Risk Factors of Renal Failure and Severe Complications in Patients With Emphysematous Pyelonephritis—A Single-Center 15-Year Experience

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Abstract: *Introduction:* Emphysematous pyelonephritis (EPN) is a rare but severe infection of renal parenchyma. Risk factors of renal failure in patients survived from EPN are not clear. *Methods:* The authors retrospectively reviewed the patients with a diagnosis of EPN at Taipei Veterans General Hospital from January 1, 1995, to December 31, 2009. The authors analyzed the demographic, characteristics and the treatment modalities of those patients. The renal function of survivors after EPN episode had been followed for 1 year. *Results:* A total of 23 patients with a mean age of 62.8 ± 17.1 years were enrolled. Mean hospital duration was 31.8 ± 21.6 days. Fifteen (65.2%) patients had a history of diabetes mellitus. Mean serum HbA1c level among the diabetic patients was 11.7 ± 3.3. More than half of patients had *Escherichia coli* in culture. Eleven (47.8%) patients received antibiotic treatment alone. Twelve (52.2%) patients received the concurrent percutaneous drainage and antibiotics. The overall mortality rate was 8.6%. Shock, long hospital duration and the extensive classes of computed tomography image were correlated with poor outcome. A higher initial serum creatinine level (2.8 ± 1.4 versus 1.6 ± 0.8, $P = 0.015$) and receiving invasive therapy (67.7% versus 12.5%, $P = 0.017$) significantly contributed to chronic kidney disease in the follow-up. Shock is also an independent predictor of the poor outcome in those patients ($P = 0.026$). *Conclusions:* In the current era, antibiotics alone provide a high success rate for the treatment of EPN. Invasive therapy is a predictor of development of chronic kidney disease. Initial resuscitation and antibiotic therapy are still the cornerstone and have the benefit of the preservation of renal function.

Key Indexing Terms: Chronic kidney disease; Diabetes mellitus; Emphysematous pyelonephritis; Percutaneous drainage; Shock. **[Am J Med Sci 2012;343(3):186–191.]**

Emphysematous pyelonephritis (EPN) is a rare but life-threatening necrotizing inflammation caused by a gas-forming pathogen involving the intrarenal and perirenal tissue.[1,2] The mortality rate in patients with EPN was 70% to 90% when using medical therapy alone compared with 20% to 30% when using surgical intervention 2 decades ago.[3,4] EPN occurs most commonly in female diabetic patients (70%–90%) and might be precipitated by poor-controlled diabetes and obstructive uropathy.[5] Computed tomography (CT) was the gold standard for the diagnosis and the prognostic indicator of the disease.[6,7] Despite EPN having been traditionally viewed as a disease that required surgical intervention, in recent years, the treatment strategy has changed to a conservative and mini-invasive therapy, including percutaneous catheter drainage (PCD) or double-J catheter because of the high success and survival rates. Somani et al[8] described that antibiotics combined with a minimally invasive procedure followed by salvage nephrectomy successfully reduced the patient mortality to 6.6%. In Taiwan, the overall mortality of patients with EPN ranges from 18.8% to 25%.[7,9,10] The long-term renal outcome of EPN survivors is still unclear, owing to the fact that the different treatment modalities may affect the extent of the renal damage. Thus, the purpose of this study was to (1) investigate the effect of the different EPN treatment modalities on long-term renal outcome and (2) evaluate the risk factors of poor outcome during the EPN treatment, including those during the intensive care unit care, nephrectomy or death.

PATIENTS AND METHODS

This was a retrospective review of the charts of the patients admitted to Taipei Veterans General Hospital, Taiwan, between January 1, 1995, and December 31, 2009. Twenty-three consecutive cases were diagnosed with EPN. The diagnosis of EPN was based on (1) symptoms and signs of an upper urinary tract infection, or fever with a positive urine culture or pyuria and (2) radiologic evidence of EPN by a CT image, including gas accumulation in the collecting system, renal parenchyma or perinephric or pararenal space without a fistula between the urinary tract and bowel and no trauma or urinary catheter insertion-related gas accumulation. The classes of class of CT image were defined as following: class 1—gas confined to the collecting system; class 2—gas confined to the renal parenchyma; class 3a—perinephric extension of gas or abscess; class 3b—extension of gas beyond the Gerota's fascia; and class 4—bilateral EPN or unilateral EPN with a solitary kidney. The CT images of EPN were reviewed by 2 radiologists. The localized class of CT image was defined as class 1 or class 2, and the extensive class of CT image was defined as class 3a, 3b or 4. The patient characteristics, clinical features and laboratory data at the initial presentation and the management and outcome were collected by a medical chart review. The baseline characteristics included age, sex, duration (days) of hospitalization, history of diabetes mellitus (DM), hypertension, chronic kidney disease (CKD), end-stage renal disease, renal stones, hydronephrosis or a neurogenic bladder. The clinical features include signs and symptoms such as fever and chills, pyuria and shock. The laboratory data consisted of hemoglobin A1c (HbA1c), serum creatinine, sodium, C-reactive protein, albumin, white cell count, platelet count, admission glucose, urine analysis and blood and urine cultures. The management modalities included antibiotics alone, antibiotics

