CME Article

Urinary Tract Infection in Different Pediatric Age Groups: An Overview of Diagnosis, Investigation, Management and Outcome

Iradj Amirlak* MD, FAAP, Bardia Amirlak¶ MD

*Department of Pediatrics, Faculty of Medicine and Health Sciences, United Arab Emirates University, PO Box 17666, Al Ain, United Arab Emirates
¶ Department of Surgery, Creighton University Medical Center, Omaha, Nebraska 68131 USA

***Editor's Note**: This is the third of four articles to be published in 2007 for which up to four Category 1 credit hours can be earned. Instructions on how credit hours can be earned appear inside the front cover of the journal. Exam questions follow the article.*
The author received no financial support for this paper.

Address correspondence and reprint requests to: Iradj Amirlak MD, Department of Pediatrics, Faculty of Medicine and Health Sciences, United Arab Emirates University, P.O. Box 17666, Al Ain, United Arab Emirates.

Target Audience

This CME activity is intended for physicians, medical students and nurse practitioners. Primary care physicians will find this information especially useful.

Learning Objectives

After completion of this article, the reader should be able to:
1. Diagnose urinary tract infections.
2. Determine the best practice management of UTIs for different age groups.
3. Manage treatment modalities for each age group.

Abstract

Urinary tract infection (UTI) in childhood is very common and has been the subject of numerous original and review articles. There have been many guidelines and protocols produced for the investigation and treatment of UTI. In spite of intensive study some aspects of management are still controversial. The subject is made more difficult by the fact that several different generalists and specialists from different disciplines involved in the management may have different viewpoints.

In this article, the best practice management of urinary tract infection categorized according to different age groups is reviewed. The clinical, laboratory, imaging assessments and treatment modalities for each age group are described.

Introduction

Urinary tract infection (UTI) is the most common bacterial infection affecting mankind, and it is the second most common bacterial infection in pediatric age group. It may cause serious acute illness and at times long-term serious complications such as renal scaring, hypertension and renal failure. The appropriate management of UTI at different pediatric age groups requires consideration of many factors including clinical presentations, method of diagnosis and therapeutic approach with the aim of prevention of serous sequels. In this review, attempts have been made to produce an acceptable and easily administered management plan for different pediatric age groups. Emphasis has been placed on the clinical presentation, proper methods of urine collection and the most relevant investigations in each age group. Not uncommonly, childhood UTI is frequently misdiagnosed at both end of the spectrum; missed when present, or diagnosed on unreliable evidence.

The term "Urinary Tract Infection" denotes infection within the urinary system. This includes the parenchyma of the kidney called "Acute pyelonephritis" which is usually associated with fever and flank pain, as well as the infection of the urinary bladder referred to as "acute cystitis" or lower UTI, with localized clinical symptoms such as urgency, frequency and dysuria.[1]

UTI can predispose children, more so the infants and younger children, to acute renal injury[2] with an in-

creased risk of high blood pressure and chronic renal failure later in life.[3] The morbidity of urinary tract infection in the pediatric population is high and can affect up to 10% of children.[4]

Urinary tract infection affects females more often than males in children and adults[5,6] with a female to male ratio of 3:1. However, in the neonatal period and early infancy this is reversed with male being 75-80% of the affected infants[5,6]

The signs and symptoms of UTI can vary considerably in different pediatric age groups. Also there is variation in the underlying anatomical abnormality responsible for the infection at different ages. Therefore the element of age in mind the management of the UTI is classified as follows:

1. Early neonatal period (≤ 72 hours of age)
2. Late neonatal period up to 2 months (≤ 72 hours – 8 weeks)
3. Two months to two years
4. Two years to five years
5. Five years and above

The clinical presentation, mode of diagnosis, appropriate investigations, treatment with short and long term follow up as well as the need for further studies will be covered when each of the above mentioned groups is being discussed.

