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Case Report

# *Salmonella* Emphysematous Pyelonephritis in a Nondiabetic and Non-Obstructive End-Stage Renal Disease Patient

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**Abstract**

Emphysematous pyelonephritis (EPN) is a rare, severe, and gas-forming infection of the kidney. EPN is common in patients with diabetes mellitus and/or urinary tract obstruction. EPN rarely occurs in patients with end-stage renal disease, and is rarely caused by non-typhoidal *Salmonella*. This is a case report of end-stage renal disease in a 28-year-old woman who refused regular hemodialysis. She presented with fever, abdominal pain and right flank pain. Unenhanced computed tomography showed air within the right kidney. *Salmonella* group D was isolated from the drainage. The patient was successfully treated with antibiotics and percutaneous catheter drainage. To our knowledge, this is the first case report in the literature of EPN caused by *Salmonella* in a patient with end-stage renal disease who did not have diabetes mellitus or urinary tract obstruction. [*Tzu Chi Med J* 2007;19(4):249–252]

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## 1. Introduction

Emphysematous pyelonephritis (EPN) is a rare, severe necrotizing infection of the kidney that leads to accumulation of gas in the collecting system, renal parenchyma, and perinephric tissue [1–4]. In general, EPN is common in patients with diabetes mellitus (DM) and in nondiabetic patients with urinary tract obstruction (UTO) [1–12]. EPN rarely occurs in end-stage renal disease (ESRD), and only two such cases have been reported [13,14]. In addition, urinary tract infection (UTI) caused by *Salmonella* is rare [15–17]. Only one case of EPN induced by *Salmonella* has been reported in a renal transplant recipient [18]. Here, we present the first case report in the literature of EPN caused by *Salmonella* in a patient with ESRD who did not have DM or UTO; it was successfully treated with antibiotics plus percutaneous catheter drainage (PCD).

## 2. Case report

A 28-year-old woman was brought to the emergency department with a 7-day history of right flank pain, fever, dyspnea and oliguria. She was known to have chronic renal failure and creation of an arteriovenous shunt had been recommended about 5 years ago. However, she did not have regular outpatient clinic

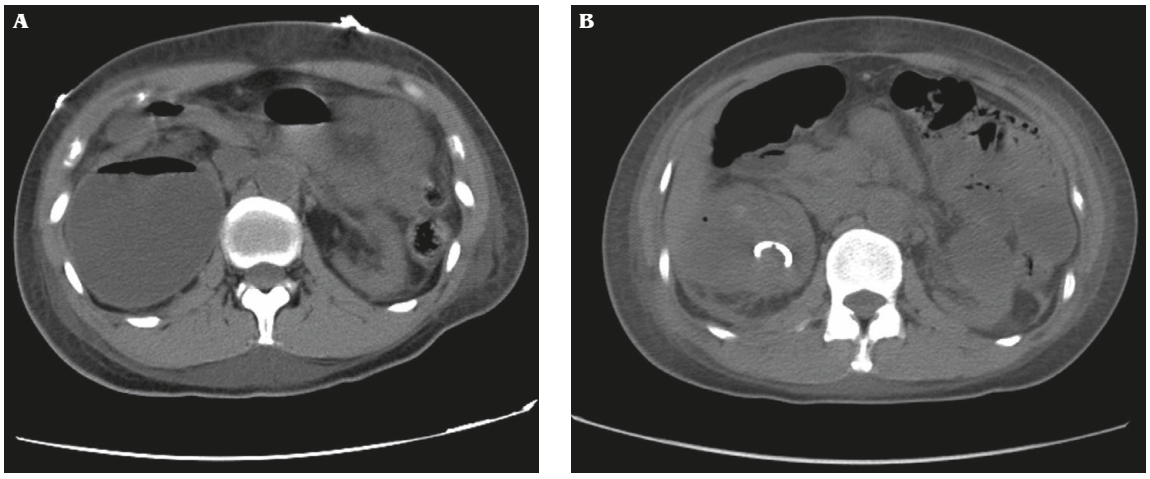


**Fig. 1 — (A) Unenhanced computed tomography of the abdomen at the time of diagnosis shows air accumulation within a subcapsular collection at the posterior aspect of the enlarged right kidney. (B) A percutaneous catheter was inserted into the subcapsular collection of the right kidney for drainage.**

