beta-lactam ring hydrolysis has been shown to develop (Farzand*et al.*2021). Extensive-spectrum beta-lactamase (ESBL) ESBLs may be able to hydrolyze oxyimino cephalosporins which render cephalosporins of third-generation ineffective,because of this, carbapenems have become a choice for the treatment of ESBL (Hayder& Aljanaby,2019A ;Hayder& Aljanaby,2019B).

## Epidemiology:

Human beings represent *K. pneumoniae* as the main reservoir (Kadhum& Hasan,2019). There are (5%-38%) of individuals in the population have the organism in their stomach and 1%-6% in the nasopharynx (Hasan & Al-Harmoosh,2020). The main sources of infection are the gastrointestinal tract and the medical staff19. It can lead to an outbreak of nosocomial infections (Majeed *et al.*,2020). The carrier prevalence of *K. pneumoniae* is substantially higher in hospitalized patients than in the population (Hasan *et al.*,2020). Carrier concentrations of up to 77 percent in one study are seen on the stool of those admitted to hospital and are believed to have been linked to the number of antibiotics (Hasan,2020A).*K. pneumoniae*was divided into two types: pneumonia acquired by the population or pneumonia acquired by the hospitals (Hasan,2020B). Although a typical diagnosis is community-acquired pneumonia, *K.pneumoniae* infection is very rare (Ablaa*et al.*,2021). It is estimated that about (3 to 5%) of all pneumonia population infections that caused due to *K. pneumoniae* in Western culture but it is approximately 15% of all pneumonia cases in developing countries, such as Africa (Hasan *et*

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*al.*,2021A).*K. pneumoniae* constitutes around 11,8% of all pneumonia acquired by hospitals worldwide (Hasan *et al.*,2021B). In people with pneumonia in the ventilator, *K. pneumoniae* causes between (8% and 12%), while in those that do not ventilate, just 7%,although mortality differs from that of patients with alcoholism and septicemia from 50 % to 100 % (Munoz-Price *et al.*,2013).

*Klebsiella* pneumonia is poorly expected, especially in patients with alcoholic, diabetic, nosocomial, or septicemic conditions,this pneumonia mortality is more than 50%(Patel *et al.*,2008; Bengoechea& Sa Pessoa, 2019). Also,*K. pneumoniae* cancause bacteremia, lung abscesses, and the development of empyema can cause pneumonia(Ye *et al.*,2001).

In nature, *Klebsiella* probably has two environments common to them; one is the ecosystem in which they find themselves and their colonized mucosal areas of humans, horses, or swine on surface waters, sewage and soils, and plants(Tumbarello*et al.*,2012). The *Klebsiella* genus is like *Enterobacter* and *Citrobacter* in this regard, but it is different from *Shigella spp*. or *E. coli*, common to individuals, but not environmentally (Nordmann *et al.*,2009).

*K. pneumoniae* is present in humans in the nasopharynx and intestinal tract as a commensal (Paczosa&Mecsas, 2016). Carrier rates vary widely from one study to the next. The rate of detection in stool samples is between 5% and 38%, while in the nasopharynx range between (1% and 6%) (Elemam*et al.*,2009).*Klebsiella*spp is not good for human skin as gram-negative bacteria do not find good conditions for growth. It's seldom found and is simply called transient flora members(Lautenbach *et al.*,2001).

In hospital settings, these carrier rates change significantly, where colonization rates are directly proportionate to the duration of the stay. The number of *Klebsiella* carriages is also high for hospital staff[37]. In hospitalized patients, the reported carriers' rates are 77% in stools, 19% in pharynxes, and 42% in patients' hands (Martin & Bachman,2018).

The high rate of nosocomial *Klebsiella* colonization appears to be associated with the use of antibiotics rather than with factors connected with the delivery of care in the hospital (Cano *et al.*,2020). Previous antibiotic therapy is significantly associated with the acquisition of *Klebsiella* by the patient (Wyres*et al.*,2020). The increase occurred

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primarily in patients receiving antibiotics, especially in persons receiving broad-spectrum or multiple antibiotics(Wang *et al.*,2018).

The local antibiotic policy in the hospital setting is a significant determinant of the pattern of colonization (Tumbarello*et al*,2019). It was found that the attack rate for *Klebsiella*nosocomial was four times higher in patients carrying *Klebsiella* intestinal infection than in patients who were acquired with the hospital (Gorrie *et al*.,2017).

Moreover, routine use of antibiotic care in hospitals has also been known to be responsible for multiplying resistant *Klebsiella* strains (Galvão*et al*.,2018). Because these undesirable effects can be reversed by rigorous antibiotic treatment, techniques to prevent overuse of antibiotics are increasingly being called for in prophylaxis and empirical therapy (Gu *et al*., 2018).

