Emphysematous pyelonephritis (EPN) is an uncommon but life-threatening acute, severe, necrotizing infection of the renal parenchyma and surrounding areas, characterized by the presence of gas within the renal parenchyma, collecting system, and perinephric tissue [1]. EPN deserves special attention because of its septic complications with life-threatening potential. EPN is caused by gas-forming organisms and almost always occurs in patients with uncontrolled diabetes mellitus (DM), with or without obstructive uropathy [2]. Traditionally, management of EPN is aggressive, and surgery is mandatory [3–6]. However, EPN has also been successfully treated with antibiotics, with or without percutaneous catheter drainage (PCD) [2,7].

Several prognostic factors can affect the outcome of EPN, including the radiologic typing, thrombocytopenia, acute renal function impairment, disturbances of consciousness and shock [1,8,9]. Wan et al observed the imaging findings and clinical outcomes in patients with EPN and proposed the existence of two different
Radiologic subtypes of EPN: type I and type II [1]. Type I EPN is characterized by parenchymal necrosis with either total absence of fluid on computed tomography (CT) images, or a streaky or mottled gas pattern demonstrated by radiography or CT with lung window display (Figure 1). Type II EPN is characterized either by the presence of renal or perirenal fluid in association with a bubbly or loculated gas pattern, or by the presence of gas in the collecting system with acute bacterial nephritis, or renal or perirenal fluid-containing abscesses (Figure 2). They demonstrated higher mortality in patients with type I EPN [1]. Huang and Tseng [8] and Wan et al [9] disclosed that patients with thrombocytopenia, acute renal impairment, initial disturbances of consciousness and shock also had higher mortality rates, especially when the platelet count was <60×10⁹/L and creatinine levels were >106.75 μmol/L. These factors may affect the outcome when comparing management strategies for EPN. As a consequence, the optimal strategy for treating patients with EPN remains controversial (Table 1) [1,2,6–14].

Figure 1. Type I emphysematous pyelonephritis in both kidneys in a 61-year-old male. (A) Plain abdominal X-ray reveals streaky and mottled gas (*) in both kidneys with crescent-shaped gas in the left renal fossa (curved arrow). Note that the gas extends into the paravertebral regions (white arrow) and bladder wall (black arrow). (B) Sonography shows gassed-out kidney (*). (C, D) Computed tomography of the abdomen with soft tissue window and lung window settings shows streaky gas in both renal parenchymas (*) with subcapsular gas (curved arrow) in the left side. The gas extends to the paraaortic and paraaortic spaces (white arrows). This patient underwent conservative treatment only to preserve right renal function and autonephrectomy of the left kidney.
In this study, we retrospectively reviewed our experience in managing patients with EPN and reappraised the prognostic factors and treatment outcomes associated with different modalities of treatment.

METHODS

Patients
During the period from September 1996 to August 2005, 21 patients (7 male, 14 female; age range: 29–82 years, mean: 59.43 ± 15.05 years) with gas-producing bacterial renal infections were diagnosed with EPN and treated at our hospital. They all met the following criteria [1,8,9]: (a) clinical manifestations of fever, chills, and flank pain or tenderness; (b) imaging findings of a renal lesion with gas in the renal parenchyma, collecting system, or perirenal space; (c) no fistula between the urinary tract and the bowel, and no history of trauma or instrumentation such as urinary catheter insertion or drainage or other possible iatrogenic causes that could have led to gas collecting in the urinary tract (such as tumor embolization or endoscopy); and (d) positive cultures of blood, pus, or urine. Their medical records and radiologic images were retrospectively reviewed, including clinical histories of symptoms and signs, laboratory investigations, radiologic findings, modes of treatment, clinical courses, and outcome.

All patients were admitted via the emergency department, and all received adequate fluid resuscitation. Blood and biochemical laboratory screening was conducted following abdominal plain radiography. Abdominal CT was performed in patients at high risk of complicated nephritic disorders such as renal abscess or EPN, especially diabetic patients with symptoms and signs of upper urinary tract infection, including fever, chills, knocking pain in the flank region, nausea/vomiting, leukocytosis, or pyuria. In patients with renal infections, EPN needed to be carefully differentiated from other non-gas-forming renal infections such as acute pyelonephritis, renal or perinephric abscess, pyonephrosis and xanthogranulomatous pyelonephritis. The extent of the emphysematous process was traced and localized, which helped to define the type of EPN. Based on the CT findings, patients were classified as having either type I or type II EPN.

