Infection and Drug Resistance

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CASE REPORT

Aggressive Infection by K1/ST1265 *Klebsiella pneumoniae* Leading to Multiple Abscesses: Case Report and Literature Review

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Abstract: Hypervirulent *Klebsiella pneumoniae* (hvKp) has attracted increasing attention in recent years. Diabetes and serotype K1 or K2 are risk factors for invasive liver abscess syndrome including liver abscesses and the metastatic complications such as bacteremia, meningitis, endophthalmitis, and necrotizing fasciitis. Simultaneous infections of the liver, lungs, prostate, brain, and eyes are exceedingly rare. In this paper, a 41-year-old male patient who presented with a 4-day history of fever with polydipsia and polyuria and untreated diabetes deteriorated dramatically with sepsis, prostate abscess, lung abscess, liver abscess and intracranial infection as well as endophthalmitis. He was diagnosed with infection by K1/ST1265 hypervirulent *Klebsiella pneumoniae* and after treatment with antibiotics and abscess drainage, while the patient still passed away. K1/ST1265 hvKp exhibits exceptionally high virulence and invasiveness, necessitating broad awareness and vigilant monitoring.

Keywords: *Klebsiella pneumoniae*, liver abscess, prostate abscess, brain abscess, serotype K1, sequence type 1265

Introduction

Unlike classical *Klebsiella pneumoniae*, hvKp primarily causes severe community-acquired infections in healthy populations.[1] *Klebsiella pneumoniae* serotype K1 or K2 have high virulence and predisposes to invasive liver abscess syndrome, which is defined as a liver abscess caused by the K1/K2 serotype resulting in at least one extrahepatic abscess[2] with a mortality rate ranging from 3% to 31%.[3] The most common metastatic sites include the eye, lung and brain, each occurring in approximately one-third of patients who have metastatic disease.[3] Besides, prostate abscess is a rare complication of *Klebsiella pneumoniae* infection.[4] The optimal management of *Klebsiella pneumoniae*-induced abscesses includes confirming via imaging, administering appropriate antimicrobial therapy, and ensuring adequate drainage.[4] Patients with diabetes or infected by serotype K1/K2 *Klebsiella pneumoniae* are more likely to develop metastatic disease.[2] However, simultaneous infections of the liver, lungs, prostate, brain, and eyes are exceedingly rare.

Case Description

A 41-year-old male patient was admitted to emergency room, presenting with a 4-day history of fever along with polyuria and dysuria., with a peak temperature of 37.6°C, and he had a history of untreated diabetes for 8 years.

On physical examination, he exhibited a body temperature of 37.4°C, heart rate of 108/min, respiration rate of 26/min, blood pressure of 110/61 mm Hg. He was tachypneic and wet rales and rough breath sounds could be heard in two lungs. The patient's GCS score was 15/15 and the Babinski, Oppenheim, and Gordon reflexes were all negative, indicating no upper motor neuron involvement. Negative findings on abdominal examination with no evidence of tenderness, masses, or fluid accumulation.

Received: 19 August 2024
Accepted: 21 December 2024
Published: 3 January 2025

Laboratory examination showed a white blood cell count (WBC) of 2.1×10^9/L (normal range: $3.5 \times 10^9 - 9.5 \times 10^9$/L), with neutrophil rate of 82.4% (normal range: 40.0–75.0%). Additionally, C-reactive protein (CRP) was elevated at 305.9 mg/L (normal range: 0.0–6.0mg/L), while procalcitonin (PCT) levels were markedly high at 50.6 ng/mL (normal range <0.05 ng/mL). Arterial blood gas analysis revealed acidosis and lactate of 3.1 mmol/L (normal range: 0.5–1.8 mmol/L). Blood glucose was 45.5 mmol/L (normal range: 3.9–6.1 mmol/L) with hemoglobin A1C(HbA1c) of 12.6% (normal range: 4.0–6.0%). Urinalysis revealed leukocytes of 7.1/HPF (normal range: 0–1.7/HPF).

