Case Report

DOI: 10.6966/EDMJ.202112_8(4).0004

# Bilateral Emphysematous Pyelonephritis in a Non-Diabetic Man Undergoing Peritoneal Dialysis

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Emphysematous pyelonephritis (EPN) is a rare but potentially life-threatening disease requiring prompt treatment. EPN with bilateral kidney involvement represents the rarest and most serious form of EPN. We report a middle-aged non-diabetic man undergoing continuous ambulatory peritoneal dialysis who presented to the emergency department with low-grade fever and fluctuations in consciousness. Abdominal computed tomography revealed gas accumulation in bilateral renal cortex, collecting systems, and bladder. Under the impression of bilateral EPN, he received broad-spectrum antibiotics and underwent bilateral percutaneous nephrostomy. He was discharged after six weeks of hospitalization. Poorly controlled diabetes mellitus with high glucose levels and obstructed urinary tract are common features in the majority of EPN cases. Although both factors were not observed in our patient, chronic dialysis with immunocompromised status and high-glucose dialysate exposure predisposed him to EPN development. The diagnosis of EPN is often delayed because of its nonspecific presentations. EPN treatment focuses on fluid resuscitation, electrolyte replacement, and antibiotic coverage. Regarding treatment, percutaneous drainage is required for specific types of EPNs and nephrectomy is considered the last-resort. Clinicians should have a high index of suspicion for this rare but serious infection.

**Key words:** computed tomography, emergency department, emphysematous pyelonephritis, peritoneal dialysis

## Introduction

Emphysematous pyelonephritis (EPN) is a rare but potentially life-threatening infection characterized by necrotizing inflammation due to bacterial production of gas accumulated within the kidney parenchyma, which may extend to the surrounding tissues including the peri-renal tissues, collecting systems (i.e., emphysematous pyelitis), and bladder (i.e., emphysematous cystitis), leading to substantially high mortality if treatment is delayed.[1-3] EPN has been reported mostly in middle-aged women with diabetes, frequently involving the left kidney.[3] EPN in patients with end-stage

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Received: September 16, 2020 Accepted: November 25, 2020
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renal disease, especially in those undergoing peritoneal dialysis (PD), have rarely been reported.[4] With the development of diagnostic modalities (e.g., computed tomography) and treatment measures (e.g., percutaneous drainage), the current reported mortality rate of EPNs has improved over the past decades, ranging from 9.8% to 16.2%.[5,6] Here, we report a rare case of bilateral EPNs diagnosed in a non-diabetic male patient undergoing PD.

## Case Report

A 49-year-old man presented to our emergency department (ED) in February 2019 with generalized weakness and fluctuating consciousness for several days. He also had low-grade fever without abdominal pain, vomiting, or flank pain. He had a history of end-stage renal disease with anuria under continuous ambulatory peritoneal dialysis for more than ten years and experienced a cerebral vascular accident in the past year with no significant disability (modified Rankin Scale 1). No history of diabetes mellitus, hyperglycemic events, recent trauma, or turbid dialysate was reported. On ED arrival, he had a Glasgow Coma Scale score of 15/15, body temperature of 37.6°C, pulse rate of 83 beats/min, respiratory rate of 20 breaths/min, and blood pressure of 104/57 mmHg. Physical examination showed unremarkable findings except for mild tenderness in the lower abdomen without muscle guarding or rebound tenderness. Laboratory data were