Management of EPN
Empiric antibiotics were administered once EPN was diagnosed. Blood and urine cultures were obtained from all patients, and pus cultures were also obtained during PCD. The antibiotics were adjusted according to the results of the cultures and the clinical conditions. Penicillin-group or cefazolin-group antibiotics combined with gentamicin were the most frequently administered antibiotics, based on the results of sensitivity tests. Patients with coagulopathies were given fresh frozen plasma transfusions if their international normalized ratio was > 2, and platelet transfusions if their platelet count was < 100 × 10^9/L. However, in patients with uncorrectable coagulopathies, emergent PCD was performed with simultaneous blood transfusion. An attempt at prompt control of blood sugar was made in diabetic patients. The management strategies for these patients were divided into two groups: (1) Group 1 patients received conservative treatment, including medical treatment, with/without PCD; and (2) Group 2 patients underwent nephrectomy following medical treatment and PCD. All PCD procedures were performed by a 24-hour on-call interventional radiology team and two experienced interventional radiologists (Chen YF; Tzeng YH) within 1 hour of completion of the CT. Insertion of the PCD catheter, mostly an 8-Fr pig-tail catheter, into the renal or extrarenal abscess was performed using the Seldinger technique under CT guidance, or ultrasonography combined with fluoroscopic guidance. More than one drainage catheter was inserted in cases of non-communicating abscess formation. During PCD, a small amount (<20 mL) of abscess fluid was obtained and sent for
In addition to drainage of the EPN lesion, percutaneous nephrostomy was performed simultaneously to release obstructive uropathy. The patient’s vital signs, clinical symptoms and signs, and drainage volume were closely monitored. If the drainage volume decreased and the patient’s clinical symptoms and signs did not improve, irrigation of the drainage tube, suction of the debris, and replacement with a bigger catheter were performed under fluoroscopy to maintain adequate drainage. All patients and their families were fully informed about the procedures and potential complications before abdominal CT or any interventional procedures were conducted. Informed consent was obtained from all patients.

**Analysis of prognostic factors**

Survivors and nonsurvivors were compared with clarify the prognostic factors affecting the outcome.

<table>
<thead>
<tr>
<th>Authors [Ref.]</th>
<th>Case number</th>
<th>Management</th>
<th>Recommendations &amp; remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chen et al [7]</td>
<td>25</td>
<td>Elective nephrectomy after drainage (3), PCD (20), conservative treatment* (2)</td>
<td>Antibiotics + CT-guided PCD is an acceptable alternative in treating emphysematous pyelonephritis</td>
</tr>
<tr>
<td>Shokeir et al [6]</td>
<td>20</td>
<td>Elective nephrectomy (19), conservative treatment* (1)</td>
<td>Nephrectomy after rehydration, antibiotics and control of blood sugar</td>
</tr>
<tr>
<td>Wan et al [9]</td>
<td>38</td>
<td>Nephrectomy (16), PCD (12), surgical drainage (1), conservative treatment* (9)</td>
<td>High-risk patients have poor outcome, regardless of modality of treatment</td>
</tr>
<tr>
<td>Huang &amp; Tseng [8]</td>
<td>48</td>
<td>Nephrectomy (10), PCD (33), conservative treatment* (5)</td>
<td>1. CT classes 1–2 and classes 3–4 with ≤2 risk factors*: PCD + antibiotics 2. Classes 3–4 with &gt;2 risk factors: nephrectomy</td>
</tr>
<tr>
<td>Tang et al [2]</td>
<td>21</td>
<td>Elective nephrectomy (2), PCD (13), conservative treatment* (6)</td>
<td>Appropriate medical treatment and immediate nephrectomy or drainage</td>
</tr>
<tr>
<td>Abdul-Halim et al [10]</td>
<td>7</td>
<td>Emergency nephrectomy (3), delayed nephrectomy following PCD (2), PCD (2)</td>
<td>1. Early nephrectomy 2. PCD or surgical drainage: performed in patients too ill for immediate nephrectomy</td>
</tr>
<tr>
<td>Soo Park et al [11]</td>
<td>17</td>
<td>Nephrectomy (10), conservative treatment* (4), PCD (3)</td>
<td>1. Immediate nephrectomy 2. PCD can be an effective treatment option in inoperable cases</td>
</tr>
<tr>
<td>Wang et al [12]</td>
<td>26</td>
<td>Conservative treatment* (9), nephrectomy (10), PCD (2), open drainage (5)</td>
<td>1. Nephrectomy 2. Antibiotics + CT-guided PCD is a reasonable alternative in treating emphysematous pyelonephritis</td>
</tr>
<tr>
<td>Somani et al [14]</td>
<td>210</td>
<td>Conservative treatment* (24), emergency nephrectomy (64), open drainage (2), PCD (118)</td>
<td>1. PCD should be part of the initial management strategy for emphysematous pyelonephritis 2. Delayed elective nephrectomy may be required in some patients</td>
</tr>
</tbody>
</table>