To correct shock and hypoxia, rapid rehydration was initiated, and he was intubated subsequently due to respiratory failure. Because indwelling catheter encountered difficulties, a guidewire was used. However, hemorrhagic urine was drained. Because of the rapid deterioration and the high inflammatory markers, he received Imipenem and Cilastatin Sodium for Injection (1g IV q6h) empirically, along with insulin to control blood glucose. On the fifth day of admission, PCT decreased to 10.2 ng/mL, but CRP elevated to 406.4 mg/L, and blood glucose still at high level. Given that blood, urine, and sputum cultures all revealed *Klebsiella pneumoniae* and liver abscesses were observed on abdominal CT, we considered the patient had invasive infections caused by hvKp. Cranial CT was performed but showed no abnormalities. However, the chest CT showed multiple infections in both lungs with cavitation formation. (Figure 1). The abdominal CT revealed a faintly hypodense shadow on the liver (Figure 2), isointense foci in the posterior prostate area of the bladder, and multiple instances of pneumoperitoneum (Figure 3). Thoracic and abdominal ultrasound also indicated pleural and pelvic effusions, along with abscesses in the liver, lungs, and prostate. Subsequently, 340 mL bloody fluid was drained from the chest, while a small amount of gas yielded from perineal abscess. After drainage, the patient's temperature stabilized at 36.6°C, CRP decreased to 144.5 mg/L, PCT decreased to 2.7 ng/mL, and urinary leukocytes were at 1.8/HPF, so he underwent spontaneous breathing trial.

On the 9th day of admission, the patient abruptly became unresponsive. Cranial CT imaging revealed new patchy low-density areas in the left frontal, temporal, and parietal lobes, indicative of brain abscesses (Figure 4). On the 10th day of admission, cloudiness with slight secretions developed in the patient's left eye (Figure 5), and the patient passed away very soon thereafter.

Because it was rare to develop five-site abscesses in short time, we conducted whole genome sequencing of the isolated bacteria (XLS-B) from blood to detect if the strain carries special genes and plasmids. Our analysis identified the strain as hypervirulent *Klebsiella pneumoniae* of K1/ST1265, harboring a plasmid carrying virulence genes, including rmpA2, iutA, iucC, and iucA (Figure 6). Furthermore, the wax moth (*G. mellonella*) larvae infection testing was

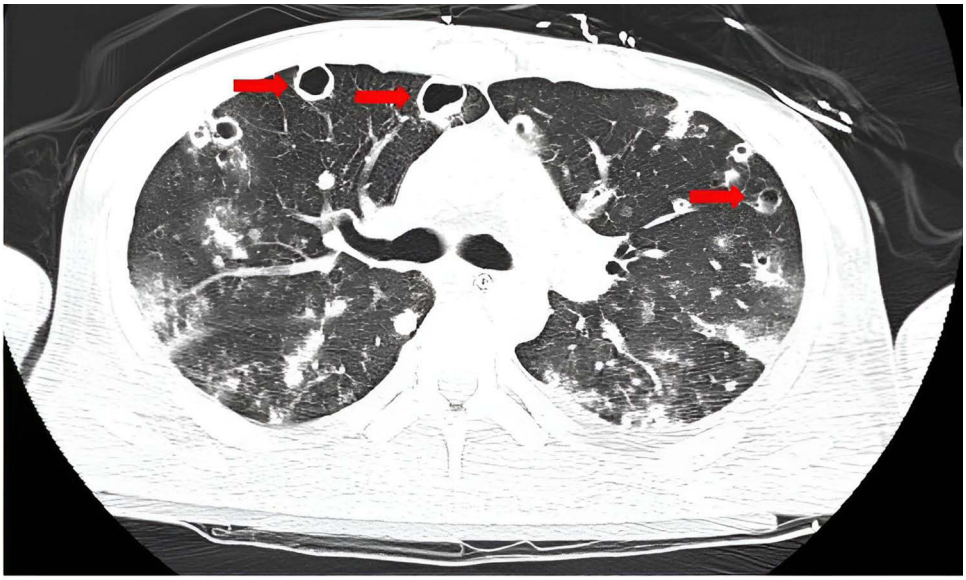

Figure 1 Chest CT on the 5th day of admission, showing multiple nodular and patchy high-density opacities in both lungs, with ill-defined margins, some of which are associated with cavitation. The red arrow indicates a cavity.