follow-up and took Chinese herbs during this period. On physical examination, she was in acute distress. She was febrile with a temperature of 38.4°C, pulse rate of 103 beats/min, respiratory rate of 25 breaths/min, and blood pressure of 163/83 mmHg. Tenderness was noted at the right flank and right costovertebral angle when percussed. Biochemistry data showed blood urea nitrogen of 237 mg/dL, creatinine of 33.1 mg/dL, sodium of 130 mmol/L, potassium of 6.3 mmol/L, glucose of 126 mg/dL, glutamic oxaloacetic transaminase of 17 IU/L, and C-reactive protein of 2.85 mg/dL. Arterial blood gases were pH 7.286, bicarbonate 11.7 mmol/L, and $pCO_2$ 24.4 mmHg. Complete blood count showed white blood cell (WBC) $9.45 \times 10^3/\mu L$ with 93% segmented neutrophils, 1% lymphocytes, 6% monocytes, and no bands; hematocrit 9.1%; and platelets $179 \times 10^3/\mu L$. Urinalysis showed protein >300 mg/dL, and glucose of 100 mg/dL. Microscopic examination revealed WBCs 23–25/high-powered field (HPF), and red blood cells 6–8/HPF. Plain abdominal radiograph revealed no significant finding. Unenhanced computed tomography (CT) of the abdomen showed air accumulation within a subcapsular collection at the posterior aspect of the enlarged right kidney (Fig. 1A).

Under the impression of renal failure with hyperkalemia and general edema, emergency hemodialysis was performed. In addition, a percutaneous catheter was inserted into the subcapsular collection in the right kidney (Fig. 1B). The drainage culture eventually grew *Salmonella* group D. Blood culture and stool cultures were sterile. Intravenous ciprofloxacin 200 mg every 12 hours was prescribed according to sensitivity test from the drainage culture and regular hemodialysis was performed. Significant improvement in abdominal and flank pain was noted during treatment. Afterwards, the plasma glucose level was 89 mg/dL with no antidiabetic medicine. Intravenous ciprofloxacin was replaced by oral ciprofloxacin on day 7. Revision of the drainage tube was performed twice during this period due to obstruction. A repeat culture continued to show *Salmonella* group D but with fewer flora. On day 14, she was discharged with oral ciprofloxacin for 2 weeks plus PCD for EPN. She received regular hemodialysis at another hospital. Two weeks after discharge, she had a traffic accident resulting in hematuria originating from the left kidney, and nephrectomy of the left kidney was performed due to persistent hematuria from the left kidney. Additionally, the PCD catheter was removed because of no drainage from the right kidney and oral ciprofloxacin was prescribed for another 2 weeks. There was no fever, chills or other discomfort after removal of the catheter and nephrectomy. Two months later, she visited our outpatient clinic for follow-up and unenhanced renal CT showed neither gas nor necrotic tissue within the small right kidney (Fig. 2).

## 3. Discussion

EPN is a gas-producing, necrotizing infection of the kidney that results in the accumulation of air within the kidney [1–4]. More than three fourths of all reported cases of EPN occur in patients with DM [2,19], but it has been described in nondiabetic patients with UTO [2], renal allograft [12,18,20], horseshoe kidney [21], renal failure with renal cell carcinoma [13], and ESRD being treated with peritoneal dialysis [14]. Neither symptoms/signs nor laboratory data are useful in discriminating EPN from acute pyelonephritis. The diagnosis of EPN is usually made by plain radiographs of the abdomen, renal ultrasound, and renal CT. However,

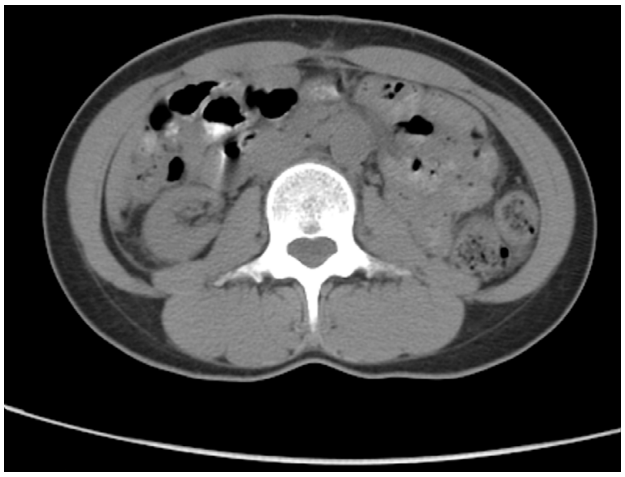

**Fig. 2 — Computed tomography scan 2 months after the patient had fully recovered shows neither gas nor necrotic tissue within the small right kidney and no left kidney because of left nephrectomy after a traffic accident.**

plain abdominal radiographs reveal gas within the renal parenchymal or perirenal space in only one third of EPN cases [4]. The diagnosis is always established via CT, which can also outline the extent of the infection and any associated obstructing lesions in the genitourinary tract.