*Conservative treatment including hydration, antibiotics, control of blood sugar in diabetics; †risk factors including thrombocytopenia, acute renal function impairment, disturbances of consciousness or shock. PCD = percutaneous catheter drainage; CT = computed tomography. Note: The numbers in parentheses following the modality of treatment are the numbers of patients who received this modality of treatment.
and survival of EPN patients (Table 2). Disturbances of consciousness included confusion, delirium, stupor and coma. Thrombocytopenia was defined as serum platelet count < 100 × 10⁹/L. Shock was defined as a systolic blood pressure < 90 mmHg or a shock index (heart rate divided by systolic blood pressure) of ≥ 1.0. Macrohematuria was defined as > 100 red blood cells per high-power field in urinary sediment. The prognostic factors were compared between survivors and nonsurvivors, and those prognostic factors that contributed to increased mortality were compared between Group 1 and Group 2 patients (Table 3).

**Statistical analysis**
Prognostic factors were analyzed using SPSS version 15.0 (SPSS Inc., Chicago, IL, USA) for Windows. Data were expressed as mean ± standard deviation. A p value < 0.05 was considered statistically significant. The differences between survivors and nonsurvivors were tested using the Mann–Whitney U test for platelet counts and Fisher’s exact test for the other three factors, to see if any prognostic factors affected the outcomes of Group 1 and Group 2 patients. In addition, the Mann–Whitney U test was also performed to compare the durations of hospitalization of survivors in Groups 1 and 2, and Fisher’s exact test was used to compare the mortalities and dialysis rates between Group 1 and Group 2.

**RESULTS**

**Clinical data**
Fourteen (66%) of our EPN patients were women. Eighteen (85%) patients had underlying DM, and the three nondiabetic patients had underlying liver cirrhosis, right staghorn stone, and graft kidney failure due to renal venous thrombosis, respectively. Five (23.8%) of our patients also had obstructive uropathy. The common clinical and laboratory presentations were fever, chills and flank pain, flank tenderness, leukocytosis, thrombocytopenia, acute renal function impairment, pyuria, hematuria, and proteinuria. Escherichia coli and Klebsiella pneumoniae were the two

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Table 2. Comparison between survivors and nonsurvivors among patients with emphysematous pyelonephritis*

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Survivors (n = 16)</th>
<th>Nonsurvivors (n = 5)</th>
<th>Total (n = 21)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creatinine (µmol/L)</td>
<td>247.05 ± 223.41</td>
<td>225.7 ± 97.6</td>
<td>241.71 ± 198.25</td>
<td>0.772</td>
</tr>
<tr>
<td>Platelet count (10⁹/L)</td>
<td>212.19 ± 129.36</td>
<td>99.38 ± 58.57</td>
<td>185.33 ± 125.14</td>
<td>0.058</td>
</tr>
<tr>
<td>Consciousness disturbance</td>
<td>1 (6.25)</td>
<td>4 (80)</td>
<td>5 (23.8)</td>
<td>0.0027</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>1 (6.25)</td>
<td>3 (60)</td>
<td>4 (19.0)</td>
<td>0.002</td>
</tr>
<tr>
<td>Shock</td>
<td>1 (6.25)</td>
<td>2 (40)</td>
<td>3 (14.3)</td>
<td>0.128</td>
</tr>
<tr>
<td>Macrohematuria</td>
<td>2 (12.5)</td>
<td>1 (20)</td>
<td>3 (14.3)</td>
<td>1.000</td>
</tr>
<tr>
<td>Radiologic type I/II</td>
<td>5/11</td>
<td>2/3</td>
<td>7/14</td>
<td>1.000</td>
</tr>
</tbody>
</table>

*Data presented as mean ± standard deviation or n (%).