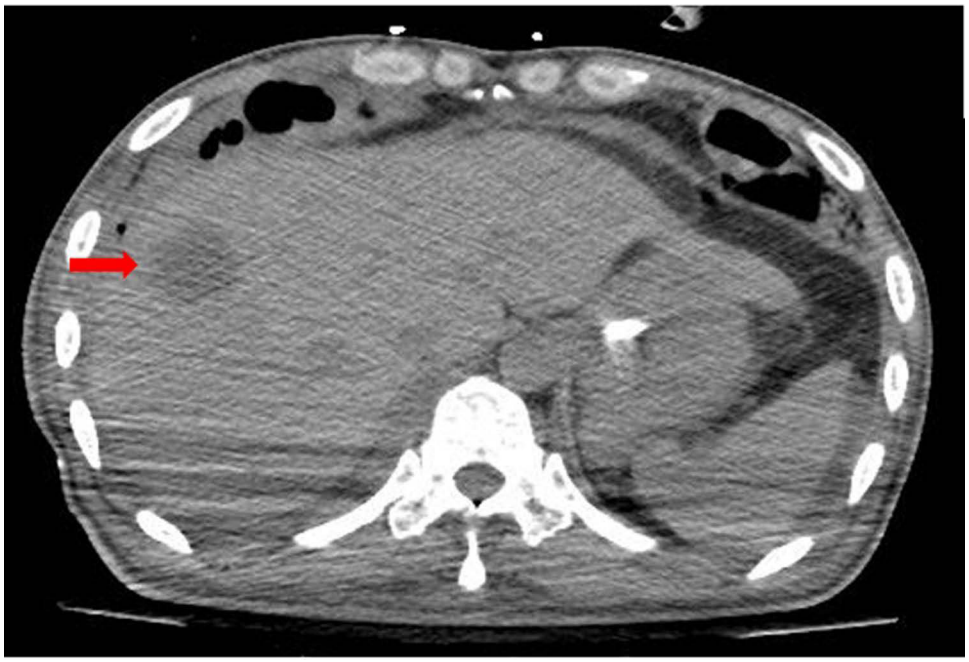

Figure 2 Abdominal CT on the 5th day of admission, showing a low-density lesion measuring approximately 30×18 mm in the right liver, with ill-defined borders, suggestive of a possible abscess. The red arrow indicates a liver abscess.

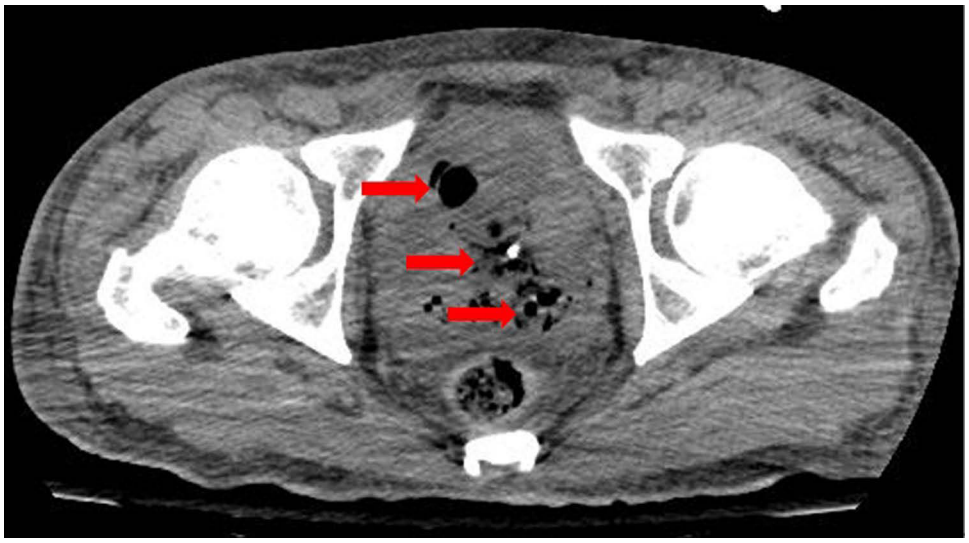

Figure 3 On the 5th day of admission, pelvic CT revealed multiple gas accumulations in the prostate area, suggestive of a possible emphysematous prostatic abscess. The red arrow indicates gas accumulation in the prostate region.

performed to evaluate the virulence of strain XLS-B. *G. mellonella* larvae infected with strain XLS-B had similar survival rates compared with those infected with hvKp strain NTUH-K2044. It confirmed that this strain exhibits virulence comparable to that of hvKp NTUH-K2044 (Figure 7).

