Diabetes Mellitus and Confusion

Leonard Chow, MD, Gulshan Sharma, MD
Department of Internal Medicine, University of Texas Medical Branch, Galveston.

PRESENTATION
Diabetes mellitus can predispose patients to many additional health calamities. A 54-year-old Hispanic woman with a known history of diabetes presented to the emergency department with a 1-day history of confusion, fever, nausea, and vomiting. On arrival, she had a temperature of 101.1° F (38.4° C), blood pressure of 115/73 mm Hg, heart rate of 125 beats/minute, respiratory rate of 20 breaths/minute, and an oxygen saturation of 99% on room air. Her physical examination disclosed dry mucous membranes, tachycardia with regular rhythm, clear lungs, mild tenderness to palpation on the suprapubic area, and dry skin with decreased turgor. She was disoriented and unable to respond appropriately to questions.

ASSESSMENT
The initial laboratory work identified an elevated white blood cell count of 15.4 \times 10^3 \text{ cells/mm}^3; 92\% were neutrophils, and 30\% of these were bands. A chemistry panel showed a blood urea nitrogen concentration of 51 mg/dL, a serum creatinine concentration of 2.5 mg/dL, and a blood glucose level of 801 mg/dL. The patient’s urinalysis was significant for many bacteria, 43 red blood cells per high-power field, and a glucose concentration of 1000 mg/dL. A plain abdominal radiograph revealed an enlarged right kidney with an air crescent along its peripheral margin (Figure 1). Retroperitoneal ultrasound confirmed the presence of air in the right kidney without evidence of obstruction. Abdominal computed tomography (CT) without contrast showed an enlarged right kidney with intraparenchymal air. It was surrounded by perinephric air that could be tracked up to the adrenal gland and down along the right latoconal fascia (Figure 2).

DIAGNOSIS
Based on the radiographic findings, the patient was diagnosed with extensive, unilateral, Class 3A emphysematous pyelonephritis with acute nonoliguric renal impairment. This acute necrotizing infection of the kidney and surrounding tissue may cause gas formation in areas such as the renal parenchyma, collecting system, and perinephric tissue.\(^1\) Urinary tract obstruction, most commonly due to urinary calculi, is seen in as many as 25\% of reported cases. Emphysematous pyelonephritis is 5-6 times more common among females than males, but diabetes mellitus is apparently the primary predisposing factor, since a history of diabetes is noted in 70-96\% of patients.\(^1,2\)

Usually, emphysematous pyelonephritis is caused by gas-forming bacteria. The most commonly identified organism is Escherichia coli, followed by Klebsiella pneumoniae.\(^1,5\) Cases also have been attributed to Proteus, Pseudomonas, Enterobacter, Clostridium, Aspergillus, Bacteroides, and Candida species.\(^2,4,6-8\) While pathogenesis of emphysematous pyelonephritis remains poorly understood, glucose fermentation is thought to play a major role in gas production.\(^3,8\) Samples of gas taken from affected kidneys have yielded hydrogen and carbon dioxide, which are known products of glucose fermentation. Specifically, hydrogen gas is a product of fermentation pathways unique to Enterobacteriaceae organisms and anaerobes.\(^2,5\) High glucose levels in tissue, impaired host response, urinary tract obstruction, and decreased perfusion have been postulated to influence the extent of gas production.\(^2,7,8\)

Most patients with emphysematous pyelonephritis present with nonspecific signs and symptoms. Fever, nausea, vomiting, changes in mental status, flank, back and abdominal pain, dyspnea, acute renal function impairment, and shock are common.\(^2,7,8\) Presence of thrombocytopenia, altered mental status, or acute renal failure on presentation are associated with a poor prognosis.\(^2\)
Diagnosis of emphysematous pyelonephritis is established radiographically.\textsuperscript{3,8} Although plain radiography and ultrasound can be used, CT of the abdomen is the preferred diagnostic tool. Abdominal CT defines both the extent and location of the gas and characterizes any destruction of renal parenchyma. In addition, the diagnostic sensitivity for CT is 100\% in patients with emphysematous pyelonephritis, compared to 69\% and 65\%, for plain radiography and ultrasound, respectively.\textsuperscript{4}

**MANAGEMENT**

No standard therapy has been defined for emphysematous pyelonephritis. Most treatment regimens, selected on the basis of radiologic findings and the patient’s underlying condition, consist of combinations of intravenous antibiotics, percutaneous drainage, and total nephrectomy.\textsuperscript{2,3-9} Table 1 presents the radiologic classification of emphysematous pyelonephritis used for management of our patient’s case. For patients with localized disease (class 1 and 2), percutaneous drainage with antibiotic treatment is recommended initially. This treatment also is recommended for patients with extensive disease (class 3 and 4) and \(< 2\) poor prognostic factors (ie, thrombocytopenia, acute renal impairment, altered mental status, or shock). Surgical nephrectomy is reserved for those with extensive emphysematous pyelonephritis; that is, cases with \(\geq 2\) poor prognostic factors, widespread intraparenchymal destruction, or inadequate response to conservative management with antibiotics and percutaneous drainage.\textsuperscript{2}

Overall mortality from emphysematous pyelonephritis ranges from 13-50\%.\textsuperscript{5} Medical management alone is associated with a much higher mortality rate than is medical management combined with additional percutaneous drain-

### Table 1 Classification of Emphysematous Pyelonephritis

<table>
<thead>
<tr>
<th>Class</th>
<th>Radiologic Findings on CT</th>
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<tbody>
<tr>
<td>1</td>
<td>Gas in the collecting system</td>
</tr>
<tr>
<td>2</td>
<td>Gas in the renal parenchyma without extension to extrarenal space</td>
</tr>
<tr>
<td>3A</td>
<td>Extension of gas or abscess to perinephric space</td>
</tr>
<tr>
<td>3B</td>
<td>Extension of gas or abscess to pararenchymal space</td>
</tr>
<tr>
<td>4</td>
<td>Bilateral EPN or solitary kidney with EPN</td>
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</tbody>
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CT = computed tomography; EPN = emphysematous pyelonephritis.
age or surgical nephrectomy. Somani et al reported 13.5% mortality in patients undergoing percutaneous drainage and medical management compared with 50% in those receiving medical management alone.\(^4\) Mortality in patients with emergency nephrectomy was reported as 25%.

Our patient was initially treated with fluid resuscitation, antibiotic therapy, and glucose control. Blood and urine cultures obtained on arrival subsequently revealed *Klebsiella pneumoniae*. Given the extent of intraparenchymal destruction, consultants from both the urology and nephrology departments recommended nephrectomy. However, the patient refused the procedure and was treated with antibiotics and percutaneous drainage.

A CT performed 2 weeks later showed persistent emphysematous pyelonephritis with multiple fluid collections in the perinephric space. When the patient was informed of the failure to respond to conservative management, she agreed to undergo surgical nephrectomy. Necrosis at the inferior pole was evident in the gross specimen of the kidney (Figure 3). Pathological findings included vascular sclerosis, glomerulosclerosis, and large areas of coagulation necrosis (Figure 4). The patient was discharged home in stable condition, and at 1-month follow-up, she was completely asymptomatic with normal renal function.

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**References**