A. Early neonatal period (≤ 72 hours of age)

Incidence and Manifestations:

The incidence of UTI is lower in the first 72 hours than after 72 hours of life. In the first 72 hours of life 90% of the UTIs are accompanied by bacteremia, suggesting the presence of disseminated sepsis. In the newborn, UTI is found in about 0.7% of normal term infants[7] and 2.2% to 3.4% of premature, postmature and high-risk infants.[8,9] The symptoms and signs of UTI are non-specific and will be no different from that of septicemia or meningitis. [5,6,10]

Newborns with UTI may present with diarrhea, vomiting, abdominal distention, and refusal of feeding, with or without lethargy, hypothermia, fever, metabolic acidosis, dehydration, and jaundice.[11] However jaundice is only present in <20% of infants with UTI.[12]

The medical condition of the mother at the time of the delivery can be an important risk factor for the development of pyelonephritis as a part of sepsis in the newborn infant. These conditions include: prolonged rupture of the amniotic membranes over 18 hours, uterine tenderness, premature labor, UTI of the mother at the time of labor, or near term, fever, and positive vaginal culture for group B hemolytic streptococci. [13]

Diagnosis:

Definite diagnosis of early neonatal UTI is only made by culture of a properly collected urine sample. It is universally accepted that cultures of urine samples collected by bag are inappropriate.[14,15] Properly catheterized urine samples are considered suitable for culture by some, [16] while others consider reliability of catheterized urine no better than bag urine, with possibility of iatrogenic infection with catheterization.[17] Appropriate method of obtaining urine for culture in a neonate is suprapubic bladder aspiration (SPA) under sterile technique.[2,14,16,18]

Any growth from a bladder aspirate, even a single colony, is considered positive, while a count of 10^3 or higher from catheterized urine sample is indicative of UTI.[16]

Urine sample obtained need to be sent for immediate culture, or refrigerated over night, but must not be frozen.[19]

Bacteriology:

Escherichia coli is responsible for the majority (67%) of UTI in the newborn, followed by *Klebsiella pneumoniae* (21%) and *Proteus mirabilis* (2%).[8] The same microorganism responsible for the UTI is usually cultured from blood and vice-versa.

Factors predisposing the newborn to UTI:

Congenital malformations of the urinary tract are the most important predisposing factors in the pathogenesis of UTI in the newborn.[20] These malformations include vesicoureteric reflux (VUR), ureterocele, and obstructive uropathies such as ureteropelvic junction (UPJ) obstruction, ureterovesicular (VUJ) obstruction, and posterior urethral valve (PUV).[8,21,22]

Vesicoureteric reflux (VUR):

Vesicoureteric reflux affects up to 0.5% of all normal newborns.[23] Most of these refluxes are of low grade I or II and will disappear spontaneously by the end of the first year of life.[24] The competence of the VUJ could be affected transiently if the patient has UTI. However whether the reflux is primary or secondary, it will become signifi-

cant if there is pyelonephritis, as this will put the kidney more at the risk of damage and scarring.[25]
International Reflux Study Committee[23] grades the VUR into five grades as follows (Figure 1):

Grade l Urine refluxes to the ureter only.
Grade ll Urine refluxes into the ureter, renal pelvis and calyceal fornices
Grade lll Urine refluxes into the ureter, renal pelvis and calyces with mild to moderate dilatation and/or tortuosity of the ureter and mild to moderate dilatation of the renal pelvis, with only slight or no blunting of the fornices.
Grade lV Urine refluxes into the ureter, renal pelvis and calyces with moderate dilatation and/or tortuosity of the ureter, and moderate dilatation of the pelvis and calyces. There is complete obliteration of the sharp angles of the fornices but the papillary impression in the majority of the calyces is maintained.
Grade V Urine refluxes into the ureter, renal pelvis and calyces with gross dilatation and tortuosity of the ureter, pelvis and calyces. The papillary impressions are no longer visible in the majority of the calyces.

