

# Treatment of Emphysematous Pyelonephritis with Broad-spectrum Antibacterials and Percutaneous Renal Drainage: An Analysis of 10 Patients

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**Background:** This retrospective study was designed to determine the efficacy of broad-spectrum antibacterials combined with percutaneous renal drainage in the treatment of emphysematous pyelonephritis (EPN).

**Methods:** From July 1992 to September 2002, 10 patients (nine females and one male) with EPN were managed at our institution. All patients had diabetes and presented with fever and chills, flank pain or tenderness, vomiting, and altered consciousness. The diagnosis of EPN was confirmed by the presence of intraparenchymal and/or perinephric gas in imaging studies (kidney-ureter-bladder film, sonogram, and/or computed tomography scan). Broad-spectrum antibacterial therapy, combined with percutaneous renal drainage, was started in all patients. Follow-up studies consisted of computed tomography scan and technetium-labeled diethylenetriaminepentaacetic acid (DTPA) radioisotope renography.

**Results:** The outcome was good in all patients. Three patients underwent delayed nephrectomy due to non-functioning of the involved kidney. The DTPA radioisotope renography results (glomerular filtration rate of the diseased kidney/contralateral healthy kidney) were 0/57 mL/min, 2.7/68.1 mL/min and 3.7/63.9 mL/min.

**Conclusion:** Combined broad-spectrum antibacterial therapy and percutaneous renal drainage is a safe and effective treatment for EPN, especially in high-risk patients for whom nephrectomy under general anesthesia is not feasible.

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**Key Words:** broad-spectrum antibacterials, emphysematous pyelonephritis, percutaneous renal drainage

## Introduction

Emphysematous pyelonephritis (EPN) is an uncommon, life-threatening disease resulting from acute suppurative infection of the kidneys. It usually occurs in females with diabetes, with or without obstructive uropathy. The prominent disease characteristic is gas accumulation in the renal parenchyma, collecting system, or perinephric tissue. Clinical signs and symptoms are often similar to those of uncomplicated pyelonephritis, e.g. fever, flank pain, nausea, and vomiting.<sup>1</sup>

Recently, Wan et al classified EPN into two types, based on findings from computed tomography (CT)

studies: type I is characterized by extensive destruction of the renal parenchyma, with a large collection of air, but no fluid; type II, on the other hand, is marked by the presence of air and a large amount of fluid in the renal parenchyma, collecting system, or perinephric tissue.<sup>2</sup> These investigators also reported that the mortality rate was higher in type I than type II patients (69% vs 18%).<sup>2</sup> Surgical drainage or nephrectomy, with blood-sugar control and appropriate antibacterial schedules, are the treatments of choice.<sup>1,3-9</sup>

We report 10 cases of EPN (three type I, and seven type II) that responded favorably to percutaneous renal drainage and broad-spectrum antibacterial therapy.

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## Methods

From July 1992 to September 2002, 10 consecutive patients with documented EPN, confirmed by plain abdominal radiograph, CT scan and/or ultrasound, were seen at our institution. The patients' demographic and clinical data, including age, gender, signs and symptoms, results of laboratory tests, EPN type and location, and treatment strategies, were obtained by chart review. Information about outcomes, including complications, post-treatment kidney function, and overall satisfaction with treatment, was also collected from medical records. Follow-up studies, comprising CT scan and technetium-labeled diethylenetriamine-pentaacetic acid (DTPA) radioisotope renography, were performed.

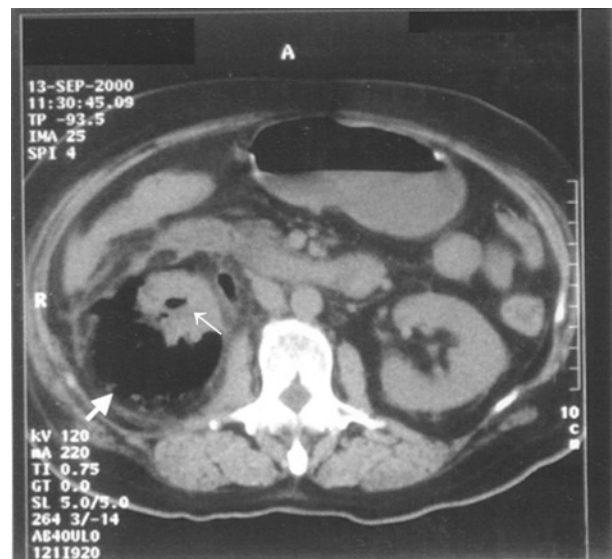
## Results

Mean patient age was 61.2 years (range, 53–79 years). There were 9 females and 1 male, all with a history of diabetes mellitus. Symptoms and signs on admission included fever (9/10), chills (7/10), flank pain or tenderness (6/10), vomiting (2/10), and altered consciousness (1/10). Laboratory tests showed positive cultures of pus (8/10), blood (5/10) and urine (5/10); thrombocytopenia (1/10) and hematuria (1/10) were also noted. One patient had a creatinine

