

A Rare Case of *Staphylococcus Aureus* Causing Emphysematous Cystitis

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Abstract

Background. Emphysematous cystitis (EC) is a rare complication of urinary tract infections commonly seen in the setting of uncontrolled diabetes mellitus and most commonly caused by gas-producing bacterium such as E Coli, Klebsiella pneumoniae, and Clostridium perfringens. Very rarely has it been caused by gram-positive bacterium such as Staphylococcus aureus. This case report details the presentation of a 61-year-old patient with uncontrolled diabetes mellitus who developed EC due to Methicillin-Resistant Staphylococcus Aureus bacteremia. Not only is this an uncommon bacteria found in the urinary tract, but it rarely produces gas. After being treated with broad spectrum antibiotics, she experienced multiple complications with S aureus seeding and was ultimately lost to follow-up. This case raises the question of incorporating gram-positive antibiotic coverage, like vancomycin, early on in the treatment of EC despite the more common causative pathogens being gram-negative.

Key words: emphysematous cystitis, urinary tract infection, antibiotics

A 61-year-old woman with a medical history of type 1 diabetes mellitus on insulin pump, coronary artery disease (CAD) status post-coronary artery bypass graft (CABG), gastroesophageal reflux disease, Hashimoto thyroiditis, hypertension, and osteoporosis presented to the emergency department (ED) after 3 days of nausea, vomiting, and diarrhea. The vomiting was nonbloody, nonbilious and occurred after

every meal and attempt at oral hydration. It was associated with nonbloody diarrhea, with three episodes per day before presentation. She reported mild periumbilical abdominal pain and associated dyspnea on exertion secondary to the abdominal pain. She denied dysuria, hematuria, urinary hesitancy and urgency, chest pain, headache, dizziness, fever, and chills. She denied recent travel and expo-

sure to COVID-19 (as the presentation was amid the SARS-CoV-2 pandemic).

The patient reported that she saw an endocrinologist for diabetes and hypothyroidism. Her most recent hemoglobin A1c level was 11.8% (approximately 5 months prior). She stated that she intentionally kept her glucose level high because she experienced undesirable symptoms at a level of 100. She also saw a cardiologist for her CAD and history of post-CABG 1 year prior.

Physical examination

Upon evaluation in the ED, the patient was awake, alert, and oriented to person, place, and time. She did not appear in distress. Her mucous membranes appeared dry with no apparent injury or lesions.

Lung examination was clear to auscultation bilaterally with normal breath sounds and good chest expansion. she was tachycardic, with regular rhythm, normal S1 and S2. Her abdomen was nondistended and soft, with mild diffuse tenderness to

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Figure 1. CT of the abdomen and pelvis (coronal view) shows extensive intramural gas in the urinary bladder, demonstrating emphysematous cystitis. There is a small amount of extraluminal gas anterior to the urinary bladder which is likely due to extension of intramural gas into the adjacent soft tissue; however, a contained perforation was not excluded.

palpation with no rebound tenderness or guarding. She had no palpable masses or organomegaly.

On musculoskeletal examination, the patient had tenderness to her lumbar spine with decreased range of motion that she stated was ongoing for the last 2 months. The exam of her integumentary system showed a healing ulcer on her left great toe, a splinter under the second digit of her right hand, and insulin injection sites on her abdomen.

The patient's vitals were as follows: temperature 38.7°C, heart rate 121 beats per minute, respiratory rate 33 breaths per minute, blood pressure 161/72, and oxygen saturation level of 100% on room air.

Laboratory testing

Laboratory values revealed mild leukocytosis (white blood cell count, $12.0 \times 10^9/L$), mild anemia (hemoglobin concentration level, 11.5 g/dL), mild hyponatremia (blood sodium level, 128 mEq/L), acute kidney injury with a serum creatinine level of 1.45 mg/dL (baseline of 0.7 mg/dL), hypocalcemia (serum calcium concentration, 8.1 mg/dL), and lactic acidosis (blood lactate level, 2.9 mmol/L). The remainder

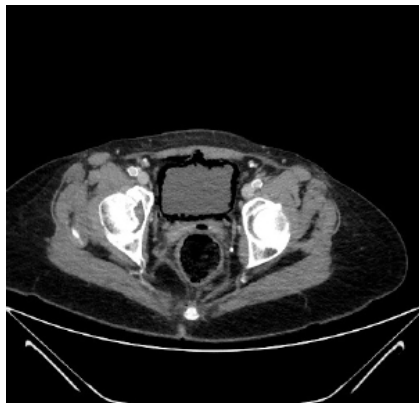


Figure 2. CT of the abdomen and pelvis (axial view) shows extensive intramural gas in the urinary bladder demonstrating emphysematous cystitis. There is a small amount of extraluminal gas anterior to the urinary bladder, which was likely due to extension of intramural gas into the adjacent soft tissue; however, a contained perforation was not excluded.

of her laboratory workup was largely unremarkable, including negative troponins and negative COVID-19 PCR testing.

