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CASE REPORT

Acute focal bacterial nephritis due to methicillin-resistant *Staphylococcus aureus* in an immunocompetent adult

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Abstract Acute focal bacterial nephritis (AFBN) is a rare, acute focal infection of the renal parenchyma without liquefaction. The pathogenesis is thought to be due to hematogenous infection or ascending infection from the lower urinary tract. *Escherichia coli* has been the major pathogen isolated in prior cases, but other Gram-negative enteric pathogens and *Staphylococcus aureus* have been reported as well. It is well described in children and adults with diabetes and organ transplantation, but has not been previously reported in healthy adults. We report a case of an immunocompetent adult female who presented with a methicillin-resistant *Staphylococcus aureus* bacteremia after a skin and soft tissue infection that resulted in AFBN.

Keywords Renal abscess · Pyelonephritis · Methicillin-resistant *Staphylococcus aureus*

Introduction

Acute focal bacterial nephritis (AFBN), previously known as acute bacterial nephronia, is a localized infection of the renal parenchyma. AFBN is well described in children and adults with impairments in immune function. We describe a rare case of this syndrome caused by hematogenous spread in an immunocompetent adult.

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Case history

A 33-year-old female presented to the emergency department with a 10-day history of fever, rigors, dysuria, and left flank pain. Two weeks prior to presentation, she had a superficial skin abscess near her left breast, treated with incision and drainage alone; no antimicrobial medications were prescribed and no cultures were obtained at that time. She described a long history of recurrent nonfebrile urinary tract infections, reporting more than 60 episodes treated with intermittent self-treatment with nitrofurantoin in the last 15 years. She endorsed only one episode of pyelonephritis in her teens. A prior urology evaluation, including renal ultrasound and a voiding cystourethrogram, revealed no genitourinary anatomic abnormalities.

Her initial vital signs at presentation showed a temperature of 38.4 °C, blood pressure of 96/52 mmHg, pulse of 108 beats per minute, and a respiratory rate of 18 breaths per minute. Physical examination was significant for exquisite left costovertebral angle tenderness, and a small, well-healed scar under her left breast. A complete blood count revealed 9,100 leukocytes/mm^3, with a neutrophilic predominance and bandemia. Urinalysis was normal. Serum electrolytes and blood glucose were also normal, and her hemoglobin A1c was 5.6 mmol/mol. Blood and urine specimens were sent for culture. Computed tomography (CT) with intravenous contrast of the abdomen and pelvis showed a large heterogeneous 6.9 × 5.1 × 6.1-cm area of inflammation involving the interpolar region of the left kidney. There were no definitive renal parenchymal

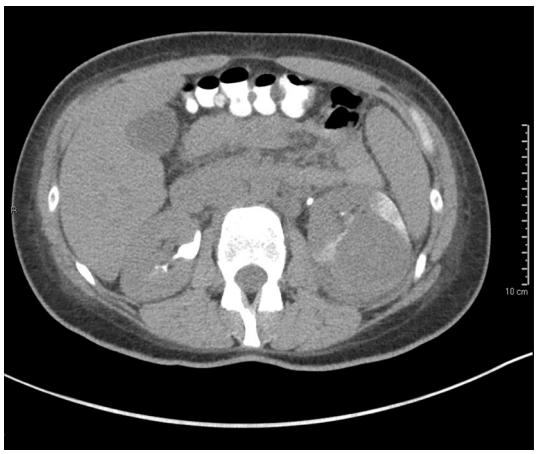

Fig. 1 A large 6.9 × 5.1 × 6.1-cm mass involving the interpolar region of the left kidney, with associated perinephric fat stranding

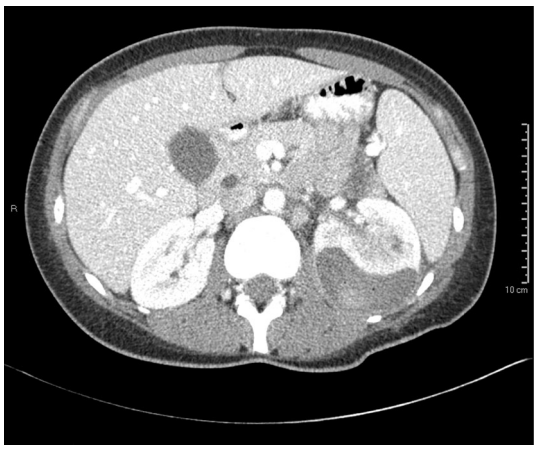

Fig. 2 Interval development of a rim-enhancing subcapsular renal abscess, 4.0 × 6.6 × 6.7 cm in size

fluid collections, inflammation of Gerota's fascia, or masses suspicious for neoplasm (Fig. 1).