Obstructive Uropathies:
A poor urinary stream and a distended bladder in a newborn male with or without a UTI is suggestive of urinary tract obstruction. UPJ obstruction may be seen as dilatation of renal pelvis in prenatal ultrasound. There may also be unilateral or bilateral obstruction at the level of VUJ. Such an obstruction may cause unilateral or bilateral dilatation, tortuosity of the ureter or ureters in conjunction with hydronephrosis. Such an obstruction may also be identified in prenatal ultrasound. PUV is the most common cause of obstructive uropathies in the male neonate, and may present with poor urinary stream. Hypertrophy of the bladder neck as well as the detrusor muscle may result secondary to obstruction at the level of the PUV. Thickening of the bladder wall will result in either obstruction or allow reflux at the level of the ureteropelvic junction. The increased pressure in the pelvicalyceal system may further cause hydronephrosis and as well as "intrarenal reflux". This may further cause rupture at the fornix and extravasation of the urine into the perirenal space and produce an urinoma. Extravasation of the urine into the peritoneal cavity (urinary ascites) may then follow. Also urine may pass via the mediastinum into the chest producing urothorax. Another uncommon complication of PUV is oligohydramnios. Prune belly syndrome is also associated with poor urine stream and distended bladder as well as possible hydroureter and hydronephrosis. In the female infant the commonest obstructive lesion of lower urinary tract is an ectopic ureterocele.[20]

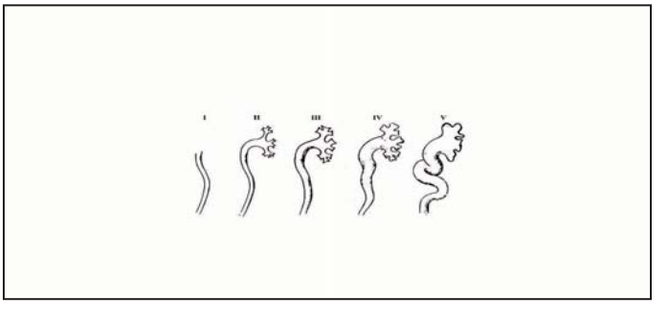

Figure 1: Grades of the Vesicoureteric reflux

Imaging investigations:
All newborns with proven UTI need to have imaging reviews and investigations with the following sequence:
1. Review the prenatal ultrasounds of the fetus before delivery and identify any abnormalities related to the kidney and urinary tract.[26-28] This can be useful in identifying any possible existing anomalies of the urinary system.
2. Renal ultrasound is the first imaging modality to be performed after diagnosis of a first UTI. This noninvasive procedure can demonstrate most of the anatomical abnormalities of urinary tract.[2] The ultrasonogram is normally obtained within the first 48 hours of the diagnosis of UTI if the condition of the infant allows this.[29,30] However ultrasonography is believed not to be sensitive enough to detect the presence of hydronephrosis, hydroureter, VUR and renal scarring.[31]
3. Newborns with established UTI will need to have a micturation cysto-urethrogram (MCU).[16] In general VUR is the commonest abnormality that is detected by this procedure, and is observed in about 50% of newborns with UTI. Grading of the reflux will be a guide for the next line of the investigation as well as for management.[32] It is also important to evaluate the shape and the anatomy of the bladder as well as the presence of posterior urethral valve in boys. The best time of doing a MCU or voiding cystourethrogram (VCUG) is debatable. A retrospective case review showed no difference in the rate of detection of VUR whether the VCUG was performed early (within the first 7 days of diagnosis) rather than later.[33] However a delay may not be justified in the presence of grade 1V-V reflux or major obstructive uropathies such as PUV.[32,33]

Therefore VCUG should be performed at the earliest convenience. Infants undergoing this procedure should be under antibiotic coverage during and for a few days after the procedure as the process of catheterization may introduce infection.

4. Isotope renal scanning using 99mTechnetium-dimercaptosuccinic acid (DMSA) is recommended to be performed early to identify any residual parenchymal damage.[34,35] Such an early study may also be used to identify the presence of pyelonephritis if there was any difficulty in establishing the diagnosis.[29,34,35]

B. Laboratory investigations:

Laboratory investigations would include CBC, C reactive protein (CRP), electrolytes, blood urea nitrogen (BUN), serum creatinine, urine culture, blood culture and possible cerebrospinal fluid culture if required as part of the sepsis work up. The level of serum creatinine in the first few days of life will reflect the maternal serum creatinine levels rather than that of infant.

