Bilateral Emphysematous Pyelonephritis Associated with COVID Pneumonia: A Case Report

Slaviša Savić
Tadija Pejović
Nataša Savić

Corresponding Author: Slaviša Savić, e-mail: drsavics@yahoo.com, drsavicsasa@gmail.com

Background: Optviral pneumonia and bilateral emphysematous pyelonephritis create a rapid acute respiratory distress syndrome.

Case Report: A 59-year-old diabetic man with altered awareness was admitted as an emergency due to fever, shivering, and pain in the lap. Based on the accurate diagnosis, we concluded that the patient had bilateral emphysematous pyelonephritis, as well as inflammatory changes in the lung parenchyma caused by coronavirus infection (SARS-CoV-2). Active therapy – nephrectomy – was ruled out due to the late detection of the gas collection in the kidneys, as well as the general condition caused by respiratory symptoms. With symptomatic, supportive, and antimicrobial therapy, such as percutaneous renal drainage, renal abnormalities improved. Unfortunately, the virus-induced parenchymal inflammation progressed and proved fatal. The inflammatory process in the urothelial cell is most likely where the linkage and potentiation of COVID-19 infection and emphysematous pyelonephritis begins. Local inflammation that obstructs the movement of the generated gas is one of the hypothesized processes of emphysematous pyelonephritis. The renal and urothelial tubular cells contain the angiotensin-converting enzyme II (ACE2) receptor, which is used by the SARS-CoV-2 virus to enter human cells and may be a risk factor for simultaneous and direct viral injury to urinary tract cells. Sepsis was most likely caused by viral pneumonia, based on the resolution of changes in the kidneys.

Conclusions: The combination of EPN and COVID-19 is difficult to treat. Despite multidisciplinary treatment, it has been linked to a worse prognosis and fatal outcome.

Keywords: Case Reports • Pyelonephritis • Diabetes Mellitus • COVID-19

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Patient: Male, 59-year-old
Final Diagnosis: Septic shock
Symptoms: Septic shock
Medication: —
Clinical Procedure: CT scan • hemodialysis • mechanical ventilation support • PCN • PCR
Specialty: Urology
Objective: Unusual clinical course

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Background

Emphysematous pyelonephritis (EPN) requires immediate, aggressive, general surgical treatment. Gas buildup in the kidney and perirenal region characterizes this necrotic parenchymal kidney infection [1].

EPN was first reported in the ninth century, and the term also describes the core pathogenic process [2]. Women, diabetics, and individuals with urinary tract blockage, as well as the immunocompromised, are at risk. Diabetes patients have a 6-fold increased risk [3], which can be explained in part by the presence of glucose in the tissues, alterations in tissue perfusion, and an insufficient immunological response [4].

Hyperglycemia, a proclivity for necrosis of urinary tract cells due to stress or infection, and a weakened immune system due to chronic kidney disease are all thought to be factors that promote bilateral emphysematous pyelonephritis (BEPN) in diabetics. One explanation of gas formation mechanisms in emphysematous infections involves the production of carbon dioxide (CO₂) by enzyme-producing microorganisms, which further convert acids to CO₂ when the pH reaches 6 or lower, and fermentation conditions of high glucose concentration in urine and tissues, which actually lowers pH in tissues due to acid accumulation. It should be noted, however, that urinary lactose or tissue proteins can also act as substrates for gas formation. Rapid catabolism, which increases gas production, is part of the pathogenesis of gas bubble formation. Gas accumulation raises local pressure and can cause infarction of neighboring tissues, which can serve as a good culture medium for gas-producing pathogens, increasing the gas transport barrier and creating a vicious circle [5,6]. As a result, patients with urinary tract structural abnormalities and urolithiasis are more likely to develop this type of infection [6].

This condition is only mentioned in the context of adults. E. coli was the most prevalent bacteria recovered from blood and urine, followed by Enterococcus species, Klebsiella pneumoniae, Pseudomonas aeruginosa, Pseudomonas aeruginosa, and Candida species [7].