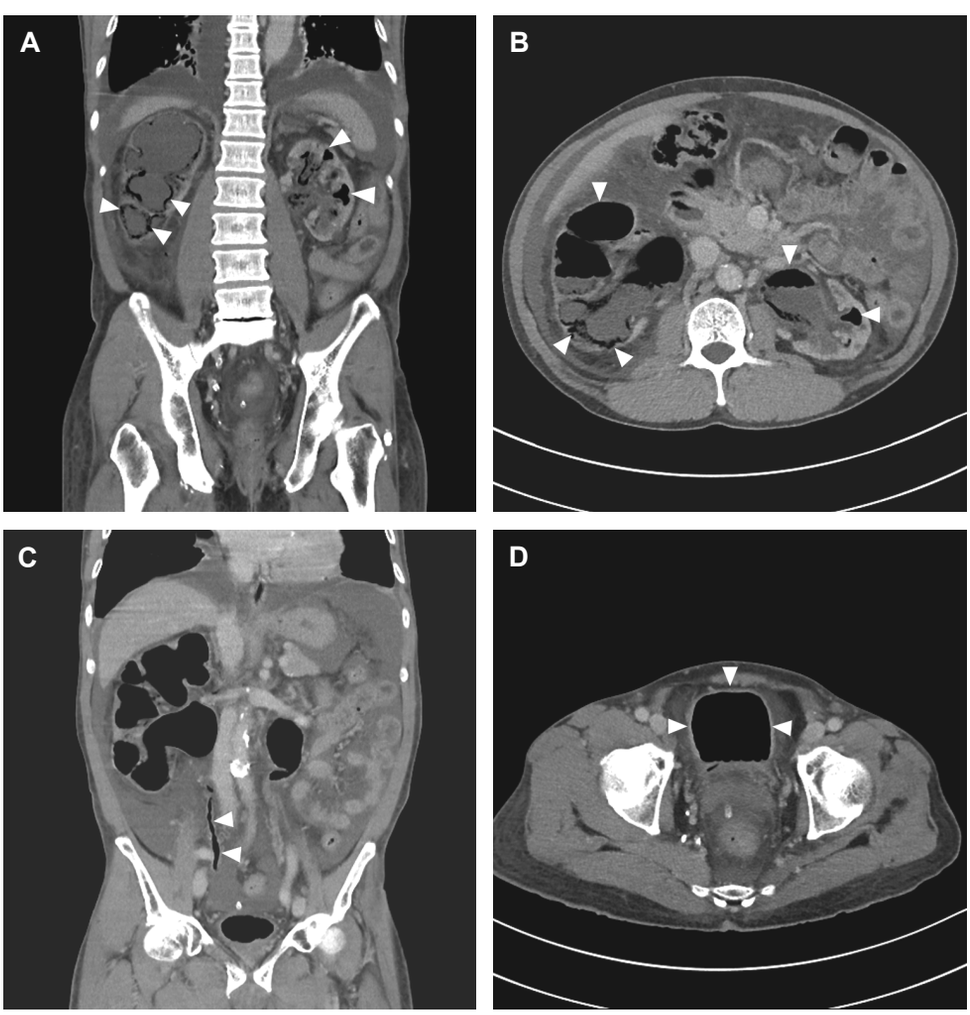


*Fig. 1 Contrast-enhanced computed tomography of the abdomen demonstrating gas accumulation in bilateral renal cortex (A and B, arrowhead), collecting systems (C, arrowhead) and bladder (D, arrowhead).*

as follows: white blood cell count, 22 × $10^9$/L with neutrophil segment 90.2%; hemoglobin level, 7.6 g/dL; platelet count, 249 × $10^9$/L; blood albumin, 3.6 g/dL; glycated hemoglobin (HbA1c), 4.4%; blood urea nitrogen, 78.5 mg/dL; blood creatinine, 14.9 mg/dL; C-reactive protein level, 109.5 mg/L; glucose concentration, 97 mg/dL; and aspartate aminotransferase level, 16 U/L. Chest radiography revealed nonspecific infiltrates in the bilateral lung fields. Urinalysis revealed a turbid appearance with pyuria (i.e., WBC > 100/HPF, RBC > 100/HPF, protein 15 mg/dL). Analysis of dialysate revealed no evidence of infection (i.e., WBC 4/μL).

Contrast-enhanced computed tomography (CT) of the abdomen aiming at identifying the origin of infection revealed gas accumulation in bilateral renal cortex (Fig. 1A & 1B, arrowhead), collecting systems (Fig. 1C, arrowhead), and bladder (Fig. 1D, arrowhead). The diagnosis of bilateral emphysematous pyelonephritis with ureteritis and cystitis was confirmed. The patient underwent bilateral CT-guided percutaneous nephrostomy with intravenous meropenem coverage. He was admitted to the intensive care unit with relatively stable hemodynamics without recourse to vasoactive agents. Bacterial culture of the urine specimen yielded *Enterobacter aerogenes*, which was sensitive to meropenem treatment. Follow-up contrast-enhanced CT of the abdomen two weeks after admission demonstrated resolution of the air pockets in bilateral renal cortex, collecting systems, and bladder (Fig. 2A & 2B, arrowhead). The C-reactive protein level also decreased gradually to 30.9 mg/L. The patient was discharged uneventfully after six weeks of hospitalization.