Treatment

The treatment of UTI in the neonatal period is the same as that for early neonatal septicemia. This will include a combination of ampicillin and an aminoglycoside administered intravenously. It is recommended that the combined antibiotics be changed to a single one in accordance with the sensitivity as soon as possible, and the route of administration from intravenous to oral when the clinical condition of the patient permits such a change. The recommended duration of antibiotic therapy parenteral and oral combined is 14 days.

B. Late neonatal period and up to 8 weeks (≤ 72 hours – 8 weeks)

Incidence and Manifestations:

The incidence of UTI in infants younger than 8 weeks of age who are febrile is around 7.5%.[36] Only 6% of these infants will have bacteremia.[36] About 80% neonates younger than one month of age with UTI will be febrile on presentation, 20% may have poor feeding while 33% may demonstrate irritability.[36] About 84% of neonates with positive urine culture also have pyuria.[37] Up to 50% of UTI in neonates may be missed if diagnosis is based on the criterion of urinalysis alone showing >10 WBC/HPF in unspun urine.[38]

Two thirds of the patients with UTI in this age group are males. Uncircumcised males are said to be more at risk of UTI.[39,40] However the American Academy of Pediatrics does not find sufficient data to recommend routine neonatal circumcision.[41] The subject of circumcision will be discussed separately below.

Diagnosis:

The definite diagnosis is based on positive culture of a properly collected urine sample for microorganism. Urine collection by suprapubic bladder aspiration (SPA) is the recommended method in this age group.

Bacteriology:

Escherichia coli is the commonest (90-91%) organisms causing UTI in this age group, followed by *Klebsiella* (6%) and *Enterococcus* (3%).[36]

Predisposing factors:

a) Congenital anomalies of the urinary tract are still the most important predisposing factors for UTI in this age group.

b) Circumcision:

Many studies in the past two decades have addressed the association of UTI and male circumcision in the first year of life.[41-43] Almost all the studies have shown a 4-10 fold increased risk of UTI in uncircumcised compared to circumcised male infants. However, few of these studies have addressed the potential confounders such as prematurity, method of urine collection, breastfeeding and definition of UTI in an analytical way with respect to circumcision. Premature infants are at higher risk for UTI.[44-46] Also premature infants are not usually circumcised because of their risky health status. Therefore the inclusion of hospitalized premature infants, will introduce a confounder.[44-46] Breastfeeding has three fold protective effect against developing UTI in a population of uncircumcised infants.[47] However, studies assessing the relationship of UTI to circumcision had not included the effect of breastfeeding.

The absolute risk of developing UTI in uncircumcised male infants is at around 1%. The complication rate of circumcision is 0.2-0.6%, with the most frequent complication being bleeding followed by infection, phimosis and meatal stenosis.[48,49] Infants with hypospadias should not be circumcised prior to correction of the hypospadias.

Some medical societies do not recommend routine circumcision of male infants.[50-52]

Investigations:

Investigative work for established UTI in this age group is almost the same as that mentioned for early neonatal period. This includes all the imaging modalities and the necessary initial laboratory work up.

Treatment:

The treatment of choice for UTI in this age group will be parenteral administration of an aminoglycoside in conjunction with a third-generation cephalosporin or ampicillin.[1] Combination of a third-generation cephalosporin (Cefotaxime) with ampicillin has been used.[37] Parenteral antibiotic therapies should be continued until the clinical condition of the patient improves when a switch can be made to a single oral antibiotic in accordance with the sensitivity. The total duration of therapy is suggested to be 7-14 days.