Simultaneous inflammatory processes in both kidneys are uncommon (10% of all EPNs), but it is evident that bilateral gas inflammation raises the risk of complications in terms of acute renal function impairment and septic state, which causes and consequently increases risk of mortality. According to statistics, up to 33% of all people are overweight [8,9].

Early diagnosis and initiation of effective and optimal medical treatment, as well as an adequately scheduled surgical intervention, leads to a better prognosis and may potentially prevent progression, even leading to cure of the patient with this type of kidney infection.

Many people with urological disorders, both malignant and benign in nature, are now infected with SARS-CoV-2. Because of the nature of this pandemic disease and the medical system’s load of caring for a huge number of COVID-19 patients, we have seen patients who are aware of the basic urological condition and seek medical care in the later stages of the disease. Treatments must be modified and adapted to the current situation.

Case Report

In this paper, we present a patient with bilateral EPN and SARS-CoV-2 pneumonia. He was transferred from another hospital where he had been receiving care for 3 days before being admitted to our hospital.

The anamnestic data acquired were insufficient, given his severe general state, changed mental status, and requirement for aggressive oxygen replacement therapy. He had a tooth surgically removed 5 days before admittance to the hospital, according to previous documents. He had been diabetic for many years, and his blood sugar was kept under control with oral hypoglycemics. The patient was febrile, adynamic, anxious, and confused during his previous hospitalization. Increased white blood cell counts, high CRP levels, hyperglycemia, and nitrogenous compounds in the blood were discovered during a laboratory examination.

Rehydration, supportive and symptomatic medication, and empirical antibiotic therapy were all administered. During the 3-day hospitalization at the regional health center, the patient received Longacef/ceftaxime at a dose of 2 g/24 h in combination with marocen/ciprofloxacin/500 mg/12 h. Antibiotic therapy was changed immediately after admission to our hospital, taking into account the risk of potential dysglycemics. The patient was febrile, adynamic, anxious, and confused during his previous hospitalization. Increased white blood cell counts, high CRP levels, hyperglycemia, and nitrogenous compounds in the blood were discovered during a laboratory examination.

A neurologist was called because of the changed state of consciousness and sought medical care in the later stages of the disease. Treatments must be modified and adapted to the current situation.
Lumbar discomfort was discovered during an abdominal examination. Leukocytosis, anemia, thrombocytopenia, metabolic acidosis, dyselectrolytemia, hyperglycemia, and acute renal failure with the uremic syndrome were discovered in the blood tests (Table 1). Before intubation, the gases were: pH 7.5; pCO₂ 28 mmHg; pO₂ 60 mmHg; Glyc 19.1 mmol/L; K 4.8 mmol/l; Lac 4 mmol/L; sO₂ 82%. Respiratory rate was 35 breaths per minute (tachydyspnoeic, with poor respiratory mechanics). Due to peripheral saturation (70%), a respiratory rate of 35/min, a poor state of consciousness, and respiratory rhythm disorders, the patient was placed on the most aggressive form of non-invasive ventilation (NIV) upon admission.

An ultrasound examination of the abdomen and pelvis revealed enlarged kidneys with edematous parenchyma and a large number of hyperechoic areas in the parenchyma, indicating the presence of intraparenchymal gas.

An urgent computed tomography scan of the chest, abdomen, and pelvis was conducted after further evaluation. The CT scan of the lungs revealed bilateral basal zone lung parenchyma consolidation, compressive atelectasis, and bilateral pleural effusions with a diameter of 31 mm and a density of clear liquid (Figure 1).

Abdominal CT revealed bilaterally enlarged kidneys with voluminous, inhomogeneous parenchyma, some signs of necrosis with pronounced vascular structures, larger irregular gas particles in the parenchyma next to the perirenal capsule, and extrarenal extension subfascial, more pronounced on the left kidney (Figures 2, 3). It does not emit a contrast agent. Acute renal failure symptoms can also be seen.

