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Klebsiella-caused Bilateral Emphysematous Pyelonephritis and Emphysematous Cystitis in a Patient with Type 2 Diabetes

Wei Yang[1], Chendong He[2]

[1]Department of Radiology, Jiangsu Province Hospital of Chinese Medicine, Affiliated Hospital of Nanjing University of Chinese Medicine, Nanjing, China
[2]Department of Radiology, The First Affiliated Hospital of Bengbu Medical College, Bengbu, China

An 84-year-old female presented with a week-long sudden fever and the peak temperature of 38.5 °C, accompanied by brick-red, sticky phlegm upon coughing. Further, a scanty, amber-colored urine was noted. The patient had been diagnosed with type 2 diabetes for 10 years, for which she received long-acting insulin injections. Arterial blood gas analysis revealed the following results: FiO_2, 33%; pH, 7.398; pCO_2, 22.2 mmHg; pO_2, 62.1 mmHg; HCO_3^-, 16.6 mmol/l; Na^+, 115 mmol/l; K^+, 3.7 mmol/l; glucose (Glu), 37 mmol/l; and lactate (Lac), 2.7 mmol/l. Her blood tests indicated the presence of sepsis, hypoproteinemia, anemia, electrolyte imbalances, and hyperglycemia. In addition, urine analysis showed a severe urinary tract infection. A chest and abdominal computed tomography examination was performed, and her initial diagnosis indicated severe pneumonia (Figure 1a), concomitant with bilateral emphysematous pyelonephritis (EPN) (Figure 1b) and emphysematous cystitis (EC) (Figure 1c).

Considering the severity of the presented condition, we initiated an extensive treatment regimen, encompassing the administration of meropenem and levofloxacin for a broad-spectrum infection therapy, crystalloid fluid resuscitation to address shock, lung-protective ventilation, insertion of a deep venous catheter, and the administration of albumin for additional support. To identify the causative pathogens, sputum and blood cultures were conducted. Sputum next-generation sequencing (NGS) analysis revealed the presence of *Klebsiella pneumoniae* (sequence count: 503,843), *Candida albicans* (sequence count: 70,762), and a novel coronavirus strain EG.5.1 (sequence count: 34,857). Furthermore, blood NGS identified *K. pneumoniae* (sequence count: 99,285). An anti-infection regimen of meropenem and voriconazole was tailored to target the causative pathogens. Despite these therapeutic adjustments, the patient's oxygenation index continued to deteriorate. On the seventh day of hospitalization, the patient experienced a sudden cardiac arrest, ultimately leading to her unfortunate demise.

EPN represents a rare yet potentially life-threatening acute infection, distinguished by characteristic features including a structural disruption of renal parenchyma accompanied by intraparenchymal and perirenal gas accumulation.[1] In contrast, EC constitutes a separate clinical entity defined by the presence of gas within or surrounding the bladder wall, originating from the pathogenic bacterial fermentation processes. Infections may arise from a diverse array of pathogens, with Gram-negative facultatively anaerobic bacteria, mainly *Escherichia coli*, followed by *K. pneumoniae*.[2] Recent studies have also identified *C. albicans* and *C. glabrata* as emerging pathogens.[3] In particular, poorly managed diabetes is a significant risk factor associated with this condition.[4] Immune compromise, urinary tract obstruction, and structural anomalies represent underlying factors that facilitate bacterial proliferation and subsequent infection.[5] The intricate mechanism underpinning the formation of gas in the EPN and EC is centered on gas-producing pathogens catalyzing urinary glucose or protein degradation, resulting in the production of CO_2 as a byproduct. The accumulated gas causes an increase in local pressure, consequently initiating necrosis in the surrounding tissues and perpetuating a destructive cycle of damage.

In this particular case, the patient presented with a severe pulmonary infection with bilateral EPN and EC. Bilateral EPN, accounting for only 10% of all cases,[6] is relatively uncommon, with concurrent EC being even rarer. Sputum culture revealed the presence of multiple pathogens, including *K. pneumoniae*, *C. albicans*, and a novel coronavirus, suggesting a potential pathogenic synergy. Considering the detection of *K. pneumoniae* in urine cultures, we attribute it as the causative agent of both EPN and EC. The prolonged,

Corresponding author: Wei Yang, Department of Radiology, Jiangsu Province Hospital of Chinese Medicine, Affiliated Hospital of Nanjing University of Chinese Medicine, Nanjing, China
e-mail: youngwei0713@163.com

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ORCID iDs of the authors: W.Y. 0000-0002-7216-3808; C.H. 0000-0002-2216-7245.