Discussion

Hypervirulent *Klebsiella pneumoniae* (hvKp) is a highly pathogenic strain of *Klebsiella pneumoniae* that is characterized by its ability to cause severe infections in otherwise healthy individuals, including liver abscesses, meningitis, and septic shock. Unlike classical *Klebsiella pneumoniae* (cKp), hvKp possesses enhanced virulence factors, such as

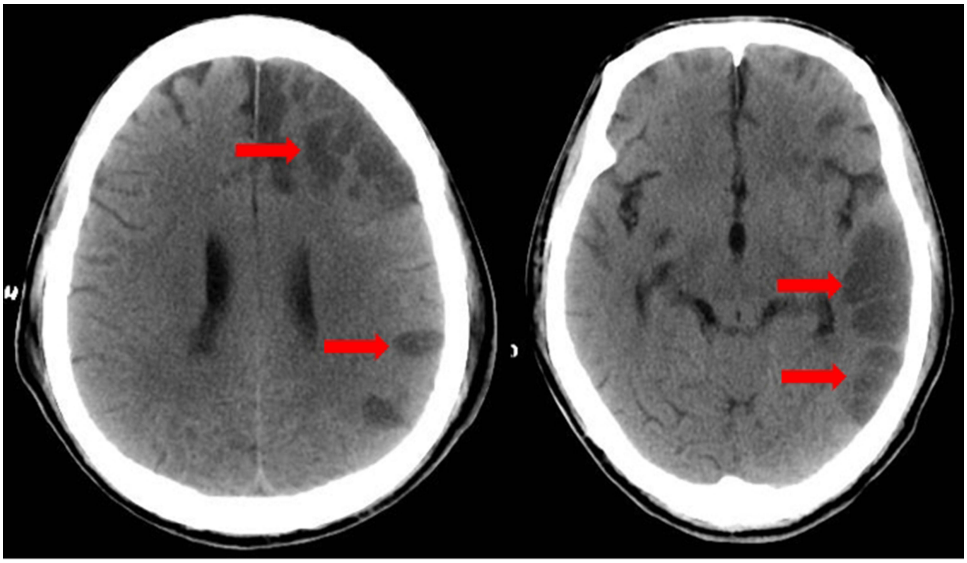

Figure 4 Cranial CT on the 9th day of admission showing sheet-like low-density shadows in the left frontal, temporal, and parietal lobes of the skull indicative of multiple brain abscesses, The red arrow indicates a brain abscess.

Figure 5 On the 10th day of admission, the left eye exhibited a fluorescent green appearance.

hypermucoviscosity, which contributes to its increased ability to cause invasive disease.[5] These strains are associated with a higher incidence of metastatic infections, particularly in immunocompetent patients. Advances in sequencing technologies have significantly enhanced our understanding of hvKp, highlighting unique genetic traits, such as capsular polysaccharide regulators and siderophore systems, which enable the pathogen to evade host immune responses and cause invasive diseases.[5] Differentiating hvKp from cKp is critical for effective clinical management and surveillance. Key genotypic markers included iucA, iroB, peg-344, rmpA, and rmpA2, which are associated with virulence factors such as siderophore production and mucoviscosity. Besides, the biomarker count—based on the presence of these virulence-associated genes—was found to be the most reliable predictor for distinguishing hvKp from cKp.[6]

In resource-limited settings, diagnosing hvKp can be challenging due to the limited availability of advanced diagnostic tools. The string test—a simple and cost-effective diagnostic method—can aid in the early identification of