Table 3. Comparison between Group 1 and Group 2 patients with emphysematous pyelonephritis*

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Group 1 (n = 14)</th>
<th>Group 2 (n = 7)</th>
<th>Total (n = 21)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platelet count (10⁹/L)</td>
<td>155.5 ± 126.158</td>
<td>245.0 ± 107.17</td>
<td>185.33 ± 125.14</td>
<td>0.073</td>
</tr>
<tr>
<td>Consciousness disturbance</td>
<td>5 (35.7)</td>
<td>0 (0)</td>
<td>5 (23.8)</td>
<td>0.123</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>3 (21.4)</td>
<td>1 (14.3)</td>
<td>4 (19.0)</td>
<td>1.000</td>
</tr>
<tr>
<td>Radiologic type I/II</td>
<td>5/9</td>
<td>2/5</td>
<td>7/14</td>
<td>1.000</td>
</tr>
<tr>
<td>Hospitalization (d)</td>
<td>34.11 ± 14.41</td>
<td>31.43 ± 14.65</td>
<td>32.94 ± 14.09</td>
<td>0.672</td>
</tr>
<tr>
<td>Mortality</td>
<td>5 (35.7)</td>
<td>0 (0)</td>
<td>5 (23.8)</td>
<td>0.124</td>
</tr>
</tbody>
</table>

*Data presented as mean ± standard deviation or n (%).
most commonly (19/21 patients, 90.5%) isolated microorganisms. *Candida* and β-hemolytic streptococci were also isolated.

**Patient management, outcome and prognostic factors**

There were 14 patients in Group 1 and seven in Group 2. The percentages of type I and type II EPN were 35.7% (5/14) and 64.3% (9/14), and 28.5% (2/7) and 71.5% (5/7) in Groups 1 and 2, respectively. The overall mortality and the mortalities in Group 1 and Group 2 were 23.8%, 35.7% and 0%, respectively. The mortalities in patients with type I EPN and type II EPN were 28.5% and 21.4% (p = 1.00), respectively. The durations of hospitalization of the survivors in Group 1 and Group 2 were 34.11 ± 14.41 days and 31.43 ± 14.65 days (p = 0.67), respectively. There were no statistically significant differences between the two groups in terms of mortality, duration of hospitalization, or other prognostic factors (Table 3), although patients in Group 1 had a relatively lower platelet count (155.5 ± 126.158 × 10⁹/L, p = 0.07). Additionally, no patient who received nonsurgical treatment required dialysis, although three patients who underwent nephrectomy required dialysis (p = 0.03).

Although there were no significant differences in prognostic factors between these two groups, most patients with initial consciousness disturbances (5/5, 100%), underlying congestive heart failure (3/4, 75%) or thrombocytopenia (8/9, 90%) were inoperable and were thus included in Group 1. These factors contributed to the mortality, especially in Group 1 patients.

There were no statistically significant differences between the survivors and nonsurvivors with respect to most prognostic factors (Table 2), except for four patients with underlying congestive heart failure (p = 0.02) and five patients who initially presented with consciousness disturbances (p < 0.01) and who had higher mortalities. Nonsurvivors also had lower platelet counts (99.38 ± 58.57 × 10⁹/L, p = 0.06), though this difference was not statistically significant.

**DISCUSSION**

EPN is an uncommon infectious process that deserves special attention because of its high mortality [1]. EPN affects women more commonly than men, presumably because of their increased susceptibility to urinary tract infections [6]. Factors involved in the pathogenesis of EPN include high levels of tissue glucose and impaired host immunity, the presence of glucose-fermenting bacteria (gas-forming coliform bacteria such as *E. coli* and *K. pneumoniae*), impaired tissue perfusion, and obstruction of the urinary tract [15,16]. These may explain why most patients are poorly-controlled diabetics, and why *E. coli* and *K. pneumoniae* are the most commonly isolated organisms. EPN can also be encountered in non-diabetics or in well-controlled diabetic patients suffering from immunodeficiencies resulting from conditions such as alcoholism, liver cirrhosis, renal grafting, or in patients with obstructive uropathy [2,6].