Empiric antimicrobial therapy with vancomycin and piperacillin–tazobactam was initiated in the emergency department. Interventional radiology and infectious diseases consultations were obtained. An initial attempt at percutaneous drainage of the left renal lesion yielded only 3 cm^3 of purulent fluid. Urine cultures obtained at admission remained negative, but blood cultures obtained on admission, as well as cultures from the scant aspirated fluid, were positive for methicillin-resistant *Staphylococcus aureus* (MRSA). A transthoracic echocardiogram (TTE) showed no valvular vegetations. Piperacillin–tazobactam was discontinued, and she was continued on vancomycin as monotherapy.

Despite adequate vancomycin trough levels, she remained febrile to 38.5 °C after 48 h of therapy. Repeat blood cultures were negative for persistent bacteremia. The

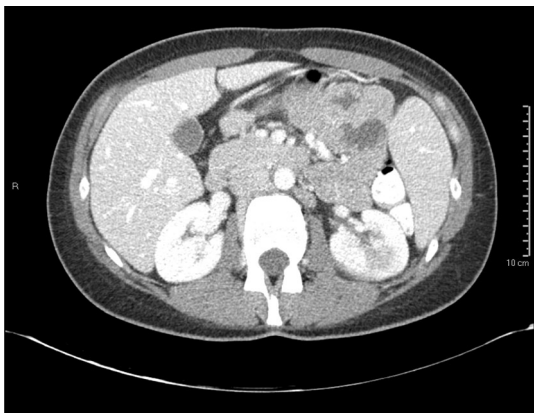

Fig. 3 Marked interval decrease in subcapsular fluid and size of the left kidney following percutaneous drainage

vancomycin minimum inhibitory concentration (MIC) of her MRSA isolate was 1.5 mcg/mL. Because of persistent fevers, vancomycin was discontinued, and intravenous daptomycin 8 mg/kg every 24 h was initiated. Fevers persisted through hospital day 7, and a repeat CT demonstrated a new large fluid collection in the left kidney (Fig. 2) corresponding to the prior area of focal interstitial inflammation. Repeat percutaneous aspiration and drain placement produced 50 ml of purulent fluid.

By the ninth hospital day, she defervesced and was discharged 72 h later with a left flank drain in place on intravenous daptomycin. Four weeks after beginning systemic antibiotics, a repeat CT revealed marked improvement with no recurrent renal fluid collections (Fig. 3), and daptomycin was discontinued. During 2 years of follow up, she has had no further urinary tract infections (UTIs) or renal parenchymal infections, and her renal function has remained normal.

Discussion

AFBN is a focal, nonsuppurative renal infection. It lies on the spectrum between pyelonephritis and renal abscess. The true incidence is unknown, but cases in children are well reported. In adults, the historical risk factor has been diabetes mellitus, although cases have been reported in patients with kidney transplants and human immunodeficiency virus (HIV) infection [1, 2]. Common presenting symptoms include fever, chills, flank pain, and nausea. Pyuria and elevated inflammatory markers are frequently seen on presentation. The diagnosis may be suspected with renal ultrasonography, revealing a well-defined hypoechogenic area within the kidney. CT may confirm the diagnosis by demonstrating a wedge-shaped, hypodense mass-like lesion that falls outside the range of Hounsfield units (0–20) that are typical for renal abscess [3, 4].

Histological features include localized hyperemia, interstitial edema, and leukocyte infiltration.

The pathogenesis is thought to be caused by hematogenous infection or ascending infection from the lower urinary tract. In a case series of 25 children, 48 % (5) were found to have urinary tract abnormalities [5]. Urinary tract abnormalities in adults are not as common. *Escherichia coli* is the most common causative organism; however, other pathogens include *Staphylococcus aureus*, *Klebsiella* spp., *Proteus mirabilis*, *Pseudomonas aeruginosa*, and enterococci [5]. There are limited data regarding pathogen urovirulence factors associated with AFBN, although one study did find an *E. coli* allele that was suggestive of an association with AFBN [6].