### Table 1. Laboratory analyses at hospital admission.

| Parameter       | Value            |
|-----------------|------------------|
| Leukocytes      | 24×10⁹/L         |
| Erythrocytes    | 4.24×10¹²/L      |
| Hemoglobin      | 123 g/L          |
| Platelets       | 56×10⁹/L         |
| Na              | 141 mmol/L       |
| K               | 4.9 mmol/L       |
| Urea            | 39 mmol/L        |
| Creatinine      | 820 umol/L       |
| ALT             | 45 IU/L          |
| AST             | 65 IU/L          |
| CRP             | 229.9 mg/L       |
| Glucose         | 24 mmol/L        |
| Procalcitonin   | >200 ng/mL       |

Figure 1. CT of the lung shows bilateral consolidation of the lung parenchyma of the basal zone, bilateral pleural effusions, and compressive atelectasis.

Figure 2. CT of the abdomen reveals bilaterally enlarged kidneys with signs of necrosis, irregular gas particles, and extrarenal enlargement of the process.

Figure 3. CT exam revealed bilateral emphysematous pyelonephritis type 4 according to the Huang-Tseng classification.
Because the patient’s general condition was extremely poor due to poor hemodynamic status secondary to associated sepsis, it was decided to postpone active treatment in consultation with anesthesiologists and internists. We began with intensive supportive therapy and resuscitation techniques. It was decided to intubate and link to mechanical ventilation because the patient was in a state of acute sepsis and multiorgan failure. Active treatment in septic circumstances and hemodynamic instability was not a current treatment choice after consultation with anesthesiologists and internists.

He was medicated, hemodynamically unstable, and on vasopressor support all of the time. Treatment included fluid resuscitation, electrolyte management, and ionotropic support, as well as empirical triple broad-spectrum antibiotic therapy (carbapenems with aminoglycosides and metronidazole, in doses tailored to renal insufficiency). An insulin infusion was used to help him manage his diabetes. Upon admission, blood and urine cultures were obtained for bacteriological investigation.

A 2-volume central venous catheter for hemodialysis was inserted due to the bilateral presentation, oligoanuria, and azotemia. The patient was admitted to hemodialysis by the nephrologist. Cultures of blood and urine were also collected. Hemodialysis was used to treat acute renal failure and hyperkalemia, with laboratory values being monitored daily. During his stay in the hospital, he had 8 hemodialysis treatments.

The day after hospitalization, a percutaneous kidney puncture was conducted. After 3 days, the patient’s infectious status and renal function improved, as evidenced by an increase in diuresis (about 35 ml per hour), afebrile state, improved laboratory test results (Table 2), and hemodynamic stability.

The presence of gas implies that there is an active infection and that antibiotic medication is ineffective. Daily repeated control echotomography of the abdomen in our patient revealed improvement in the local findings, as well as regression of the inflammatory process and gas inclusions.

Based on the results of bacteriological parameters (urine and blood culture results showed the presence of *Klebsiella pneumonia* in urine, and *Citrobacter* and *Candida albicans* in the blood), as well as antimicrobial susceptibility testing, and antibiotic treatment was switched. Imipenem and metronidazole were given, along with colistin, tigecycline, and caspofungin. The metabolic imbalance was progressively resolved. From the start of his hospitalization and for the next 10 days, he received imipenem 500 mg/8 h, metronidazole 500 mg/8 h, colistin 2 000 000/8 h, tygacil 50 mg/12 h, and caspofungin was dosed so that he received 70 mg i.v. infused on the first day, followed by 50 mg i.v. 4 times a day for 7 days as a maintenance dose.

Unfortunately, 6 days after admission, his overall state and laboratory test results deteriorated (Table 3), along with recurring fever, cardiac instability, and poor respiratory function.