Because no specific symptoms, signs, or laboratory data can be used to distinguish EPN from other upper urinary tract infections, further investigations using a variety of imaging studies such as CT should be initiated, especially in diabetic patients thought to have uncomplicated pyelonephritis but with a poor response to antibiotic therapy [3,6].

Treatment of EPN has been controversial (Table 1) [1,2,6–14]. The majority of studies have reported on the management of EPN with nephrectomy. For example, Shokeir et al recommended nephrectomy immediately after vigorous rehydration, intravenous antibiotics and control of blood sugar, and suggested that nephrectomy should not be delayed, even if the patient begins to improve [6]. They found that PCD combined with medical therapy was unable to preserve renal function or reduce morbidity [6]. However, more conservative management of patients with EPN has been proposed [1,7,10–14]. Wan et al identified two distinct radiologic types of EPN: type I and type II [1]. It is important to differentiate between these due to prognostic differences: type I has a fulminant clinical course and a subsequently poor prognosis, while type II has a slower clinical course and a better outcome. Wan et al suggested that emergency nephrectomy was the optimal treatment method for type I EPN. PCD is indicated for patients with perirenal or unilocular renal abscesses, and nephrostomy is indicated for gas in the collecting system with obstructive uropathy [1]. Chen et al described their experience of treating 25 EPN patients over the course of 10 years [7]. Of the 25 patients, 80% required only conservative treatment. Huang and Tseng classified their EPN patients into four classes according to the extent of the lesions on CT images: within the collecting system.
include thrombocytopenia, impaired renal function, the management of EPN. These prognostic factors can affect the comparative evaluation and outcome of different treatment strategies for the management of EPN. They demonstrated that patients in classes 1 and 2 survived after combined PCD and antibiotic treatment and could have preserved renal function. For patients in classes 3 and 4 with more than two risk factors, nephrectomy provided the best outcome [8]. Abdul-Halim et al [10] and Soo Park et al [11] suggested that early nephrectomy offered the best outcome, and that PCD should be reserved for inoperable patients. Aswathaman et al [13] and Somani et al [14] recommended that PCD should be part of the initial treatment of patients with EPN, and that nephrectomy may be required in some patients, such as those with high risks.

Surgeons who prefer nephrectomy consider that, when the abscess is confined within Gerota’s fascia, nephrectomy following nonsurgical treatment will rapidly control sepsis and reduce the duration of hospitalization. It is believed that aggressive EPN will impair tissue perfusion and cause extensive infarction, resulting in a reduced blood supply and subsequent failure of leukocytes and antibiotics to reach the affected area. The affected tissue can be removed en bloc with less manipulation so reducing the chance of the septic source spreading into the blood stream.

Other clinicians prefer vigorous hydration, intravenous antibiotics and PCD, with control of blood sugar if a patient has DM, and percutaneous nephrostomy is indicated if obstructive uropathy is present. The role of interventional radiologists in the conservative treatment of EPN cannot be overlooked. Experienced radiologists are required to place the drainage tube in the right location, irrigate the catheter and suck out the debris frequently, to search for non-communicating abscess cavities and to carefully evaluate indications for further PCD catheter insertion. All these measures contribute to the success of conservative treatment of EPN.

Although no patients who underwent nephrectomy died in our study, these results may be biased, because some patients who were treated medically did not undergo surgery due to inherent risks, such as disseminated intravascular coagulopathy, hemodynamic instability, or a rapid clinical course with multiple organ dysfunction. Consequently, several prognostic factors can affect the comparative evaluation and outcome of different treatment strategies for the management of EPN. These prognostic factors include thrombocytopenia, impaired renal function, macrohematuria, disturbances of consciousness, shock, and type I EPN. In comparison with type II EPN, patients with type I EPN tend to have a defective immune reaction with disseminated intravascular coagulation, leading to renal thrombosis and a poor prognosis [9]. Macrohematuria implies severe necrosis or destruction of the kidney due to the infectious process and the presence of renal vein thrombosis [9].