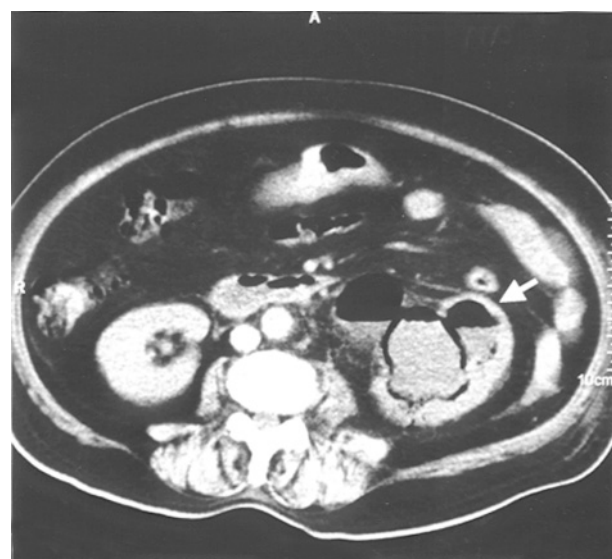
level of 1.8 mg/dL, whereas this parameter was less than 1.4 mg/dL in the other patients. All patients satisfied the imaging criteria of a gas-filled lesion in the renal parenchyma, collecting system, or perinephric space, and demonstrated by a plain kidney-ureter-bladder film (Figure 1), CT scan (Figures 2 and 3), and/or ultrasound (Figure 4). There were 3 type I and 7 type II cases confirmed by CT scan. The most common organism isolated from cultures was *Escherichia coli* (6/10) (Table). More than 1 infecting organism was identified in 3 patients: *E. coli* and



**Figure 1.** Plain abdominal, kidney-ureter-bladder film showing a large, crescent-shaped air density (arrow) in the right upper quadrant.



**Figure 2.** Type I emphysematous pyelonephritis: computed tomography scan of the abdomen showing abnormal gas, without fluid, collection in the right kidney (small arrow) and perirenal space (arrow).



**Figure 3.** Type II emphysematous pyelonephritis: computed tomography scan of the abdomen showing acute pyelonephritis of the left kidney, with confluent gas collection in the renal parenchyma and perirenal abscess (arrow).

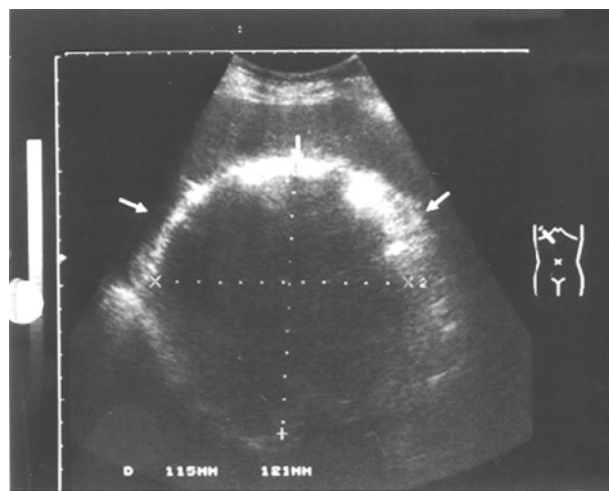
*Proteus mirabilis* ( $n = 2$ ); and *E. coli* and *Klebsiella pneumoniae* ( $n = 1$ ).

Percutaneous renal drainage in the prone position was performed in all patients. A 10-Fr pigtail tube was placed in the renal parenchyma, collecting system, or perinephric space, under ultrasound guidance. An additional 12-Fr pigtail catheter was positioned in 4 patients because of a residual lesion detected on follow-up CT scan 2 days later. All patients were also initially given a first-generation cephalosporin (cefazolin) plus gentamicin. The antibacterials were then changed to ceftriaxone or ceftazidime, according to culture findings, administered for 9–21 days (mean, 13.6 days). Blood glucose levels were controlled with insulin. Catheters were removed when drainage was less than 10 mL and follow-up CT scans showed no residual lesions.

All patients recovered well, and no mortality occurred. However, 3 patients with a non-functioning kidney underwent nephrectomy 6 weeks after percutaneous renal drainage.

