OPINION AND ANALYSIS
Viruses in Acute Otitis Media—O. Ruuskanen et al. 425
General Theory of Paradigms in Health—E. Mohs 428

ORIGINAL STUDIES
Detection and Treatment of Brucellosis by Screening a Population at Risk—O. Abramson et al. 434
Calves as a Source of Cryptosporidiosis in Children—D. Miron et al. 438
Prognostic Factors in Childhood Acute Encephalitis—J. Rautonen et al. 441
Renal Abscess in Childhood: Diagnostic and Therapeutic Progress—C.-F. Wippermann et al. 446
TNF-alpha, IL-1 and p24 Ag in Children with HIV Infection—M. Arditi et al. 450

PERSPECTIVES ON PEDIATRIC HIV INFECTIONS
Passive Immunization in HIV Infection: Future Directions—L. M. Mofenson, D. N. Burns 456

INSTRUCTIVE CASE
Neonatal Renal Abscess Caused by Staphylococcus aureus—F. E. Dougherty et al. 463

BRIEF REPORTS
Pneumococcal Bacteremia during Oral Treatment with Cefixime for Otitis Media—M. G. Ottolini et al. 467

Second Attacks of Exanthema Subitum—K. Kusuhas et al. 468
Leukocytosis in Hemolytic-Uremic Syndrome—M. B. Salzman et al. 470
Acute Primary Epstein-Barr Virus Infection Presenting as Acute Abdomen—C. M. Chen et al. 471
Pneumocystis Detection by Nonbronchoscopic Bronchoalveolar Lavage—R. Amaro-Galvez et al. 473

YOUR DIAGNOSIS, PLEASE
Persistent Pleural Effusion—D. Fitzgerald et al. 475

LETTERS
Q & A—G. Peter 477

CURRENT ABSTRACTS—H. F. Eichenwald 480

INFORMATION FOR PARENTS AND PATIENTS
Genital Herpes in Women (English and Spanish versions)—A. M. Arvin 483
Gingivoestomatitis Herpetica—S. Kohl 487

THE PEDIATRIC INFECTIOUS DISEASE JOURNAL® NEWSLETTER (Yellow pages)
Neonatal renal abscess caused by
Staphylococcus aureus

FRANCES E. DOUGHERTY, MD, RUTH P. GOTTLIEB, MD, GEORGE W. GROSS, MD AND
MARK R. DENISON, MD

Renal abscesses are uncommon in children and rarely reported in neonates. In a recent survey Sood et al. 1 identified only three reported cases of neonatal renal abscess formation. Staphylococcus aureus was the causative organism in two cases whereas Escherichia coli was identified in the third case. He reported a fourth case caused by Klebsiella pneumoniae. We present a case of S. aureus renal abscess in the neonate to emphasize its potentially insidious onset and to review current management.

CASE

JY was a 28-day-old white male infant who was admitted to a community hospital with a 1-day history of fever, irritability and decreased feeding. There were no previous problems in the neonatal period, and although weight gain had been slow while breast feeding, he had been well. There was no recent infection of the family or of anyone else in contact with the infant. On admission he was noted to be irritable with a rectal temperature of 103°F, heart rate of 170/minute, respiratory rate of 32/minute, blood pressure of 108/58 mm Hg and a weight of 3.4 kg. The remainder of his physical examination was normal except for a glanular hypospadias.

Cultures of blood, cerebrospinal fluid and urine were obtained. A complete blood count showed a hemoglobin of 10.6 g/dl and a hematocrit of 31.4%. The white blood cell count was 9400/mm^3 with 44% segmented neutrophils and 14% band forms. The urinalysis showed cloudy urine containing 4+ protein, large occult blood, too numerous to count white blood cells and many bacteria. The blood urea nitrogen was 6 mg/dl and the creatinine was 0.3 mg/dl; both remained normal throughout the hospital course.

Empiric therapy was started with ampicillin, gentamicin and acyclovir because of a past history of maternal genital herpes. Blood and urine cultures grew S. aureus which was susceptible to gentamicin but resistant to ampicillin; therefore the ampicillin was discontinued. During a 10-day course of gentamicin the patient remained intermittently febrile, although his urinalysis cleared completely and follow-up blood and urine cultures showed no growth. He had intermittently elevated blood pressure with sustained hypertension noted on the eighth hospital day with values ranging from 110 to 140/70 to 102 mm Hg. A renal ultrasound which had been obtained on the day following admission was normal; the patient was given hydralazine but his hypertension did not resolve or improve.