In addition to medical equipment and blood products, the main sources for *Klebsiella* transmission in hospitals are the gastrointestinal tract of patients and hands of the hospital staff and are contaminated by faulty hygiene procedures (Petrosillo*et al*.,2019). The capacity of the organism, particularly in neonatal units, to spread rapidly frequently causes nosocomial diseases (Ramos-Castañeda*et al*.,2018).

*Klebsiella* spp. are implicated with many epidemic hospital infections,in the 1970s, these strains were primarily *Klebsiella* strains that were aminoglycoside resistant. Production of ESBLs that make them safe to cephalosporins of a wider range have developed since 1982 (Falcone *et al.*,2020). Both *K. pneumoniae* and *K. oxytoca* isolates are distinguished by their resistance to ceftazidime (Shields *et al*.,2017). In Europe, ceftazidime-resisting *Klebsiella* strains are usually β-lactamases of an SHV-5 type whereas the US has a higher prevalence of TEM-10 and TEM-12 (Caneiras*et al.*,2019).

In the US 5 % of the *K. pneumoniae* strains tested in the National Nosocomial Infection Research System have been identified for ESBL-producing *Klebsiella* Isolates (Mohammed &Aljanaby, 2020). Europe appears to be much more common with such strains. For France and Britain, a proportion of 14-16% of ESBL producers has been identified among clinical *Klebsiella* isolates. Incidence can be up to 25 to 40% in regions or hospitals (Al-labban and Aljanaby, 2020).

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Even so, this is possible because the percentage of ceftazidime-resistant strains in the routine laboratory underestimates the occurrence of these isolates (Alfaham, &Aljanaby, 2020).

The plasmid is normally mediated by ESBLs. Since plasmids can be transmitted easily among various Enterobacteriaceae members, the accumulation of resistance genes leads to strains containing multi-resistant plasmids. Therefore, isolates developed by ESBL are resistant to several antibiotic groups (Lee *et al*.2017; Mohamed & Aljanaby,2020).

Also, the appearance of these multi-drug resistant strains in *Klebsiella* accompanies relatively high stability of the ESBL-encoding plasmids (Temkin *et al*.,2018). There has been continued colonization of patients using ESBL-producing *Klebsiella* strains many years after ceftazidime and other extended-spectrum cephalosporins had ceased (Thorenoor *et al.*,2018). A long period of stay in the hospital and the success of invasive procedures tend to be the risk factors for the acquisition of these strains (Giannella*et al.*,2019).

In that ESBL development is often accompanied by antibiotic resistance, therapeutic options are minimal (Shimasaki*et al*.,2019). However, *Klebsiella* strains developed by ESBL were previously responsive to carbapenems like imipenem or meropenem. In the treatment of infections caused by ESBL-produced species, both antibiotics are the drugs of choice. A recent comment is extremely troubling in this regard (Thorenoor*et al.*,2018).

Over the first time, *K. pneumoniae* strains to produce ESBL which demonstrated additional imipenem resistance was isolated (Quan *et al.*,2017). These strains have an AmpC-type β-lactamase transmissible by the plasmid. The advent of imipenem ESBL-producing *Klebsiella* strains will be watched closely, as it will have a significant effect on other therapeutic options (Dunn *et al.*,2019).

Over the first time, *K. pneumoniae* strains to produce ESBL which demonstrated additional imipenem resistance was isolated (Kidd *et al*.,2017). These strains have an AmpC-type β-lactamase transmissible by the plasmid. The advent of imipenem ESBL-producing *Klebsiella* strains will be watched closely, as it will have a significant effect on other therapeutic options (Zhang *et al*.,2020).

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Treatment for the spread of nosocomial *Klebsiella* infections is aided by strict observance of the basic epidemiological principles of urinary catheter management, injection, and tracheostomy, wound, maintenance, and hand-washing procedures (Decraene*et al*.2018).

The regulation of antibiotic use in hospitals to avoid abuses and overuse of antibiotics is another step to manage *Klebsiella* infectionsBesides, nosocomial infection monitoring is important for collecting data for the prevention and control of nosocomial infection rates of *Klebsiella*(Gomez-Simmonds *et al*.,2017).

## Conclusion

*Klebsiella pneumoniae* was an urgently defined threat inthe rise of multi-drug-resistant hospitals andhyper virulent strains. The appearance of these hazardous isolates and their global distribution has left very few therapeutic options to clinicians and determined one of the essential strains of nosocomial infections.Additional research on resistance and survival mechanisms for *K. pneumoniae* can inform infection prevention and control strategies to decrease *K. pneumoniae* transmission.

## Conflict of Interest

The authors have no conflicts of interest.

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