Current antibiotics that have been recommended for oral use are as follows:[2]

1. Cefixime 8 mg/kg /day in two divided doses
2. Cefpodoxime 10 mg/kg/day in two divided doses
3. Cefprozil 30 mg/kg/day in two divided doses
4. Cephalexin 50-100 mg/kg/day in four divided doses
5. Trimethoprim (TMP) 6-12 mg, in combination with sulfamethoxazole (SMX) 30-60 mg/kg /day in two divided doses
6. Sulfisoxazole 120-150 mg/kg/day in four divided doses
7. Amoxicillin 20-40 mg/kg/day in three divided doses
8. Loracarbef 15-30 mg/kg/day in two divided doses

C. Two months to two years

Incidence and manifestations:

Unexplained fever in this age group would strongly suggest the presence of UTI[2] Below the age of one-year, infection rate of UTI in girls is twice that of the boys. Between age of one and two the prevalence of UTI is 8.1% in girls, and 1.9% in boys, with female to male ratio of 4 to 1.[10,53]

Diagnosis:

To establish the diagnosis of UTI in this age group, a strategy should be based upon minimizing the risk of false positive and false negative urine culture results. Urine sample obtained by SPA is the method of choice. Next best to SPA is the urine sample collected by transurethral bladder catheterization, which has a sensitivity of 95% and specificity of 99% when compared to SPA sample.[54] However, there is a chance of introduction of infection by transurethral catheterization. Urine samples collected by urine bag for culture have a very high false-positive rate around 85%.[2]

Bacteriology:

Escherichia coli is the predominant microorganism causing UTI (80-85%). *Klebsiella, enterococcus* and proteus mirabilis account for the other 15%. *Proteus mirabilis* need special attention, as these bacteria can be grown from preputial sac in boys,[55] and are important microorganisms causing UTI in this sex. *Proteus mirabilis* produces urease, which splits urea into ammonia resulting in alkaline urine. Alkaline urine will decrease the solubility of ions, in the urine. These ions include calcium, magnesium, and phosphate, which then precipitate and form triple phosphate stones.

Predisposing factors:

Urinary tract infection in this age group has a high incidence of being associated with abnormalities of the urinary tract.

Imaging Investigations:

In a patient with established UTI in this age group, it is recommended to use different imaging modalities to identify the underlying anatomical abnormalities, which may predispose the patient to renal damage. Sequence of utilization of imaging modalities, is similar to the recommendation made for the previous age group.

Laboratory investigations:

In addition to the urine culture, laboratory investigations will include: CBC, ESR, CRP, electrolytes, BUN, serum creatinine as well as blood culture.

Treatment:

In an infant of two months to two years of age who is febrile and sick without obvious focus, it will be essential to obtain a urine sample by SPA or transurethral catheterization for culture and to start immediate antibiotic therapy. The choice of antibiotic will be the parenteral cephalosporin. There are clinical as well as experimental data that support the fact that delay in antimicrobial therapy may increase the risk of renal damage.[56,57]

Repeated UTI increases the risk of kidney damage.[58,59] Repeat UTI with a new microorganism is labeled

"Recurrent UTI" On the other hand repeat infection with the same bacteria is classified as having "relapsed UTI".[59]

The clinical condition of the majority of the patients on parenteral antibiotics will improve after two days; the route of administration then can be changed to oral to complete 14 days of treatment.

D. Two years to five years

Incidence and manifestations:

Unexplained fever in this age group may suggest UTI especially if the focus of infection is not evident on physical examination. However, fever may not be the dominant presenting clinical feature as it was in younger infants. With cystitis the common manifestation will include symptoms such as dysuria, urgency and frequency, localized suprapubic pain and hematuria. Dysuria alone can also be due to pinworm infestation, vaginitis and urethritis.[1] Another important clinical feature of UTI in this age group is daytime or nighttime urinary incontinence, which is more common in girls.[60] Upper urinary tract infection may also present with flank pain, fever with chills, and costovertebral pain. Microscopic hematuria has been reported in 26% of patients having UTI, more frequent in boys (43%) than in girls (9%).[61] In another study, 25% of children being investigated for gross hematuria had UTI.[62] Another rare but important manifestation of UTI in this age group and in older children is acute renal failure,[63,64] which may need dialysis. Association of kidney stone with UTI may suggest recurrent UTI with Proteus species.

