



Devastating Community-Acquired Bacterial Meningitis Caused by Hypervirulent *Klebsiella pneumoniae* in an Immunocompetent Patient

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Dear Editor,

Community-acquired bacterial meningitis in adults is mostly caused by *Streptococcus pneumoniae* and *Neisseria meningitidis*. *Klebsiella pneumoniae* is an uncommon etiology of community-acquired meningitis in adults, especially hypervirulent *K. pneumoniae* (hvKp). Its primary reservoir is the human intestine, and it causes community-acquired urinary tract infection and liver abscess. We recently experienced a case of rapidly progressing fulminant hvKp meningitis in a previously healthy adult.

A 57-year-old female presented with a 2-day history of low-grade fever, headache, and altered mental status. She had no medical history. On admission, the physical examination revealed confusion and neck stiffness. Her blood pressure was 155/106 mm Hg, pulse rate was 100/min, respiration rate was 22 breaths/min, and body temperature was 36.0°C. Laboratory studies revealed a white blood cell (WBC) count of 13,000/mm³ (normal, 4,500–11,000/mm³), C-reactive protein at 26.93 mg/dL (normal, 0–0.3 mg/dL), and procalcitonin at 23.36 ng/mL (normal, 0–0.005 ng/mL). Fluid-attenuated inversion recovery (FLAIR) magnetic resonance imaging (MRI) revealed diffuse increased signals throughout the cortices and the presence of a fluid-fluid level in both lateral ventricles, suggesting diffuse meningoencephalitis (Fig. 1A and B). After assessing blood cultures, dexamethasone (10 mg every 6 hours), cefotaxime (2 g every 4 hours), and vancomycin (25 mg/kg every 24 hours followed by 18 mg/kg every 12 hours) were administered intravenously. A lumbar puncture exhibited an opening pressure of 50 cm H₂O and a turbid color. The cerebrospinal fluid (CSF) analysis revealed a WBC of 1,064/mm³, polymorphonuclear leukocytes at 93%, protein at 2.6 g/dL, and glucose at 3 mg/dL (serum glucose, 258 mg/dL).

We initially diagnosed acute bacterial meningoencephalitis and ventriculitis. Despite treatment with empirical broad-spectrum antimicrobials, her consciousness deteriorated rapidly to stupor, and follow-up brain FLAIR MRI revealed the progression of brain edema, increased signals throughout the cortices, and meningeal enhancement in the ventricles and brain surfaces (Fig. 1C and D). Mechanical ventilation was applied in the intensive care unit. *K. pneumoniae* susceptible to beta-lactam and fluoroquinolone antibiotics was identified in blood and CSF cultures using the automated VITEK II system (BioMérieux, Durham, NC, USA) and agar dilution methods. Based on the culture results, all empirical antibiotics were replaced with ciprofloxacin (400 mg intravenously every 12 hours). Contrast-enhanced abdominal-pelvic computed tomography (CT) revealed a 9-cm liver abscess and cholecystitis on day 8 of hospitalization. *K. pneumoniae* was also identified in the liver abscess culture. In addition, hvKp was confirmed based on hypermucoviscosity (HMV) in the string test (Fig. 1E), and the virulent K1 capsular serotype in a polymerase chain reaction. The hvKp strain was similar to that commonly isolated from communities in East Asia, as

Received January 12, 2021
Revised March 17, 2021
Accepted March 18, 2021

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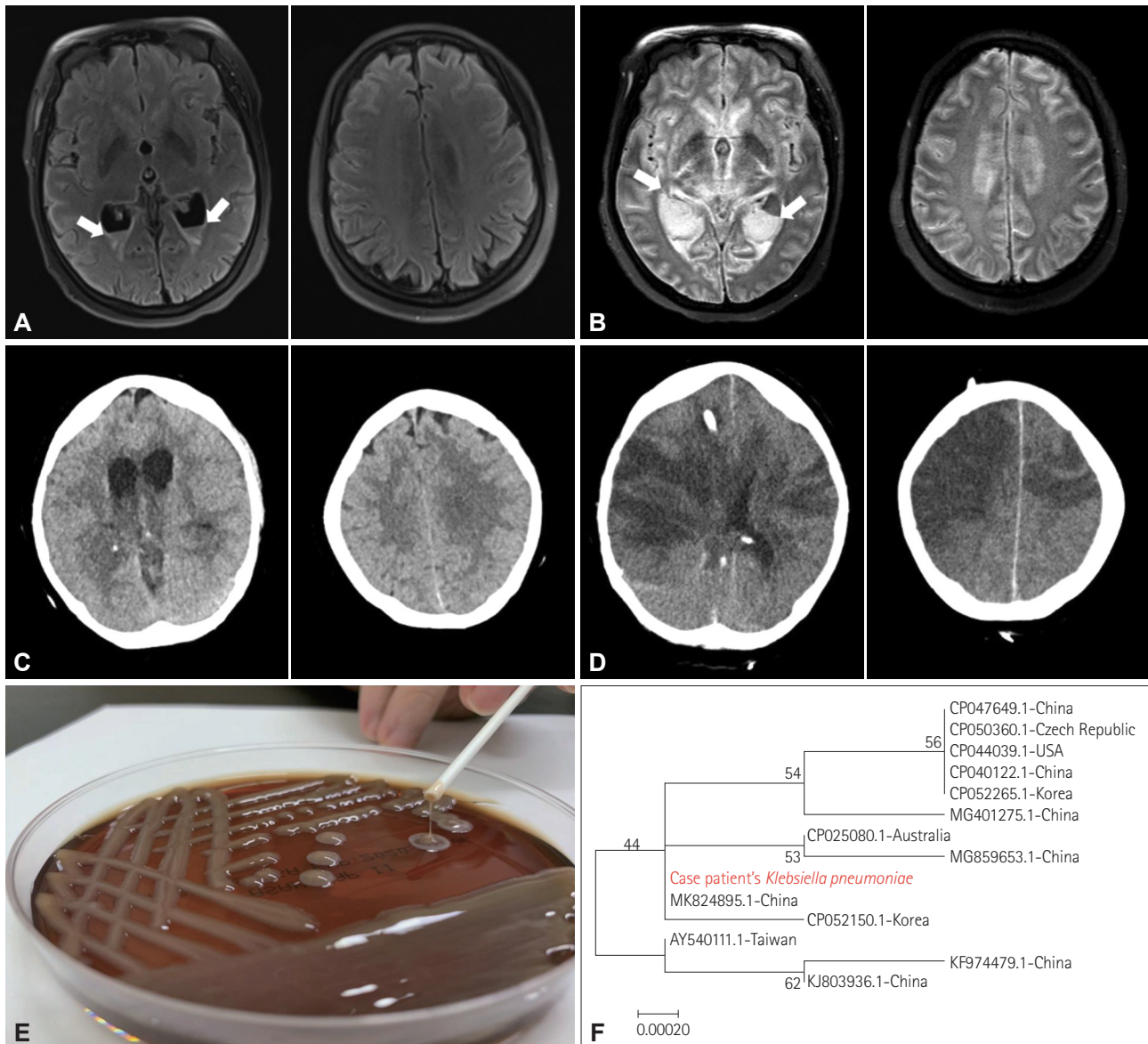