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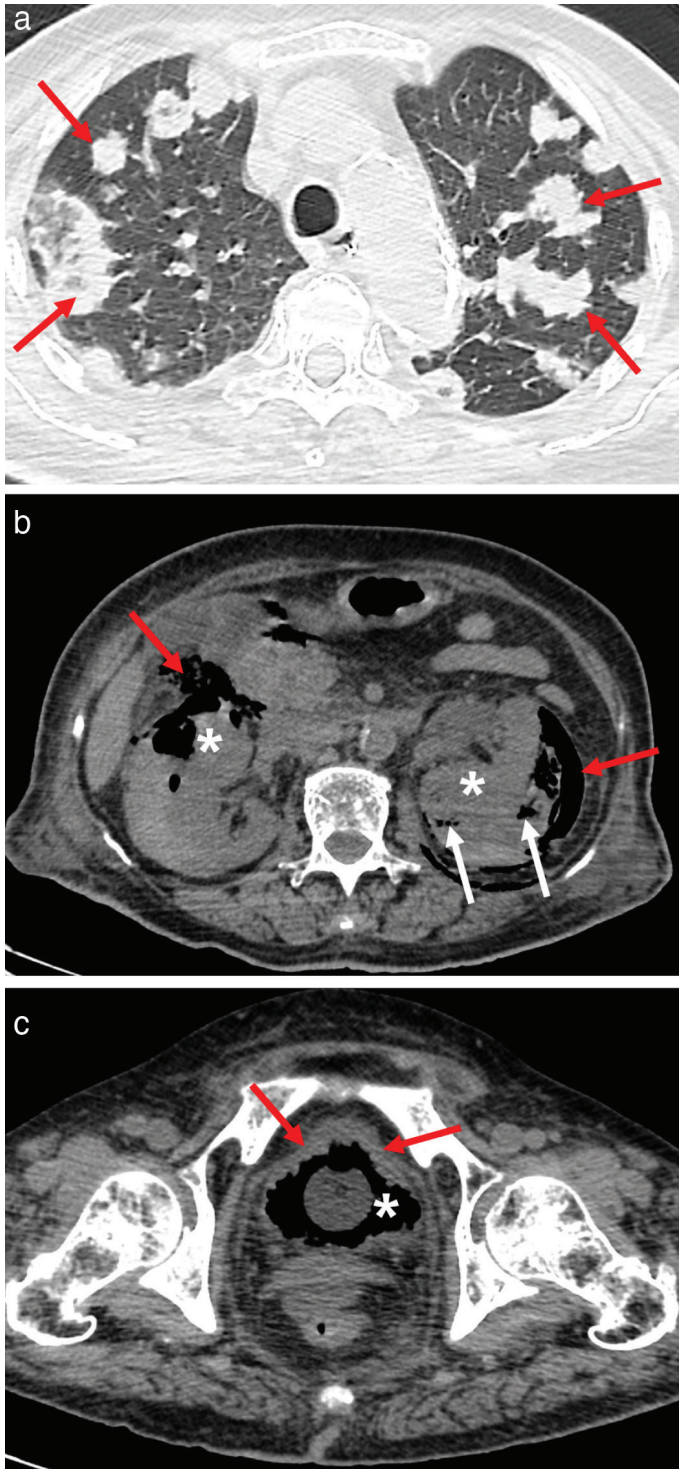

FIG. 1. Chest and abdominal CT findings.

(a) Chest CT showing bilateral lung patchy lesions (red arrow); (b) Abdominal CT showing bilateral renal structural destruction (asterisk), parenchymal gas (white arrow), and perirenal gas (red arrow); (c) Abdominal CT showing diffuse thickening of the bladder wall (red arrow) and intravesical gas (asterisk). CT, computed tomography.

inadequately controlled type 2 diabetes, with elevated urinary protein and glucose levels, may create a conducive environment for gas-producing bacteria.

The therapeutic regimen comprises antibiotic therapy, fluid resuscitation, glucose control, and the consideration of percutaneous nephrostomy, with nephrectomy being considered in case of ineffective initial treatment[7]. Particularly, we emphasize the critical importance of blood sugar management, especially among patients with diabetes. Urgent hospitalization is strongly recommended to mitigate potentially irreversible consequences when patients exhibit symptoms of infection and oliguria.

Informed Consent: Informed consent was obtained from the patient's immediate family for the anonymous use and publication of clinical and imaging data.

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