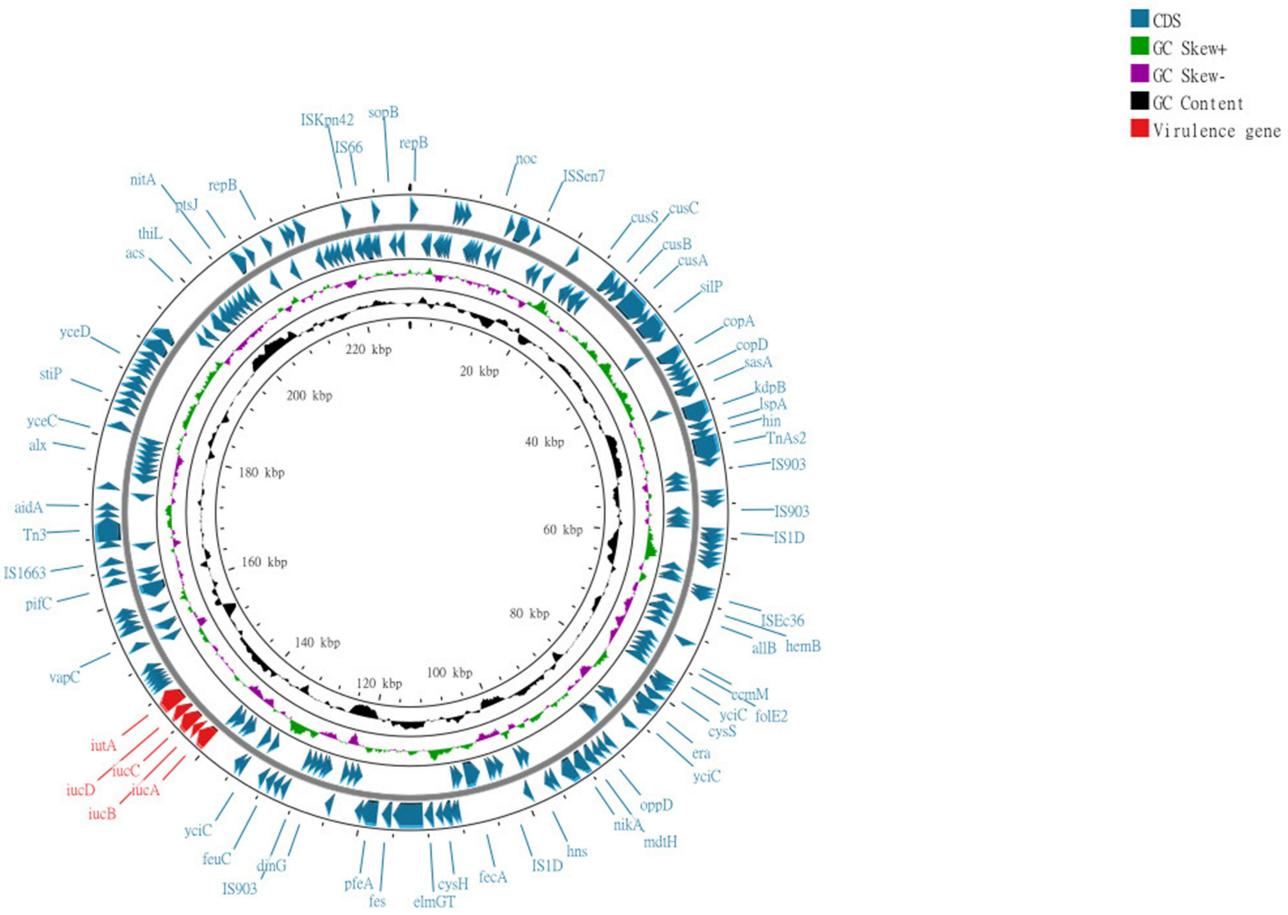

Figure 6 Schematic representation of the plasmid carried by K1/ST1265 hypervirulent *Klebsiella pneumoniae*..

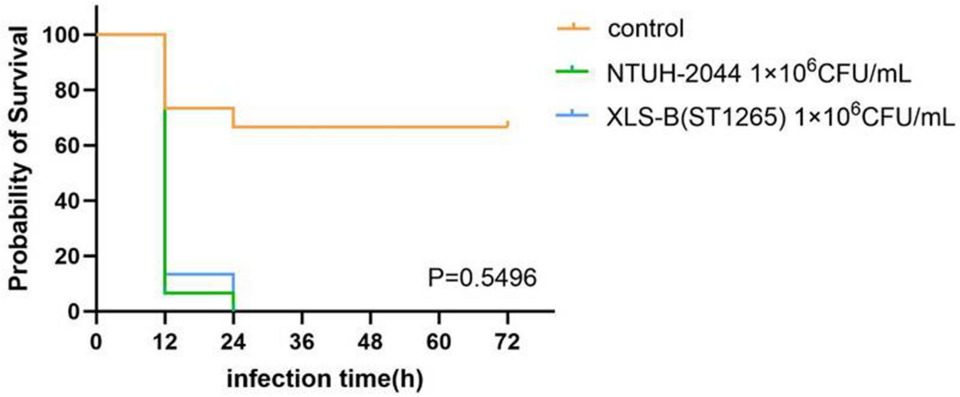

Figure 7 The in vivo virulence of XLS-B(ST1265) through Galleria mellonella infection model. The virulence was determined by the survival rates of G. mellonella infected with the bacteria (1×10^6 CFU/mL) and the control group was injected with phosphate buffered saline.

hvKp strains. This test involves using a bacteriology inoculation loop or needle to stretch a bacterial colony on an agar plate. The presence of a viscous string greater than 5 mm indicates a positive result for hvKp.[7] Although not definitive, the string test provides a practical tool for early diagnosis in resource-constrained environments, facilitating prompt management of hvKp infections. The patient presented with symptoms of polyuria and dysuria, and urinalysis revealed the presence of leukocytes. Difficulty was encountered during catheter insertion, resulting in hemorrhagic drainage, and bacteria were first cultured from the urine. Based on these findings, we speculated that the patient might have experienced a complicated urinary tract infection, with the urethra being the primary site of the infection. In

https://doi.org/10.2147/IDR.S489161

a relevant paper,[8] a patient solely experienced abdominal and lung infections caused by K1/ST1265 hvKp, yet succumbed to the infection. This suggested that K1/ST1265 hvKp was relatively uncommon but highly virulent, which should raise concern among clinicians.

