

KLEBSIELLA SPP.

PATHOGEN SAFETY DATA SHEET - INFECTIOUS SUBSTANCES

INFECTIOUS AGENT

NAME: *Klebsiella spp.*

SYNONYM OR CROSS REFERENCE: Human pathogens include *K. pneumoniae* subspecies *pneumoniae*, *ozaenae*, and *rhinoscleromatis*; *K. oxytoca*; *K. granulomatis*; *K. variicola*; and *K. singaporensis*.

CHARACTERISTICS: *Klebsiella spp.* are Gram-negative, nonmotile, usually encapsulated rod-shaped bacteria, belonging to the family *Enterobacteriaceae*. These bacteria produce lysine decarboxylase but not ornithine decarboxylase and are generally positive in the Voges-Proskauer test. Members of the *Enterobacteriaceae* family are generally facultative anaerobic, and range from 0.3 to 1.0 μm in width and 0.6 to 6.0 μm in length. *Klebsiella spp.* often occur in mucoid colonies. The genus consists of 77 capsular antigens (K antigens), leading to different serogroups.



Klebsiella spp., gram-stained¹⁾

Klebsiella spp. cells²⁾

HAZARD IDENTIFICATION

PATHOGENICITY/TOXICITY: *Klebsiella spp.* have been identified as important common pathogens for nosocomial pneumonia (7 to 14% of all cases), septicaemia (4 to 15%), urinary tract infection (UTIs; 6 to 17%), wound infections (2 to 4%), intensive care unit (ICU) infections (4 to 17%), and neonatal septicaemias (3 to 20%). *Klebsiella spp.* can also cause bacteremias and hepatic infections, and have been isolated from a number of unusual infections. They are also important opportunistic pathogens, particularly among the immunocompromised. Pathogenicity factors of *Klebsiella spp.* include adhesins, siderophores,

capsular polysaccharides (CPLs), cell surface lipopolysaccharides (LPSs), and toxins, each of which plays a specific role in the pathogenesis of these species. Depending on the type of infection and the mode of infectivity, cells of *Klebsiella* spp. may adhere and attack upper respiratory tract epithelial cells, cells in gastrointestinal tract, endothelial cells, or uroepithelial cells, followed by colonization of mucosal membranes. Common underlying conditions include alcoholism, diabetes mellitus, chronic liver disease (cirrhosis), chronic renal failure, cancer, transplants, burns, and/or use of catheters.

Respiratory disease:

K. pneumoniae – a leading cause of community-acquired and nosocomial pneumonia and lung abscesses. Infection of the upper lobe is more common. Symptoms include: fevers, chills, and leukocytosis with red currant jelly-like sputum. Rare complications include lung infection involving necrosis and sloughing of the entire lobe.

K. ozaenae – causes ozena, a primary atrophic rhinitis (AR) which involves chronic inflammation of the nose.

K. rhinoscleromatis – causes rhinoscleroma (RS), a chronic granulomatous infection which predominantly affects the cavity of the nose.

Central nervous system (CNS) infections:

K. pneumoniae and *K. oxytoca* – cause community-acquired meningitis and brain abscesses. Clinical symptoms include: headaches, fever, altered consciousness, seizures, and septic shock.

K. ozaenae – associated with rare cases of cerebral abscess and meningitis.

Urinary tract infections (UTIs):

Klebsiella spp. are a frequent cause of UTIs. Significant bacteriuria has been ascribed to *K. ozaenae*.

Hepatic disease:

K. pneumoniae – an important causative pathogen for pyogenic liver abscesses with symptoms including fever, right-upper-quadrant pain, nausea, vomiting, diarrhea or abdominal pain, and leukocytosis. Abscesses occur predominantly in the right lobe and are solitary.

Other infections:

K. granulomatis – causes donovanosis or granuloma, a chronic ulcerative disease that primarily affects the genitalia. Symptoms include development of small papule or ulcer at the site of inoculation that later develop into large red ulcers (lesions) that extend along the moist folds of the genitalia.