## Discussion

The pathogenesis of gas formation in EPNs is believed to involve four elements: gas-forming bacteria, high glucose levels in tissues, impaired tissue perfusion, and defective host immune response.[1,3] Diabetes mellitus with poorly controlled glucose levels and an obstructed urinary tract are the two important predisposing factors, comprising more than 90% of patients with EPNs;[1,6] interestingly, both were not observed in our patient. Few EPN cases have been reported in patients with end-stage renal disease undergoing PD.[4] It is

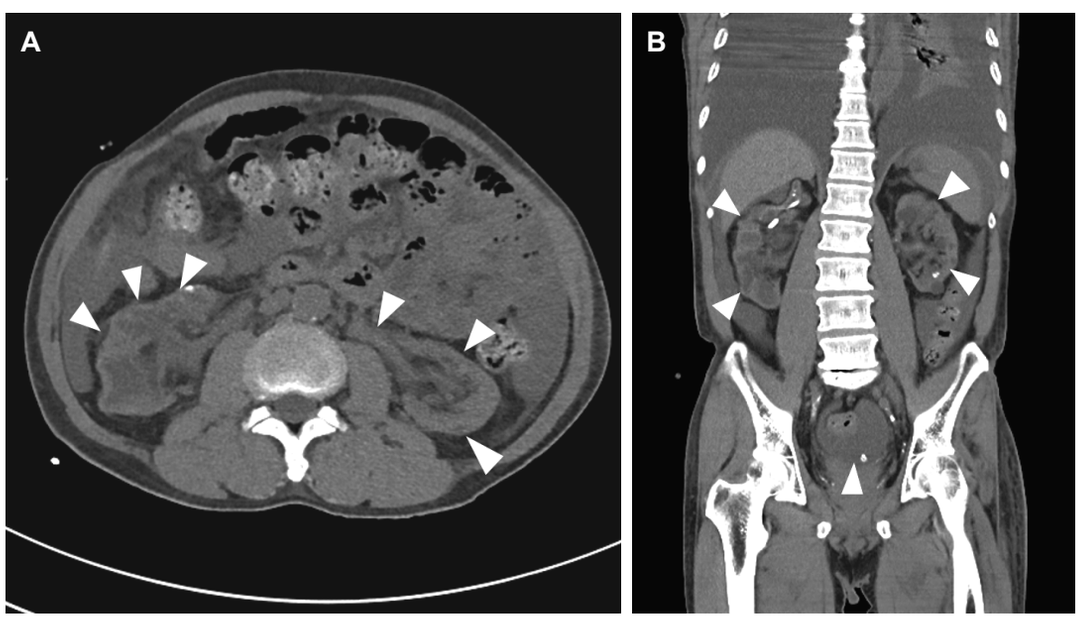


*Fig. 2 Follow-up contrast-enhanced computed tomography of the abdomen showing resolution of the air pockets in bilateral renal cortex (A and B, arrowhead), collecting systems, and bladder (B, arrowhead).*

suggested that the extra-peritoneal dialysate glucose burden may contribute to the high-glucose tissue environment and impaired tissue perfusion that facilitate the accumulation of gas-forming bacteria and the development of EPN.[7] The long-term glucose exposure due to PD dialysate could also explain the EPN diagnosed in our patient despite his non-diabetic condition with normal serum glucose levels. Furthermore, the chronic dialysis status of our patient also led to immune cell abnormalities, altered immune system response, and increased susceptibility to bacterial infection. In summary, although rarely reported, it is not surprising that EPN developed in PD patients because of their chronic high-glucose dialysate exposure and immune dysfunction.