Various studies indicated that hvKp typically originates from the intestines and could disrupt the intestinal barrier, leading to liver abscesses. The elevated fecal carriage rate of *Klebsiella pneumoniae* among healthy Asian populations[9] was a contributing factor to the higher incidence of hvKp infections in Asians compared to other racial groups. But it was proved by some reviews[10,11] that the features of *Klebsiella pneumoniae* liver abscess in the Americas and Europeans mirrored those described in Asia, confirming its global dissemination. Invasive liver abscess syndrome was increasingly being reported around the world and carried significant clinical impact.

Patients with simultaneous intracranial infections were often associated with a poorer prognosis and required preventive measures to avoid metastatic complications. Diabetes independently increased the risk of extrahepatic infections; hence, strict glycemic control was crucial in preventing metastatic infections.[12] This patient's poor glycemic control was one of the reasons for the poor prognosis. Therefore, patients infected by hvKp and combined with diabetes required precise glycemic management to be vigilant for invasive infections.

Furthermore, this patient presented with a rare complication of emphysematous prostatic abscess, carrying an approximate 25% mortality rate.[13] The cornerstone of treatment involved adequate drainage alongside antibiotic therapy. Drainage methods included transrectal ultrasound-guided suctioning, urethrotomy, decortication, and transperineally puncture. However, transrectal ultrasound-guided suctioning and transperineal puncture might result in inadequate drainage, while urethral manipulation might carry bacteria into the blood.[14] In this case, the patient underwent transperineal puncture, which did not drain the pus, and incomplete drainage might have contributed to deterioration. In patients with sepsis complicating an emphysematous prostatic abscess and failed transperineal puncture drainage, how to clear the abscess without worsening the infection was one of the difficulties faced by clinicians.

There were only a handful of reports about K1/ST1265 hvKp-related cases. Li et al isolated K1/ST1265 hvKp from a patient with severe pancreatitis, which carried an untypeable bla_{KPC}-harbored conjugative plasmid and a pLVPK-like virulent plasmid. It carried nine virulence genes and four antimicrobial resistance genes.[8] This ST type had the ability to fuse drug-resistant plasmids, thus posing a greater clinical challenge. Lepuschitz S et al discovered K1/ST1265 hvKp in the feces of healthy individuals. This strain of hvKp carried one virulence gene (*mrk*) and three resistance genes (*emr, FosA*, and *SHV*). They found food can serve as a vector for *Klebsiella pneumonia*'s transmission.[15] While there were not many reports related to K1/ST1265 *Klebsiella pneumonia*'s transmission, its highly pathogenicity and potential evolutionary ability warranted attention.

Conclusion

K1/ST1265 hypervirulent *Klebsiella pneumoniae* is relatively rare in clinical practice but can cause multiple abscesses. Due to limited treatment options, the prognosis for infected patients is poor. The few available case reports about K1/ST1265 *Klebsiella pneumoniae* emphasize its high virulence and invasiveness, highlighting the need for greater clinical awareness and vigilance.

Data Sharing Statement

Data on the case clinical information, informed consent form, and images are available for review from the corresponding author upon request.

Ethical Approval

Ethical approval was obtained from the Jiangshan People's Hospital. The Medical Department of Jiangshan People's Hospital had approved the publication of case details.

Consent

Because the patient experienced shock upon admission and was intubated immediately, we were unable to obtain consent from the patient himself, but we obtained authorization and written informed consent for publication of the details from the family.

Acknowledgments

We would like to acknowledge Dr Jiancang Zhou from the Department of Critical Care Medicine, Sir Run Run Shaw Hospital, Zhejiang University School of Medicine, Hangzhou, China, for his valuable guidance on experimental methods, assistance with research design, support for manuscript revisions, and providing funding for this study.

Funding

This work was supported by National Natural Science Foundation of China (No. 82472214),and Zhejiang Provincial Natural Science Foundation of China (No. ZCLZ24H1901).

Disclosure

The authors report no conflicts of interest in this work.

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