On Hospital Day 11 the infant was transferred to Thomas Jefferson University Hospital (TJUH) for further evaluation of the hypertension. On admission to TJUH he was in no distress and his vital signs were: blood pressure, 140/80 mm Hg in all extremities; heat rate, 156/minute; respiratory rate, 40/minute; and rectal temperature, 101°F. A Grade II/VI systolic murmur was heard over the entire chest. The lungs were clear on auscultation and the abdominal examination was unremarkable. The hypertension responded to the addition of propranolol to the hydralazine medication. The initial laboratory studies at TJUH showed a hemoglobin of 7.9 g/dl, hematocrit of 23%, a white blood cell count of 21 600/mm^3 with 45% segmented neutrophils and 6% band forms, blood urea nitrogen of 11 mg/dl and creatinine of 0.4 mg/dl. A urinalysis was normal. Blood and urine cultures showed no growth.

A renal ultrasound scan was obtained the following morning (Day 12) which showed a markedly abnormal right kidney which was enlarged (6.7 cm long) and demonstrated hydropyonephrosis with possible renal abscess (Fig. 1). The left kidney was normal. A [99mTc]-diethylenetriaminepentaacetic acid renal scan showed decreased perfusion of the right kidney with evidence of obstruction (Fig. 2). The perfusion of the left kidney was normal.

From the Departments of Pediatrics (FED, RPG, MRD), Radiology (GWG) and Microbiology and Immunology (MRD), Jefferson Medical College and Thomas Jefferson University Hospital, Philadelphia, PA.

Key words: Renal abscess, Staphylococcus aureus, neonate.

Address for reprints: Mark R. Denison, M.D., Department of Microbiology and Immunology, Thomas Jefferson University, 1020 Locust, Room 376, Philadelphia, PA 19107.
The infant was treated with intravenous nafcillin but remained febrile and hypertensive for the next 3 days. Therefore under ultrasound guidance, a percutaneous nephrostomy tube was placed in the abscess cavity, pus was aspirated and contrast media were injected. Eventually with further removal of pus, the entire dilated system was visualized and contrast media passed down the ureter, relieving the obstruction. Within 48 hours of this procedure the infant became afebrile and normotensive and no longer required antihypertensive medication. The aspirated pus grew S. aureus, susceptible in vitro to nafcillin and gentamicin. A repeat renal ultrasound on the day after placement of the nephrostomy tube showed moderate decompression of the previously dilated right collecting system and a residual 1.9-cm-diameter hypoechoic area consistent with a renal abscess. A repeat $^{99m}$Tc-diethylenetriaminepentaacetic acid isotope scan revealed marked improvement in right kidney function. The infant's condition was stable for the remainder of his hospital course. The nephrostomy tube was removed after 7 days, and before discharge a voiding cystourethrogram showed Grade 2 reflux on the right.

JY was treated with a 14-day course of intravenous nafcillin with a decrease in the white blood cell count to 10,900/mm$^3$ and was then treated orally at home with dicloxacillin for 4 weeks. Subsequently he was given trimethoprim and sulfamethoxazole prophylaxis because of the right ureteral reflux. Two weeks after discharge from TJUH the infant was well and a renal ultrasound revealed normal kidneys bilaterally. At 7 months of age when last seen he remained normotensive and renal ultrasound was normal.

**DISCUSSION**

Hematogenous seeding of the kidney or ascending infection from the urinary collecting system are two proposed mechanisms of renal abscess formation. Gorrell et al. demonstrated abcess formation in mouse kidneys by intravenous injection of staphylococci. After injection of S. aureus, the bacteria disseminated and a proportion was deposited in the kidney. There was a direct relationship between the number of organisms injected and those deposited. The authors concluded that if enough organisms were present in the bloodstream, some were able to lodge and establish replication in the kidney leading to abscess formation. Other studies have demonstrated that coagulase-positive staphylococci are not cleared as readily as Gram-negative organisms by a normal mouse kidney when arterially infused. Gram-negative organisms have been implicated in hematogenous abscess formation only when the kidney has been traumatized or is obstructed. The development of abcess formation via ascending and lymphatic extension has been shown to be primarily a result of infection by Gram-negative bacilli. Experimental reflux of urine inoculated with E. coli has been associated with focal renal parenchymal infection and subsequent abscess formation in the pig. In contrast Freedman et al. inoculated 10 colony-forming units of staphylococci directly into six rat bladders and reported the development of a renal parenchymal infection in the right kidney of only one rat. A renal infection rate of 100% was achieved when the same inoculum of S. aureus was injected intravenously. Thus it appears that S. aureus renal abscesses develop primarily through hematogenous seeding, whereas those caused by Gram-negative organisms form as a result of ascending infection.