Diagnostic testing

At this time, blood cultures were drawn. Given shortness of breath and tachycardia, a computed tomography (CT) chest scan was completed, which ruled out pulmonary embolism. An abdomen and pelvis CT scan was significant for extensive intramural gas in the urinary bladder, signaling a concern for emphysematous cystitis, with small amounts of extraluminal gas anterior to the urinary bladder—likely due to extension of intramural gas, but perforation could not be excluded (Figures 1 and 2).

Treatment and management

The patient was given acetaminophen, morphine, and ondansetron while in the ED. Her pain and shortness of breath improved. She was given a 3 L normal saline bolus with broad-spectrum antibiotic coverage with piperacillin/tazobactam. A foley catheter was placed due to difficulty urinating. A urine culture was taken but showed no growth since she had been treated with piperacillin/tazobactam. She was transferred to the medical floor for



Figure 3. CT of the abdomen and pelvis (coronal view) shows redemonstration of emphysematous cystitis 24 hours after initiation of intravenous antibiotic therapy with piperacillin/tazobactam.

further workup and treatment.

On the first day of hospital admission, blood cultures resulted in 2 out of 2 positive for gram-positive cocci in clusters. Vancomycin was added to her antibiotic therapy. An echocardiogram was completed to rule out vegetation in the setting of gram-positive bacteremia and was negative. An infectious disease specialist was consulted, who recommended the continuation of the vancomycin. In the setting of possible contained perforation, the general surgery department was consulted and determined no need for surgical intervention.

On the first night of the hospital stay, the patient reported continuous low back and abdominal pain and was taken for a CT scan. There were no acute issues seen on imaging nor worsening of emphysematous cystitis; in fact, the cystitis had improved (Figure 3) with approximately 24 hours of intravenous antibiotic therapy. Subsequent urine cultures were obtained to determine a second source of the emphysematous cystitis; however, urine cultures remained with no growth.

As the patient continued to report lumbar pain, magnetic resonance imaging (MRI) of the lumbar spine was performed to determine the source of pain. There was concern of spinal abscess in the setting of methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia, as 4 out of 4 blood cultures were positive. MRI revealed

L4/L5 spondylolisthesis and disc herniation with flattening of the thecal sac. No abscesses were seen in the lumbar spine at this time.

Because 8 out of 8 cultures returned positive for MRSA bacteremia, the decision was made to increase antibiotic coverage to daptomycin and ceftaroline. The patient was taken for an MRI with contrast of the sacrum and coccyx, which showed discitis and abscess with mild cord compression. Laminectomy and microdiscectomy were performed, without complication, to evacuate the epidural abscess and remove infected disc tissue.

During the hospital stay, controlling the patient's glucose level was a major concern as she typically used an insulin pump but kept her glucose levels elevated for personal reasons. The decision was made to discontinue the insulin pump and control her glucose with basal insulin and sliding scale insulin to keep blood glucose less than 200, as this would aid in the resolution of the bacteremia.

A peripherally inserted central catheter (PICC) line was then placed for an extended course of antibiotic therapy with ceftaroline. The patient was then discharged to acute rehab for physical therapy and recovery.

After thorough consideration of this case, it was determined that the MRSA bacteremia was most likely secondary to the left toe ulceration, the splinter under the second digit of the right hand, or the insulin injection sites, as MRSA is typically a cutaneous pathogen.

Discussion

Emphysematous cystitis (EC) is a condition in which bacteria infiltrate the bladder wall and cause fermentation, which yields gas production within the wall and lumen of the urinary bladder. This condition is rare but the number of cases has increased over the last 20 years because of increased imaging and incidental findings.¹ EC can present in a range of patients from asymptomatic to severe sepsis. Patients presenting with symptoms usually experience urinary urgency, frequency, pyuria,

or dysuria. Occasionally, pneumaturia on bladder catheterization will present.²

This condition is typically found among patients who have a neurogenic bladder, indwelling foley catheter, or recent instrumentation. It is most commonly found in women (64% vs 36% of cases found in men).¹ It is also commonly found among patients with uncontrolled diabetes mellitus and an average hemoglobin A1c level of 9.9% and glucose level of 293 mg/dL.¹ In a review of 135 cases, 58% were due to *E coli* and 25% due to *Klebsiella pneumoniae*. Other bacterial pathogens that account for the remaining cases include *Klebsiella aerogenes* (7%), *Clostridium perfringens* (6%), *Clostridium welchii* (1%), *Candida albicans* (4%), *Candida tropicalis* (1%), *Pseudomonas aeruginosa* (3%), *Proteus mirabilis* (3%), group D *Streptococcus* (3%), *Enterococcus faecalis* (3%), *Aspergillus fumigatus* (1%), and *Staphylococcus aureus* (1%).³ (Note: *C perfringens* and *C welchii* are the same bacterium, however, the cases reviewed referred to them in variably. Technically, these could be combined for *Clostridium perfringens* [7%]). The bacteria most commonly associated with EC are those that are known for producing gas.⁴