Despite the disappearance of the local finding in the kidneys, daily bedside radiographic images of the lungs showed severe inflammatory changes bilaterally involving a large area of the lung parenchyma, indicating progression of bilateral pneumonia compared to previous findings, with no signs of pneumothorax or pneumomediastinum (Figures 4, 5).

**Table 2.** Laboratory analyses 4 days after admission to the hospital.

| Leukocytes      | 16.5×10⁹/L |
|-----------------|------------|
| Erythrocytes    | 4.58×10¹²/L|
| Hemoglobin      | 133 g/L    |
| Platelets       | 149×10⁹/L  |
| Na              | 141 mmol/L |
| K               | 5.0 mmol/L |
| Urea            | 47.6 mmol/L|
| Creatinine      | 795 μmol/L |
| ALT             | 27 IU/L    |
| AST             | 52 IU/L    |
| CRP             | 77.5 mg/L  |
| Glucose         | 7.7 mmol/L |
| Procalcitonin   | 20 ng/mL   |

**Table 3.** Laboratory analyses on the ninth day after hospital admission.

| Leukocytes      | 43.2×10⁹/L |
|-----------------|------------|
| Erythrocytes    | 2.7×10¹²/L |
| Hemoglobin      | 78 g/L     |
| Platelets       | 244×10⁹/L  |
| Na              | 136 mmol/L |
| K               | 5.3 mmol/L |
| Urea            | 35.7 mmol/L|
| Creatinine      | 457 μmol/L |
| ALT             | 10 IU/L    |
| AST             | 52 IU/L    |
| CRP             | 366.6 mg/L |
| Glucose         | 7.9 mmol/L |
| Procalcitonin   | 25.3 ng/mL |
| IL-6            | >1000 pg/mL|

Leukocytes — the number of leukocytes per cubic meter; Erythrocytes — the number of erythrocytes per cubic meter; Hemoglobin — the hemoglobin level; Platelets — the number of platelets per cubic meter; Na — sodium; K — potassium; Urea — urea; Creatinine — creatinine; ALT — alanine aminotransferase; AST — aspartate aminotransferase; CRP — C-reactive protein; Glucose — blood glucose; Procalcitonin — procalcitonin; IL-6 — interleukin 6.
As a result of refractory hypoxia, the disease's clinical course was marked by deterioration of respiratory function and cardiorespiratory arrest. Unfortunately, the resuscitation efforts were ineffective, and the patient died.

**Discussion**

A potentially fatal, acute, progressive, necrotizing EPN, which is more frequently recognized now thanks to the use of computed tomography in diagnosis, is typically discovered after finding gas (carbon dioxide) in the kidney, which is attributable to bacterial activity (fermentation). The majority of patients are women (4:1), diabetics, and those with metabolic syndrome. Pathogenesis is a great model for immune response and tissue perfusion capacity [10-12].

Two EPN classifications are currently available in the literature based on CT findings. According to Huang and colleagues’ classification, which proposed 4 classes of EPN, the finding in our patient belonged to Class 4. According to the classification of Wan et al, the finding in our patient were Type II EPN: the presence of renal or perirenal fluid with a bubbly gas pattern, or the presence of gas in the collecting system [13,14].

In diabetics, timely identification and prompt treatment of urinary tract infections are important aspects of disease management. Thrombocytopenia, hypoalbuminemia, acute renal failure, altered mental status, polymicrobial infection, and, of course, shock can all be assessed using radiological categorization to determine the severity and dynamics of the disease [3,15].

The treatment protocol for these patients shifts from a conservative approach using antibiotic therapy with renal drainage (percutaneously or stent), which is predicted to lower antibiotic concentrations in the tissue by reducing gas while still improving tissue perfusion, to nephrectomy. For nephrectomy, powerful antibiotic therapy is becoming a more viable alternative [16,17].

For these individuals, bilateral nephrectomy is unquestionably a life-saving procedure. With medical therapy alone, it is not possible to have excellent control of the disease’s fulminant course. On the other hand, renal drainage and conservative therapy are directly associated with survival rates, whereas emergency nephrectomy remains the final and most difficult option in situations when the septic state must be treated first [15,18-20].