These experimental data have been corroborated by reported clinical cases. In a review of 10 children with renal abscesses treated during a 25-year period at Boston Children's Hospital, it was discovered that most children with Gram-negative renal abscesses had an associated anatomic abnormality (66%) and uri-
nary tract infection (100%). By comparison none of those treated for a *S. aureus* abscess had an associated underlying abnormality and only 1 of 7 had a urinary tract infection. Timmons and Perlmutter also reported a correlation between Gram-negative abscess formation and vesicoureteral reflux in children. Since the advent of antibiotics there has been a significant reduction in the number of renal abscesses attributed to hematogenous seeding of the kidney by staphylococci from cutaneous, respiratory or dental foci and concomitantly an increase in the number of cases secondary to Gram-negative organisms in both adults and children. Whether or not this represents a true rise in Gram-negative abscesses or a decrease in Gram-positive cases is unclear. However, 3 of 5 reported cases in the neonate, including our own, were caused by *S. aureus*. The case of *E. coli* abscess was found in an infant with congenital nephrotic syndrome, a disorder associated with an increased risk of sepsis caused by *E. coli* and *Streptococcus pneumoniae*. The second case of neonatal Gram-negative abscess formation was caused by *K. pneumoniae* in a neonate with posterior urethral valves. Schiavetti et al. described a case of *S. aureus* renal abscess in a neonate without anatomic abnormalities. Although reflux was noted in our case of *S. aureus* abscess formation, it could not be determined whether the reflux was secondary to the infection or represented an underlying anatomic abnormality which allowed reflux and abscess formation.

A high index of suspicion is important in the early detection of renal parenchymal infections. Fever, lumbar pain, abdominal pain and occasionally flank mass are the usual presenting complaints in the older child. These findings may be accompanied by an increased erythrocyte sedimentation rate, by leukocytosis and rarely by a positive blood or urine culture. Findings in the neonate may be similar to those for the older child. In previous reports of neonatal renal abscess, the involved kidney was palpably enlarged, whereas hyperemia and edema of the overlying skin were seen in the third. In four of five reported cases hematuria was noted, whereas pyuria and proteinuria were seen in three cases. The urine culture was positive in our patient and in both cases of Gram-negative abscess formation. Our patient developed hypertension suggestive of obstruction and upper urinary tract involvement. This was not reported in any of the other cases.

Historically intravenous pyelography and arteriography along with surgical exploration and drainage have been the mainstays of diagnosis and therapy for renal abscesses. In recent years renal sonography has replaced these modalities in the diagnosis and follow-up of renal abscess and nephronia and is the preferred initial imaging procedure. Ultrasonography may demonstrate hypoechoic areas with debris in the parenchyma, as well as surrounding edema, which may be characteristic of an abscess. Computed tomography will also effectively identify renal abscesses but requires administration of intravenous contrast and results in substantial radiation exposure. Chelates of *99m* Tc can be used to identify renal abscesses and abnormalities of renal perfusion and filtration. In our patient, *99m* Tc-diethylenetriaminepentaacetic acid, which is quickly secreted and has minimal renal cortical binding, was used to detect perfusion defects and obstruction in the right kidney after sonography indicated the presence of pyonephrosis. *99m* Tc-dimercapto-succinic acid, which binds strongly to cortical tissue, can be used to define areas of hydronephrosis, pyonephrosis or abscess, but because of its strong binding it may result in significant radiation exposure.

Treatment should include aggressive antibiotic therapy which provides *S. aureus* and Gram-negative coverage. Specific antibiotic coverage is dependent on isolation of organisms from urine, from blood or preferably from ultrasound or computer-assisted tomography-guided percutaneous aspirations of the abscess contents. Although the *S. aureus* isolated in our patient was susceptible to gentamicin, the renal abscess enlarged radiologically during 10 days of therapy with this antibiotic. Gentamicin is not the initial drug of choice for *S. aureus*, yet it is active against *S. aureus in vitro* and is concentrated in the renal medulla and papillae. On the other hand it is also known that within the relatively anaerobic contents of an abscess cavity the MIC of *S. aureus* to gentamicin may be >10-fold that found *in vitro*. Thus in suspected or proven *S. aureus* renal abscess, nafcillin or other penicillinase-resistant penicillins should be utilized. The need for surgical intervention in neonatal renal abscess is controversial. Hantman and Berger have stated that surgical drainage is mandatory if there is evidence of extension beyond the renal capsule. Other authors conclude that only a failure of adequate antibiotic therapy warrants surgical intervention. Recently percutaneous aspiration under ultrasound guidance and placement of a nephrostomy tube for drainage has been used successfully by Crawford et al. and our group when antibiotic therapy alone failed to resolve the abscess. In both cases there was resolution of the abscess after percutaneous aspiration with no further surgical intervention needed.

**CONCLUSION**

Renal abscess formation in the neonate is rarely reported, with only four previous cases identified in the literature. A high index of suspicion is probably the most important single factor in its early detection and treatment. We feel that ultrasound is the initial diagnostic method of choice, with computer-assisted tomography and isotope scans also being effective in
identifying abscesses and renal obstruction. We believe that aggressive antibiotic treatment along with percutaneous aspiration and drainage are the best means of management. There continues to be controversy over the need for any surgical intervention. We believe at present that aspiration and drainage are necessary, but with earlier detection and intervention, this therapy may be unnecessary.

ACKNOWLEDGMENT

We thank Roch Luberti for translation of French articles.

REFERENCES