## Discussion

EPN is an uncommon, life-endangering disease caused by suppurative infection of the renal parenchyma and peripheral tissues. Most cases are associated with uncontrolled diabetes mellitus, but there have been reports of non-diabetic patients with ureteral obstruction.<sup>1,7</sup> The clinical symptoms of EPN are similar to those of acute pyelonephritis unresponsive to medical treatment.<sup>1</sup> Although *E. coli* is the most commonly reported pathogen, *Proteus*, *Pseudomonas*, *Klebsiella*, *Enterobacter*, and *Candida* spp. have also been reported as causative organisms.<sup>1,2,10</sup>



**Figure 4.** Ultrasound of the right kidney showing a well-defined hyperechoic lesion (arrows) with associated dark shadowing.

**Table.** Most common organism isolated from cultures of patients with emphysematous pyelonephritis

Organism isolated	<i>n</i> (%)
<i>Escherichia coli</i>	6 (60)
<i>Klebsiella pneumoniae</i>	3 (30)
<i>Proteus mirabilis</i>	2 (20)
<i>Pseudomonas aeruginosa</i>	1 (10)
<i>Enterobacter</i> spp.	1 (10)

In 1998, Wan and colleagues classified EPN into two types based on CT findings.<sup>2</sup> These researchers also reported that the mortality rate was greater in type I than type II patients (69% vs 18%), and that the rate increased markedly (92% vs 53%) in patients with a serum creatinine level > 1.4 mg/dL and thrombocytopenia (platelets < 60,000/mm<sup>3</sup>).<sup>2</sup> In our series, we had 3 patients with a type I lesion and 7 with a type II lesion; all patients survived. The zero mortality may have been due to early diagnosis (creatinine < 1.4 mg/dL), and treatment with percutaneous drainage and broad-spectrum antibacterials.

The mechanism for gas production in EPN is not yet well understood. One theory is that, in uncontrolled diabetes, glucose fermentation by the offending organism provides an excellent microenvironment for the organism's growth and rapid catabolism, leading to the massive production of carbon dioxide and hydrogen.<sup>1,7,11</sup> Because of impaired gaseous transport, carbon dioxide and hydrogen accumulate in tissues, leading to tissue infarction and, thus, to further damage to the renal parenchyma.<sup>11</sup> In cases of unrelieved urinary tract obstruction, urinary stasis leads to severe infection, and increased intra-pelvic pressure compromises and impairs the renal circulation, resulting in poor tissue perfusion, which makes antibacterial therapy ineffective.

CT scan has been advocated as the most useful modality for diagnosing EPN and guiding percutaneous renal drainage.<sup>5–8</sup> Some authors reported that percutaneous drainage under sonoguide was not suitable for patients with gas-producing infection, because the significant distal shadowing and reverberation artifact produced by ultrasound made it difficult to determine the exact placement of the drainage catheter.<sup>10</sup> In our experience, however, ultrasound not only clearly demonstrates the gas and fluid collection, but is also useful in guiding placement of the percutaneous drainage catheter. We successfully used ultrasound-guided percutaneous renal drainage in treating our patients.

Reports on the therapeutic approach for patients with EPN suggest that the mortality rate in patients managed medically is greater than that in patients

managed surgically,<sup>1,2,7</sup> while combined treatment has produced a survival rate of more than 90%.<sup>1</sup> Some researchers have claimed that immediate nephrectomy is necessary, since delayed operation may only increase mortality.<sup>12</sup> Conversely, several patients have been treated successfully with percutaneous drainage, control of diabetes, and institution of broad-spectrum antibacterial therapy.<sup>4-8,10</sup> This regimen is thought to be a life-saving alternative for the critically ill and for high-risk patients, who are not suitable candidates for nephrectomy under general anesthesia. In our series, all patients recovered: 3 patients underwent delayed nephrectomy due to non-functioning of the affected kidney. Therefore, early, adequate percutaneous drainage, combined with broad-spectrum antibacterial therapy is not only life-saving, but is also a kidney-salvage procedure. If prompt resolution of the gas collection or clinical improvement does not occur, open drainage or nephrectomy must be done immediately;<sup>6,7</sup> delayed operation may jeopardize the chances of survival.

EPN is a rare and life-threatening condition that needs early diagnosis and intervention to salvage the affected kidney. CT scan and ultrasound are both sensitive tools for diagnosis and for guiding catheter insertion for percutaneous renal drainage. The combination of broad-spectrum antibacterial therapy and percutaneous renal drainage seems to be safe and effective for the treatment of EPN.

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