Fig. 1. Brain MRI, string test, and phylogenetic tree of the patient with hvKp. A: Initial brain FLAIR MRI images showed subtle increased signals throughout the cortices in both cerebral hemispheres and the presence of a fluid-fluid level in both lateral ventricles (arrows), suggesting diffuse meningoencephalitis. B: On hospital day 2, follow-up FLAIR MRI images showed interval progression in diffuse increased signals throughout the cortices in both cerebral hemispheres and an increased amount of fluid in the lateral ventricles (arrows). C: On hospital day 3, brain CT images showed diffuse brain swelling and hydrocephalus. D: On hospital day 12, brain CT images showed cerebral infarctions in both hemispheres caused by progression of cerebral edema. E: The string test in an isolated colony of *Klebsiella pneumoniae* from the patient on an agar plate, which showed hypermucoviscosity with a 5-mm-long viscous filament. F: Phylogenetic tree of isolates from blood and cerebrospinal fluid of the patient with hvKp K1 based on 16S rRNA gene sequences. The tree was reconstructed using the neighbor-joining method with MEGA software (version 6). Scale bar indicates the nucleotide substitutions per site. CT: computed tomography, FLAIR: fluid-attenuated inversion recovery, hvKp: hypervirulent *Klebsiella pneumoniae*, MRI: magnetic resonance imaging.

observed from the phylogenetic analysis (Fig. 1F).

An external ventricular drainage catheter and percutaneous drains for the liver abscess and gall bladder were introduced (Supplementary Fig. 1 in the online-only Data Supplement). However, follow-up brain CT revealed large acute cerebral infarctions in both hemispheres and the progression of massive brain edema. The patient exhibited neurological

deterioration with loss of brainstem signs and multiorgan failure, and she died on day 24 of hospitalization.

hvKp causes catastrophic metastatic infection, remarkably in young and immunocompetent adults, and in association with significant morbidity and mortality.¹ The clinical manifestation, HMV phenotype, gene sequence, capsule typing, and virulence-associated genes are used to define hvKp.¹ HMV

is confirmed based on a mucoviscous string longer than 5 mm on blood agar plates. There are more than 134 capsular serotypes, among which K1 and K2 are the most strongly associated with hvKp, and these are more resistant to phagocytosis than other serotypes.¹

The prevalence of hvKp amongst *K. pneumoniae* varies in areas where hvKp is endemic, with 66.7% (22/33) of *K. pneumoniae* CSF isolates in Taiwan and 42.4% (14/33) of *K. pneumoniae* bacteremia strains in South Korea being reported.²⁻⁴ A mortality rate of 77.3% for hvKp meningitis in eastern China was reported, while mortality rates of 48.5–66% and 50% for all types of *K. pneumoniae* meningitis in adult patients in Taiwan and South Korea, respectively, were reported.^{3,5,6} Characteristic imaging findings are not well characterized for hvKp meningitis, with previous reports of multiple, irregular cord-like structures in dura and pia mater, patchy leptomeningeal enhancement followed by a focal nodular lesion in the subacute phase, diffuse and multiple brain abscesses, and ventriculitis on MRI.² In the present case, brain MRI showed diffuse increased signals throughout the cortices, meningeal enhancement in the ventricles and brain surfaces, and the presence of a fluid-fluid level in both lateral ventricles.

Physicians should consider hvKp in the differential diagnosis when patients with *K. pneumoniae* meningitis are younger, immunocompetent, and present with severe disease in the community setting. Even with adequate therapy, including abscess drainage and site-based susceptible antimicrobial agents, hvKp meningitis progressed rapidly in the present case. Therefore, when *K. pneumoniae* is identified, it is important that the metastatic infection site is preemptively explored, and serotyping and the string test are performed to identify hvKp.

Supplementary Materials

The online-only Data Supplement is available with this arti-

cle at <https://doi.org/10.3988/jcn.2021.17.3.484>.

Author Contributions

Conceptualization: Jeong Rae Yoo. Investigation: Hyunjoo Oh, Misun Kim, Chul-Hoo Kang, Sang Taek Heo. Writing—original draft: Hyunjoo Oh, Chul-Hoo Kang. Writing—review & editing: Jeong Rae Yoo.

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Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

Acknowledgements

None

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