The mechanism of gas formation and pathogenesis of EPN remain unclear, although serial studies have shown that four factors are involved in the pathogenesis of EPN [1–3,22–24]: (1) gas-forming bacteria; (2) a high tissue glucose level; (3) impaired tissue perfusion (diabetic microangiopathy or UTO); and (4) a defective immune response. Hyperglycemia provides an abnormally high energy substrate for bacteria, facilitates rapid bacterial growth, and promotes mixed acid fermentation of glucose leading to increased gas formation [24]. Diabetic microangiopathy or UTO may impair tissue perfusion leading to reduced gas elimination and decrease regional oxygen delivery to the kidney causing more obvious tissue ischemia and even necrosis. For example, a recent study investigated the roles of host and bacterial virulence factors in the pathogenesis of EPN and found that DM with poor glycemic control and UTO with impaired renal circulation were the important host factors predisposing patients to the development of EPN [1]. Also, there was no difference in gas production of *Escherichia coli* strains between EPN and non-EPN *E. coli* strains [1]. Additionally, an impaired vascular supply incurs a locally impaired host response.

Chronic uremic patients are susceptible to glucose intolerance, decreasing vascular supply to kidney, and immunodeficiency status. The immune system dysregulation in chronic uremic patients includes both the humor and cellular axes of immune systems, i.e. the chemotaxis of lymphocytes, monocytes and polymorphonuclear cells are perturbed to specific stimuli. However, it is surprising that only two EPN cases have been reported in patients with ESRD [13,14], although the predisposing factors of high tissue glucose level, presence of gas-forming microorganisms in the urinary tract, and infrequent emptying of the bladder secondary to oliguria are encountered frequently in patients with ESRD.

The most common microorganisms causing EPN is gas-forming *E. coli* (69%), followed by *Klebsiella pneumoniae* (29%) [2]. However, *Proteus* spp. [19], *Citrobacter* spp. [25], *Candida* spp. [26], *Clostridium* spp. [27], and *Salmonella* spp. [18] have also been reported as microorganisms in EPN. Extraintestinal infection from *Salmonella* is uncommon and UTI caused by *Salmonella* is particularly rare. *Salmonella* was reported as the cause of 0.056–0.07% of UTI in Spain [15,16], and 0.002–0.0037% of UTI in the United States [17]. UTI induced by *Salmonella* generally occurs in elderly patients with underlying diseases, especially DM, urologic abnormalities and immunocompromised conditions [15,16,28–30]. Therefore, the *Salmonella*-induced UTI in this uremic patient might be due to uremia-associated immunocompromise and/or urologic abnormality.

EPN is of special concern because of its life-threatening potential and mortality associated with its treatment [2,31]. Treatment for EPN includes appropriate antibiotic therapy, therapy for septic shock, correction of the underlying hyperglycemia and electrolyte disturbances, appropriate drainage via PCD and nephrectomy. Many studies stressed the high mortality rate (>50%) of EPN and recommended that urgent nephrectomy or open drainage plus systemic antibiotics is mandatory [32–34]. However, the success of conservative treatment has improved substantially in recent years [2,35,36]. One study divided EPN into four classes according to the location of gas on CT scan and provided important guidelines for the management of EPN and improved mortality [2]. Class 1 includes cases with gas in the collecting system only; Class 2, gas in the renal parenchyma without extension to the extrarenal space; Class 3A, extension of gas or abscess to the perinephric space; Class 3B, extension of gas or abscess to the pararenal space; Class 4, bilateral EPN or a solitary kidney with EPN [2]. The overall mortality rate was 18.8% with treatment using the following two therapeutic guidelines: (1) antibiotics plus PCD for patients with local EPN (Classes 1 and 2) or extensive EPN patients (Classes 3 and 4) with fewer than two risk factors (thrombocytopenia, acute renal failure, consciousness disturbance, shock); (2) nephrectomy in selected patients with extensive EPN with more than two risk factors, or in patients who do not substantially improve after appropriate medical treatment and drainage [2].

This case is rare and unique in that EPN caused by *Salmonella* occurred in an oliguric patient with ESRD but without DM or UTO. We believe that successful treatment of EPN can be achieved by rapid diagnosis, full circulatory support, appropriate antibiotic therapy plus PCD for EPN, and nephrectomy if necessary.

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