EPIDEMIOLOGY: *Klebsiella* spp. occur worldwide, particularly in tropical and subtropical regions, and are ubiquitous, including forest environments, vegetation soil, water, and mucosal membranes of host species. Although they are common pathogens for community-acquired pneumonias and bacteremias, the majority of the infections are nosocomial (hospital-acquired; ~56% of all *Klebsiella* infections). Adult males are more susceptible to infection with *Klebsiella* spp. than adult females; however, *Klebsiella* spp. demonstrate higher colonization rates among neonates and may survive up to months as compared to a few days to weeks in adults. Risk of infection and carriage rates of *Klebsiella* spp. increases with increase in duration of stay within a hospital. Infection and carriage rates also increase with antimicrobial use.

K. pneumoniae is most pathogenic to humans among all *Klebsiella* spp., followed by *K. oxytoca*, *K. ozaenae*, and *K. rhinoscleromatis*. *K. granulomatis* and *K. variicola* have also been identified as being pathogenic to humans. *K. singaporensis* is still very novel and its pathogenicity to humans has yet to be determined. Although, the number of infections is lower than some other pathogens, infections by *Klebsiella* spp. demonstrate substantial morbidity and mortality. *K. pneumoniae* occurs in the nasopharynx and intestinal tract of humans, as a saprophyte. It is one of the leading causes of community-acquired pneumonia. It is commonly isolated from infections of burns and human bites. Recently, it has become an increasing cause of chronic diarrhea in HIV infected adults in Africa. According to some reports, *Klebsiella* spp. are responsible for 16 to 43% of central nervous system (CNS) infections and brain abscesses. Environmental strains of *K. pneumoniae* have been shown to be equally virulent as clinical strains; however, whether this is true or not for other *Klebsiella* spp. has yet to be determined.

HOST RANGE: Humans, mammals (including horses, bovines, rhesus and squirrel monkeys, guinea pigs, muskrats, lemurs, and bats), aquatic animals (including elephant seals, California sea lions, and harbor seals), reptiles (including snakes, crocodiles, and American alligators), birds, insects, and plants (banana, rice sugar cane and maize).

INFECTIOUS DOSE: Unknown. According to one source, 10^8 *Klebsiella* organisms per gram of feces are required to produce damage.

MODE OF TRANSMISSION: *Klebsiella* spp. can be transmitted through skin contact with environmentally contaminated surfaces and/or objects. Fecal transmission has also been suggested for some cases of bacteremia caused by *Klebsiella* spp.

INCUBATION PERIOD: Not clearly understood.

COMMUNICABILITY: Members of *Klebsiella* spp. can be transmitted from person-to-person; however, the communicability period is unknown. Approximately one-third of people carry *Klebsiellae* in their stools. Hospital personnel have been shown to frequently carry *Klebsiellae* on their hands.

DISSEMINATION

RESERVOIR: Infected humans (with or without symptoms of disease) are the primary reservoir for *Klebsiella* spp. E.g., infected infants (usually asymptomatic) colonized with invasive strains of *Klebsiella* spp., and hospital patients (for nosocomial infections). Other sources include certain plants.

ZOONOSIS: None.

VECTORS: None.

STABILITY AND VIABILITY

DRUG SUSCEPTIBILITY: *Klebsiella* spp. are known to show resistance to penicillins, especially ampicillin and carbenicillin. Resistance of *Klebsiella* spp. to current antibiotics, however, appears to be increasing.

SUSCEPTIBILITY TO DISINFECTANTS: Gram-negative bacteria are generally susceptible to a number of disinfectants, including phenolic compounds, hypochlorites (1% sodium hypochlorite), alcohols (70% ethanol), formaldehyde (18.5 g/L; 5% formalin in water), glutaraldehyde, and iodines (0.075 g/L).

PHYSICAL INACTIVATION: Reduction in the growth and metabolic activity of *K. pneumoniae* at temperatures >35 °C has been reported. Significant growth reduction has been demonstrated at 60 °C; however, the bacteria still show some metabolic activity (i.e. not completely inactivated). Bacteria are also sensitive to moist heat and dry heat.