Our patient had an unremarkable urinalysis and negative urine culture, but had MRSA bacteremia, suggesting hematogenous seeding rather than ascending infection, most likely from her recent skin abscess. There are no prior reports of skin and soft tissue infections preceding the development of AFBN, although such infections are well described as risk factors for subsequent MRSA bacteremia [7]. Although our patient had a history of frequent UTIs, she was otherwise a healthy 33-year-old with no genitourinary tract abnormalities, did not have diabetes mellitus or any other condition affecting her immune system, and did not have a history of recurrent MRSA furunculosis. Our patient is an active duty United States Navy sailor stationed aboard a ship and very likely had a nonmedical occupational exposure. The acquisition of MRSA colonization or infection in military members in enclosed quarters has been well described.

Despite the patient's prolonged fever, she declined a transesophageal echocardiogram (TEE) following an initial normal TTE, which showed no evidence of valvular vegetation. Nonetheless, we were reassured at the time by the rapid clearance of her blood cultures. Additionally, there was a known focus of infection in her kidney which had not yet been adequately controlled. Once her lesion ultimately coalesced into an abscess, she defervesced rapidly with appropriate drainage, reducing our concern for potential infective endocarditis.

As in our case, these patients will frequently require repeat imaging and further drainage during the acute treatment phase as the zone of AFBN evolves and liquefies. This evolution had the effect in our patient of making her infection more amenable to drainage and aspiration. If percutaneous drain placement and antibiotic treatment is not successful, the patient may require surgical exploration and, potentially, nephrectomy in severe cases.

AFBN may be treated with antibiotics alone, but if renal abscess develops, drainage is required. Our patient remained febrile beyond 48 h but did not necessarily warrant a change in antibiotic but required source control.

The optimal duration of therapy is unknown, but similar infections have been treated up to 6 weeks. Shorter durations of therapy have been studied but were found to be associated with more treatment failures and relapses. In pediatric patients, 3 weeks of therapy has been found to be adequate [8]. Transitioning to oral therapy after at least 72 h after defervescence may be practical for susceptible isolates. If a renal abscess is present, a prolonged intravenous course with serial imaging is recommended. We chose an initial duration of 3 weeks of therapy based on this prior literature and obtained imaging to support discontinuation at that time.

Our patient's isolate had an MIC to vancomycin of 1.5 mcg/mL, which is less than the breakpoint of 2 mcg/mL and, thus, susceptible in vitro. Emerging evidence suggests that treatment failures for invasive staphylococcal disease are more common with vancomycin as compared with daptomycin for nominally susceptible isolates with MICs between 1 and 2 mcg/mL [9, 10]. Despite these data in support of daptomycin, we remained concerned that vancomycin treatment failures in MRSA bacteremia due to MIC creep may have some predictive value in treatment failure with daptomycin as well [11, 12]. Although AFBN is typically not considered a suppurative process, the eventual progression to liquefaction in this case may be a reflection of this vancomycin MIC creep and subsequent sub-optimal response to daptomycin.

Risk factors for relapse include prolonged fevers (>5 days) prior to the initiation of treatment, as well as shorter treatment regimens of 2 weeks or less. Once therapy has been initiated, however, persistent fever and leukocytosis while receiving antibiotics have not been associated with relapse [8]. Parenchymal cysts and renal scarring can develop after infection, with unclear implications [5]. The long-term prognosis is unknown, as the longest follow up period in a cohort of patients in the pediatric literature is 4.2 years [5].

Conclusion

In summary, we report an immunocompetent adult female with acute focal bacterial nephritis (AFBN) due to methicillin-resistant *Staphylococcus aureus* (MRSA) that evolved into a renal abscess. This observation demonstrates that AFBN can occur in adults without underlying immunodeficiencies or apparent anatomical abnormalities of the genitourinary system. Repeat imaging is critical in patients with persistent fever despite appropriate antibiotic treatment. The optimal duration of therapy is unknown, with clinical improvement and resolution of radiographic abnormalities necessary to guide treatment.

Conflict of interest The authors have no financial conflicts of interest to report. This manuscript was reviewed by the Naval Medical Center San Diego Institutional Review Board prior to submission, but formal ethical approval was not required. NA, MDJ, and RCM are employees of the United States Government. This work was prepared as part of their official duties. Title 17 U.S.C. §105 provides that 'Copyright protection under this title is not available for any work of the United States Government.' Title 17 U.S.C. §101 defines a US Government work as a work prepared by a military service member or employee of the US Government as part of that person's official duties. The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Department of the Navy, the Department of Defense, nor the US Government.

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