Diagnosis:

Diagnosis is established by having positive microorganism growth in the urine culture. Most of the children at this age group are either toilet trained or will pass urine on demand with satisfactory bladder control; therefore a urine sample obtained by clean catch midstream method will be used more often for culture. Colony count (pure culture) of $>10^4$ per milliliter of urine obtained by clean catch for culture in boys, and $\geq 10^5$ per milliliter in girls is highly suggestive of infection.

An early morning urine sample can also be tested for presence of bacteria and infection using leukocyte esterase or nitrite tests. The sensitivity of leukocyte esterase test is 83% with range of (67-94%) and a specificity of 78% with the range of (64-92%). The nitrite test has a sensitivity of 53%, range (15-82%); and a specificity of 98%, range (90-100%).[2]

An alternative method to culturing urine is dipslide best applicable to the office setting, with sensitivity range of 87% to 100%, and specificity, 92% to 98%.[65]

Bacteriology:

Majority of the urinary tract infections in this age group are due to the bacteria, which exist as the normal flora of the bowel of the patient. These bacteria will colonize the periurethral tissues and enter the urinary tract through the urethra[66] *Escherichia coli* comprise about 90% of infections in girls, and 45% in boys, while *Proteus mirabilis* infection in girls is only 5% and up to 45% in boys.[67] Only a small percentage of UTI (3.5%) is due to coagulase-negative *Staphylococcus*.[68,69] Other bacteria such as *Klebsiella*, and other organisms are rarely causative agents of UTI in this age group.

Investigations:

The search for a possible underlying cause for the UTI is of utmost importance in this age group. As in previous group early ultrasound study of genitourinary system with full bladder will help to identify many of the gross anatomical abnormalities. Isotope scanning with 99mTechnetium-dimercaptosuccinic acid (DMSA) will define the presence of any renal scaring.

The presence of the renal scar and/or repeated urinary tract infection with no apparent anatomical defect of the urinary system indicates a careful evaluation of bladder function. The subject of bladder function will be discussed in more detail below.

Laboratory investigations:

Laboratory investigation in this age group is the same as for the preceding age group. The presence of high blood pressure with scars of the renal parenchyma will require additional laboratory investigation, measuring the levels of renin and aldosterone.

Treatment:

Guidelines for therapy put forward for the previous age group need to be followed in this age group as well.[2,56,59]

Hypertension in association with high renin and aldosterone values, which may be the result of renal scarring, is usually treated with angiotensin converting enzyme inhibitors (ACEI) or angiotensin II receptor blockers.

E. Five years and above:

Incidence and manifestation:

The overall incidence of UTI in this age group is 1.7 per 1000 in boys and 3.1 per 1000 in girls.[69] It has been estimated that 5%-6% of schoolgirls between the age of 5 and 18 years will experience at least one episode of UTI.[70]

The clinical presentation of UTI in this age group can be remarkably variable ranging from dysuria or frequency to a full-blown picture of acute pyelonephritis with flank rigors, high fever and exquisite loin pain and to asymptomatic bacteruria. On occasions bacteremia will complicate the course of symptomatic pyelonephritis. The more serious complications of such bacteremia may include the symptoms of gram-negative sepsis such as shock, disseminated intravascular coagulopathies or both.[70]

Incidence of hospital acquired UTI (nosocomial) is about 14.2 per 1000 hospital admissions in the pediatric age group.[71] The presence of a foreign body such as an indwelling urinary catheter in the urinary system increases the risk of development of nosocomial UTI by 5%-10% per day.[72,73] About 2-4% of patients with nosocomial UTI will develop gram-negative sepsis.[74,75]

The term "asymptomatic bacteriuria" (ABU) is defined as having significant bacterial presence in the urine without any clinical symptoms related to the urinary tract. Asymptomatic bacteriuria is common to school-age girls with an incidence of about 1%[76-78] compared to 0.04-0.14%, in schoolboys.[79]

Diagnosis:

When the clinical investigation of the patient is suggestive of UTI, then the strategy for establishing the diagnosis will be the same as that already discussed for the previous age group of 3 to 5 years.