The pathogens most frequently isolated from the urine and kidneys of patients with EPNs are *Escherichia coli, Klebsiella pneumoniae, Proteus mirabilis,* and *Streptococcus* or *Pseudomonas* strains; occasionally, anaerobic organisms or mixed infections have also been reported.[1,5] The increasing prevalence of antibiotic-resistant pathogens is a risk factor for this patient population because improper antibiotic administration has been found to be an independent risk factor for mortality in patients with EPNs.[5] *Enterobacter aerogenes,* which was identified in our patient and has not been reported in previous cases of EPNs, is a Gram-negative bacillus species sensitive to meropenem treatment. Third-generation cephalosporins or carbapenem are the antibiotics of choice based on the results of a case series study on patients with EPNs.[5]

The clinical presentation of EPNs, which is nonspecific and often vague initially with rapid deterioration, renders the early detection of EPNs challenging.[1] Prominent presentations of EPNs include fever/chills, flank pain, nausea/vomiting, costovertebral angle tenderness, and dysuria.[1,2,6,8] Other less common characteristics such as hypotension, depressed consciousness, shortness of breath, and renal function impairment have also been reported.[1,8] It was somewhat surprising that although our patient had bilateral EPNs that even extended to the collecting systems and bladder, he exhibited subtle symptoms that merely included low-grade fever and consciousness fluctuations, further echoing the diagnostic difficulty of EPNs.

The diagnosis and staging of EPNs are based on radiological findings, mostly involving CT that can accurately evaluate the extent and location of gas accumulation.[1,6] The widely used classification of EPNs based on CT findings was proposed by Huang and Tseng: Class 1, gas confined in the collecting system only; Class 2, gas within the renal parenchyma; Class 3A, gas extending to the perinephric space; Class 3B, gas extending to the pararenal space; Class 4, bilateral EPNs or EPN in a solitary kidney.[9] The classification correlates with the prognosis, as patients with Class 1 or 2 EPNs have a survival rate of more than 90%, while nearly half of patients with Class 4 EPNs experience mortality.[8] Bilateral EPNs were also identified as an independent risk factor for mortality in a meta-analysis of patients with EPNs.[10] Only 26 cases of bilateral EPNs have been reported.[3] Our successful treatment experience may provide useful information for clinicians regarding the treatment of this particular patient population.

The appropriate initial management of EPNs include fluid resuscitation, electrolyte replacement, and antibiotic regimens.[5,6] As mentioned earlier, administration of third-generation cephalosporins or carbapenem is recommended instead of fluoroquinolone, taking into account the high prevalence of antibiotic-resistant strains.[5] Further treatment is decided based on the radiological classification and presence of risk factors (e.g., prior hospitalization and antibiotic use, need for hemodialysis, and disseminated intravascular coagulation).[5] Patients with Class 1 EPNs can be managed with antibiotic administration and

elective percutaneous drainage (PCD), while patients in Classes 2, 3, and 4 should receive broad-spectrum antibiotics and undergo PCD. The latter may require nephrectomy if treatment fails, especially in those presenting with risk factors.[5] Interestingly, although PCD plus elective nephrectomy is recommended for bilateral EPNs,[1,5] a recent case series on patients with bilateral EPNs showed that nearly half of these patients were successfully treated with antibiotics only.[3] Therefore, the findings of that study suggest that management may be individualized according to the patient's clinical condition rather than completely guideline-based.[9]

## Conclusion

There has been a significant increase in the number of patients diagnosed with EPNs in recent years due to improvements in diagnostic technologies. Chronic dialysis with immunocompromised status and high-glucose dialysate exposure may have predisposed our patient to the development of this rare disease. Due to its nonspecific clinical presentation and high mortality risk, a high index of suspicion among clinicians and rapid initiation of appropriate treatment can be life-saving. The treatment of EPNs should be individualized based on radiological findings and clinical conditions. The increasing trend of successful treatment with antibiotic administration plus minimally invasive procedures (e.g., PCD) for bilateral EPNs may provide more treatment options for clinicians. Surgical intervention remains the last resort for patients with rapid deterioration or those whose conditions do not improve with conservative treatment.

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