So far, the most prevalent cause of EPN has been identified as *Escherichia coli*, although there has also been mention of *Proteus mirabilis*, *Klebsiella pneumoniae*, Group D *Streptococcus*, and coagulase-negative *Staphylococcus* as causative agents in the literature and in practice. However, new research shows that EPN can be caused by a combination of *Candida parapsilosis* and *Finegoldia magna* infections. *Finegoldia magna*, on the other hand, can cause urinary tract infections, necrotizing pneumonia, infective endocarditis, and meningitis as an opportunistic anaerobic gram-positive pathogen. When EPN is suspected, research indicates that even less common etiological agents should be examined as probable causative agents. Keeping this in mind, when developing an antibiotic protocol, drugs that cover unusual strains of bacteria and fungi as potential causes of this infection should be used. One of the most important implications of recent studies is that suprapubic aspiration may be recommended in the specific circumstances of

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**Figure 4.** Severe inflammatory changes bilaterally involving a large area of the lung parenchymal.

**Figure 5.** Progression of bilateral pneumonia on lung radiography compared to previous findings.
COVID-19, chronic infections, immunosuppression, comorbidities, advanced age, or after urological tract manipulations and/or negative culture results for common uropathogens grown in aerobic and anaerobic conditions, or UKU, but in media that supports relatively slow-growing anaerobic cocci [21-23].

Our case study features an obese middle-aged patient with diabetes who, as a first step in the progress of the condition, had dental intervention in the form of a simple, conventional tooth extraction. The wound in the mouth, we believe, was the beginning of the body’s inflammatory reaction cascade. Clinicians in the regional center of the small town in the early days of the pandemic misunderstood his condition as a neurological disease. He tested positive for SARS-CoV-19 after developing a fever, and was subsequently moved to our hospital, which was in the COVID-19 care system at the time. After evaluation by an internist, neurologist, anesthesiologist, and radiologist/diagnostician in our patients’ admission service, it was discovered that bilateral emphysematous pyelonephritis had developed. The occurrence of 2 major inflammatory disorders was coincidental, but it made urothelial cells more vulnerable to infection with SARS-CoV-2, complicating the patient’s overall condition due to altered state of consciousness, and no kidney infection was recognized.

Infection spreads through the bloodstream. Septic shock with oliguria increases the chance of death by 54% [24]. Despite these challenges, our medical team understood that early diagnosis, comprehensive treatment, and proper and rigorous therapy play a critical role in the course and outcome of this disease. Concomitant COVID-19 pneumonia was undoubtedly the reason why nephrectomy was not performed, which could have saved the patient’s life.

Pulmonary and thrombotic problems account for the increased rate of postoperative mortality and complications in SARS-CoV-2-positive patients who had to be operated on due to diverse diseases. There is currently a trend toward a cautious approach, non-operative treatment, or delaying surgical treatment. Of course, surgical intervention should only be considered for patients who will clearly benefit more from it in comparison to the danger of postoperative problems. Perhaps the underlying danger of exposure to healthcare personnel during the operative and particularly in the perioperative period should be considered to some extent when choosing surgical therapy in a COVID-19 patient. In the current COVID-19 pandemic, it may be critical to identify patients likely to have undeniable benefits from surgical treatment [25].

Conclusions

For both EPN and COVID-19, the course and prognosis are unknown and difficult to predict. As a result, each of these infections is quite dangerous on its own, and the combination of them is a major life-threatening condition.

A CT scan indicated bilateral emphysematous pyelonephritis and bilateral interstitial pneumonia in our patient. This case report shows that late diagnosis of EPN, especially when other morbidities are present, can result in rapid progression and development of septic shock, sudden acute respiratory distress syndrome, or multiple organ dysfunction syndromes. The combination of bilateral EPN with COVID-19 is a more severe illness, with a worse prognosis and potentially deadly results.

Declaration of Figures’ Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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