In our study, two prognostic factors—disturbances of consciousness and congestive heart failure—showed statistically significant differences between survivors and nonsurvivors. Congestive heart failure has not previously been proposed as a prognostic factor, but it may be indicative of poor autoregulatory cardiovascular function when encountering septic complications. Platelet counts differed between survivors and nonsurvivors, though the difference was not statistically significant. Although the differences in prognostic factors between patients in Group 1 and Group 2 were not significant, patients with initial presentations of consciousness disturbances, thrombocytopenia, or a history of congestive heart failure might have contributed to the mortality of Group 1 patients.

Nephrectomy cannot preserve renal function, but nonsurgical treatment can allow for preserved renal function if the kidney has not been overwhelmingly destroyed by the disease. Under modern intensive care with liberal use of antibiotics and the innovative techniques of PCD and PCD revision, successful conservative treatment of EPN has been increasingly reported [2,13,14]. In our study, we found that conservative treatment could successfully treat patients with EPN while preserving most of their renal function, except in five patients who had more than two of the three risk factors (disturbances of consciousness, thrombocytopenia or a history of congestive heart failure) and who were all inoperable.

In comparison with nephrectomy, a shortcoming of nonsurgical treatment is that multiloculated abscesses may be present in patients with EPN, which may require more than one drainage tube for adequate drainage, or may need repeated revision with irrigation and suction of the debris under fluoroscopic guidance. Moreover, more than one CT examination may be indicated to evaluate non-communicating abscesses. All these procedures increase the costs of medical treatment.

Our study was limited by: (1) small sample size that may have led to an inability to detect statistically
significant differences in mortality between patients with type I and type II EPN, in some prognostic factors between Groups 1 and 2, or between survivors and nonsurvivors; (2) this was a retrospective review study and there was no randomized control. However, because EPN is an uncommon disease and several factors can affect the outcomes, a fully randomized study is difficult to conduct.

Although the sample size in our study was small, the use of suitable statistical analyses allowed us to demonstrate that intensive medical control, combined with adequate drainage, was an effective alternative modality for the management of patients with EPN, allowing the preservation of renal function without prolonging the duration of hospitalization. Inoperable patients with poor prognostic factors, including underlying heart failure, initial presentation with consciousness disturbances, or thrombocytopenia, need more vigorous hydration combined with antibiotic therapy, control of blood sugar, and aggressive PCD with/without nephrostomy to improve their treatment outcomes and reduce mortality.

REFERENCES


產氣性腎盂腎炎治療方法及其預後之再評估

林維卿 陈永芳 林建亨 何永仁 曾元宏 蒋貴嘉
张兆祥 鄭宜昌 沈武忠 陳中和
中國醫藥大學附設醫院 放射線部
中國醫藥大學 臨床醫學研究所 生物醫學影像暨放射科學學系
仁愛醫學社團法人中仁愛醫院 小兒科
林新醫院 放射科
南投基督教醫院 放射科

此研究之目的在比較產氣性腎盂腎炎的各種治療方法及其預後和預後的因子。自 1996 年九月到 2005 年八月期間，共有 21 位罹患產氣性腎盂腎炎的病人被納入此研究中。我們將這些病人分為兩組：第一組病人是接受保守治療帝王內科治療，同時有無合併經皮導管引流術；第二組病人是在接受保守治療後接受患側腎腫切除術。最後利用統計分析的方法來比較預後因子在生存者及非生存者間的差異，以及在生存者中第一組和第二組病人間的差異。第一組病人共有 14 位，第二組病人共有 7 位。其死亡率在第一組病人是 35.7% 在第二組病人是 0% (p = 0.12)。而預後因子分析在這二組病人並無統計學上的差異，除了第一組的病人血液中有相對比較低的血小板數 (p = 0.07) 及第二組病人在接收患側腎腫切除術後有比較高的機會需要接受長期的透析治療 (p = 0.03)。在比較生存者及非生存者間的差異時發現，病人若合併有充血性心腫衰竭或一開始就呈現意識混亂的病人死亡率較高 (p = 0.02 及 p < 0.01)。同時非生存者血液中有比較低的血小板數 (p = 0.06)。結論是：內科治療同時有無合併經皮導管引流術可以是治療產氣性腎盂腎炎的替代治療方式；然而若病人合併有充血性心腫衰竭或一開始就呈現意識混亂或血液中有比較低的血小板數的病人，需要施行更積極的經皮導管引流術。

關鍵詞：產氣性腎盂腎炎，腎腫切除術，經皮導管引流術
( 高雄醫誌 2009;25:16-24)