SURVIVAL OUTSIDE HOST: *Klebsiella* spp. grow rapidly on surfaces of potatoes and lettuce with counts exceeding 10³ organisms per g of surface. They also survive well within wood and sawdust. They do not grow well on human skin but can survive for extended periods of time in surface water, sewage, soil, and on plants.

FIRST AID / MEDICAL

SURVEILLANCE: Monitor for symptoms. Other tests include isolating strains of the bacteria or typing different isolates. This is often necessary for investigation of endemic and epidemic nosocomial infections and also for epidemiological investigations from the environment. *Klebsiellae* can be isolated by growth in media; they grow well on blood and non-differential media. Biotyping and serotyping are two common forms of typing methods used for typing *Klebsiella* spp. Serotyping is the most widely used technique for typing these bacteria. Biotyping is not preferred due to the large number of reactions and the amount of time required to complete these tests. Molecular typing methods are also being developed, although they are not commonly used.

FIRST AID/TREATMENT: Administer appropriate antibiotic therapy where necessary.

IMMUNIZATION: None.

PROPHYLAXIS: None.

LABORATORY HAZARD

LABORATORY-ACQUIRED INFECTIONS: 1 case of laboratory-acquired infection with *K. pneumoniae* up to 1976 has been reported.

SOURCES/SPECIMENS: Sources for clinical samples of *Klebsiella* spp. primarily include samples from respiratory tract (RT; nasopharyngeal samples) and urinary tract (UT). Specific sources identified include:

K. pneumoniae – all sites within the human body, RT and UT most common

K. ozaenae – nasal discharge most common, RT, UT, and blood

K. rhinoscleromatis – nasal discharge

K. oxycota – all sites within the human body

K. granulomatis – genital tract

K. variicola – blood, banana plants, rice, sugar cane, and maize

K. singaporensis – soil (from roots of sugar cane)

PRIMARY HAZARDS: Direct contact of mucosal membranes with contaminated surfaces and/or object, and inhalation of infectious airborne secretions, accidental parenteral inoculation and/or ingestion.

SPECIAL HAZARDS: None.

EXPOSURE CONTROLS / PERSONAL PROTECTION

RISK GROUP CLASSIFICATION: Risk Group 2. The risk group associated with "*Klebsiella* spp." reflects the genus as a whole, but does not necessarily reflect the risk group classification of every species within the genus.

CONTAINMENT REQUIREMENTS: Containment Level 2 facilities, equipment, and operational practices for work involving infectious or potentially infectious materials, animals, or cultures. The containment and operational requirements may vary with the species, subspecies, and/or strains.

PROTECTIVE CLOTHING: Lab coat. Gloves when direct skin contact with infected materials or animals is unavoidable. Eye protection must be used where there is a known or potential risk of exposure to splashes.

OTHER PRECAUTIONS: All procedures that may produce aerosols, or involve high concentrations or large volumes should be conducted in a biological safety cabinet (BSC). The

use of needles, syringes, and other sharp objects should be strictly limited. Additional precautions should be considered with work involving animals or large scale activities.

HANDLING AND STORAGE

SPIILLS: Allow aerosols to settle and, wearing protective clothing, gently cover spill with paper towels and apply appropriate disinfectant, starting at the perimeter and working towards the centre. Allow sufficient contact time before clean up.

DISPOSAL: Decontaminate all wastes that contain or have come in contact with the infectious organism before disposing by autoclave, chemical disinfection, gamma irradiation, or incineration.

STORAGE: The infectious agent should be stored in leak-proof containers that are appropriately labeled.

REFERENCE

Pathogen Safety Data Sheet (PSDS) for *Klebsiella* spp. has been modified from the ones produced by the Public Health Agency of Canada as educational and informational resources for laboratory personnel working with infectious substances.

- 1) Picture from www.atsu.edu.
- 2) Picture from www.bioquellus.com