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and mini-invasive therapy-PCD, salvage nephrectomy or open drainage and emergent nephrectomy. Shock was defined as systolic blood pressure below 90 mm Hg and evidences of end organ damage, including respiratory system, liver or kidney. Nephrectomy or open drainage performed after the failure of antibiotics or mini-invasive therapy meant salvage surgery. The patients who received a mini-invasive therapy, salvage surgery or emergent nephrectomy were all statistically included in the invasive therapy. The poor outcome group was defined as the patients who were admitted to the intensive care unit or who received a nephrectomy or died. The patients with a serum creatinine level increased above 0.3 mg/dL during the admission compared with the baseline serum creatinine level were defined as having acute kidney injury (AKI). The baseline serum creatinine levels were recorded by using the data that was checked in our hospital about 3 months before the admission. For patients in whom baseline serum creatinine values were not known, the value was estimated using the Modification of Diet in Renal Disease equation (assuming average baseline glomerular filtration rate of 75 mL/min/1.73 m^2), as recommended by the Acute Dialysis Quality Initiative workgroup. The renal function of the patients was followed up for a year, the patients with CKD were defined as having a glomerular filtration rate level of $<$60 mL/min/1.73 m^2 calculated by the Cockcroft-Gault Equation and CKD persisted for more than 3 months in 2 consecutive follow-ups. The research project was approved by the medical ethics committee of Taipei Veterans General Hospital.

Statistical Methods

The continuous variables were presented as mean ± standard deviation. Comparisons between the good and poor outcome groups were analyzed by the χ^2 test for categorical variables and the paired *t* test for continuous variables. The independent variables were selected for a multivariable analysis if they had a *P* value <0.05 in the univariate analysis. A *P* value of <0.05 was considered statistically significant.

RESULTS

Demography

Twenty-three hospitalized patients with EPN with a mean age of 62.8 ± 17.1 years (Table 1). The average hospital days was 31.8 ± 21.6 days. Twelve (52.1%) of 23 patients were women. There were 8 (34.8%) of all patients involving the right kidney and 13 (56.5%) involving the left kidney. Fifteen (65.2%) of all had type 2 DM and 8 (34.8%) had hypertension. Four (17.3%) patients with CKD were in end-stage renal disease underwent hemodialysis. Genitourethral problems were common in the patients, and there were 10 (43.5%) patients with renal stones, 3 (13%) with a neurogenic bladder and 2 (8.6%) with hydronephrosis. Other comorbidities included malignancy (4 cases, 17.4%), chronic obstructive pulmonary disease (4 cases, 17.4%), status postsimultaneous pancreas-kidney transplantation (1 case, 4.3%) and liver cirrhosis (1 case, 4.3%).There were 11 patients (47.8%) with fever and 13 (56.5%) with pyuria at initial presentation, which were the most common signs and symptoms, and it was followed by abdominal pain (34.8%), nausea and vomiting (34.8%) and hematuria (26%). Shock occurred in 8 (34.8%) patients. In the laboratory data, the median serum HbA1c level among the diabetic patients was 11.7 ± 3.3. Moreover, AKI occurred in 11 (47.8%) patients. In the classes of CT image, there were 11 (47.8%) in class 1, 3 (13.0%) in class 2, 6 (26.0%) in class 3a, 1 (4.3%) in class 3b and 2 (8.6%) in class 4. Pathogens were identified in 18 patients, 16 of them were from urine or pus cultures; the other 2 patients had negative urine cultures but positive blood cultures. *Escherichia coli* was the most common microorganism (56.5%), followed by 7 (30.4%) patients with a mixed infection.

TABLE 1. Basic demography for the patients with emphysematous pyelonephritis (N = 23)

Parameter	Number (%)
Age	62.8 ± 17.1
Female gender	12 (52.1)
Side	
Right	8 (34.8)
Left	13 (56.5)
Bilateral	1 (4.3)
Graft	1 (4.3)
Days of hospitalization	31.8 ± 21.6
Comorbidities	
Type 2 diabetes mellitus	15 (65.2)
Hypertension	8 (34.8)
Chronic kidney disease	4 (17.3)
ESRD under hemodialysis	3 (13.0)
Renal stone	10 (43.5)
Neurogenic bladder	3 (13.0)
Hydronephrosis	2 (8.6)
Symptoms and signs	
Fever/chills	11 (47.8)
Pyuria	13 (56.5)
Shock	8 (34.8)
Laboratory data	
Hemoglobin A1C (%)	11.7 ± 3.3
Creatinine (mg/dL)	3.1 ± 2.0
Sodium (meq/L)	130.9 ± 7.4
C-reactive protein (mg/dL)	18.8 ± 7.1
Albumin (g/dL)	2.8 ± 0.71
White cell count (cm^3/L)	16,930 ± 7,588
Platelet count (cm^3/L)	
Admission glucose level (mg/dL)	300 ± 208
Classes of CT image[a]	
1	11 (47.8)
2	3 (13.0)
3a	6 (26.0)
3b	1 (4.3)
4	2 (8.6)
Microbiology	
Escherichia coli	13 (56.5)
Mixed infection	7 (30.4)
Treatment	
Antibiotics alone	11 (47.8)
Invasive therapy	12 (52.2)
Outcome	
Death	2 (8.6)

[a] Class of CT image was defined as following: class 1—gas confined to the collecting system; class 2—gas confined to the renal parenchyma; class 3a—perinephric extension of gas or abscess; class 3b—extension of gas beyond the Gerota's fascia; class 4—bilateral EPN or unilateral EPN with a solitary kidney.

ESRD, end-stage renal disease; CT, computed tomography.