Treatment of EC is typically managed medically, with only 10% of cases requiring surgical intervention.² Broad-spectrum antibiotics are initiated with subsequent narrowing based on gram staining and speciation of cultures. Foley catheterization may be warranted to monitor urinary output and for bladder rest. Surgery is reserved for patients with severe, necrotizing infections and would include partial or total cystectomy.¹

This particular patient falls in line with the typical presentation, as she is a 61-year-old female; the median age of patients at presentation is 66.³ She also has uncontrolled diabetes mellitus with a hemoglobin A1c of 11.8%, which poses increased risk of bacterial infections.

This case report highlights a rare causative organism in EC. Historically, EC is caused by several gram-negative organisms, with the highest occurrence being *E*

coli followed by *Klebsiella pneumoniae*. In a review of 135 cases, only one was found to be caused by *Staphylococcus aureus*.³ *S aureus* is not a typical organism that produces gas, nor is it found in the bladder. However, in patients with diabetes and hyperglycemia, as in this case, it is likely that the glucose acted as a substrate for pathogens to produce carbon dioxide with natural processes of fermentation.⁴ *S aureus* is also capable of fermenting glucose and lactate to yield other gases such as nitrogen, hydrogen, and oxygen that are capable of collecting in the lumen of the bladder which would be responsible for the CT imaging findings seen in this case.²

Although *S aureus* is an atypical bacteria found as the causative agent in EC, it should not be entirely discounted, especially in patients with diabetes—as seen with this patient. Patients with diabetes are at risk for more serious infections because of the constant need for subcutaneous injections that can allow bacteria to pass the protective barrier of the skin. In addition, those with uncontrolled diabetes and hyperglycemia are at increased risk of gas-producing infections, even with uncommon organisms like *S aureus*, because of the fermentation process with excess glucose. This case demonstrates the complications that can arise from MRSA bacteremia and the common treatment paths for the resolution of EC. It is important to initiate treatment early and aggressively, as the mortality rate for untreated EC is approximately 7.4%. EC is also capable of progressing to emphysematous pyelonephritis, which would further complicate outcomes and increase mortality to 14%.¹

Because of the nonspecific symptomatology, EC is typically underdiagnosed.² However, with raised suspicion for such conditions, prompt treatment can be initiated sooner. This case raises the question of incorporating gram-positive antibiotic coverage, like vancomycin, early on, despite the more common pathogens being gram negative. With more prompt and accurate antibiotic coverage and treatment, patients are more likely to be treated con-

servatively and avoid surgical intervention. A key takeaway from this case is to have high suspicion for EC based on presenting symptoms and to suspect alternative pathogens, especially in the setting of diabetes mellitus, as these patients are more susceptible to gram-positive infections due to a breakdown of the skin barrier from subcutaneous injections.

Patient outcome

The patient was hospitalized for 24 days. Once her blood cultures returned with gram-positive cocci, her antibiotic regimen was increased to include vancomycin. However, despite this addition, she continued to have positive blood cultures and was found to have an abscess in her sacrum that was causing the continued bacteremia. Her antibiotic regimen then included ceftaroline and daptomycin. While in the hospital, she received 11 days of this regimen and was discharged to an acute rehab facility to continue with 8 weeks of antibiotics (ceftaroline and daptomycin) as prescribed by the infectious disease specialists.

Approximately 4 days after discharge, the patient returned to the hospital with encephalopathy which turned into an 18-day hospitalization. She was found to have gross fluid overload with bilateral pleural effusions. She required thoracentesis, which demonstrated a transudative effusion requiring multiple days of IV furosemide and acetazolamide. Her PICC line was found to be infected and therefore removed and replaced. The infectious disease specialist changed IV antibiotics to vancomycin with plans for 6 weeks of therapy. The patient was discharged to a skilled nursing facility with plans to follow-up with infectious disease specialists at 6 weeks.

Several days after discharge, the patient returned again to the ED because of altered mental status and continued reports of leg and back pain. Additional imaging with MRI showed progressive L4/L5 osteomyelitis and discitis. Her antibiotic regimen was changed back to ceftaroline. She underwent aspiration with disc biopsy culture; a

neurosurgeon recommended at that time to undergo several more weeks of antibiotics and advised reconstructive back surgery. After this surgery, she was hospitalized; two weeks into this hospitalization, she became lethargic and had cardiac arrest, but spontaneous circulation was regained. Over the course of the following week, her condition improved, and she was discharged to the skilled nursing facility.

After discharge, the patient was lost to follow-up, as there were no further records of hospitalization or outpatient visits. On the follow-up imaging, the EC had resolved. Her further complications were, unfortunately, due to the complicated nature of MRSA bacteremia and seeding into the spine.

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