Bacteriology:

The bacteriology of the urinary tract infection in this age group is more or less the same as for the 3-5 year age group. In addition there may be repeated UTI in sexually active female teenagers due to *Chlamydia trachomatis*.[70]

Clinical, Imaging and laboratory investigations:

The aim of clinical evaluation, imaging, and laboratory investigations in this age group will be to elaborate on the following:

a) Any pre-existing anatomical abnormality of the urinary system, such as VUR or obstructive uropathies.

b) Presence of "intrarenal reflux".[80,81] Intrarenal reflux plays an important role in the pathogenesis of pyelonephritic scar formation,[82,83] and is usually seen in association with the higher grades of VUR.

c) Documentation of any abnormal bladder function such as detrusor instability, hyperactive bladder sphincter, neurogenic bladder and non-neurogenic neurogenic bladder.

d) Identify any structural abnormality of the spine such as spina bifida, sacral agenesis and meningomyelocele, which may precipitate abnormal bladder nerve innervation resulting in abnormal bladder function.

e) Identify any defect or absence of abdominal muscles, which is usually associated with hydroureter and hydronephrosis.

f) Presence of chronic constipation, which is an important factor in initiation of UTI as well as urinary incontinence in children.[84]

g) Identify the existence of congenital megacolon, which can co-exist with abnormal nerve innervations of urinary system and hence be the underlying cause of UTI.

h) Identify any pre-existing elements of renal scaring using isotope scanning. Long-term follow up of schoolgirls with history of bacteriuria and renal scarring has clearly shown a three-fold increase risk of hypertension in their adulthood, and greater than seven-fold risk of preeclampsia when they become pregnant.[85]

i) Identify any abnormal renal function such as defective urinary concentration or proteinuria due to existing UTI from that of preexisting renal damage or failure.

j) Identify any unusual bacteriological agent causing infection, which could be the result of any defect or abnormality of the anatomy of the urinary system, as well as the social and/or sexual life of the patient.

Treatment:

The treatment of full-blown pyelonephritis in this age group is similar to that already discussed for the previous two age groups.

In the case of *Chlamydia trachomatis* infection, the sexual partner of the patient will also need treatment so as to avoid reinfection.[70]

Treatment of nosocomial urinary tract infection, which is usually related to indwelling urinary catheters, is more complex. All efforts must be made to avoid set-

ting infection in catheterized patients by observing strict sterility for catheterization, and use of a close drainage system. The appearance of chills, fever and other signs and symptoms of septicemia in a patient with an indwelling catheter requires immediate initiation of antimicrobial therapy after taking proper urine culture. Such an event is common if the urinary catheter is totally or partially obstructed. In an asymptomatic patient who has a urinary catheter and bacteruria, no therapy is indicated.[71-75]

Management of asymptomatic bacteriuria (ABU) has remained controversial for a long time. 81 However, it has now been shown that treatment of ABU will have no affect on the long-term recurrence or eradication rate.[86,87] Renal function of children with ABU will remain intact if there was no underlying urologic abnormalities or renal scars.[88,89] Based on this observation, the current recommendation is that children with ABU should not be treated with antibiotics and further more there is no need for routine screening of children for ABU.[86-89]

Indication for the use of long-term prophylactic antimicrobial therapy:

Prevention of renal tissue damage identified, as renal scars, or reduction of renal tissue mass, as well as the appearance of new scars, comprise a very important axis of treatment of urinary tract infection in children. Recurrence of UTI in children in combination with a high grade VUR has been advocated to be a major contributor to formation of renal scars as well as to the progression of previously existing scars and hence, reduction of renal mass. Medical management of these patients with long-term low dose antimicrobial as a preventive measure of recurrence of UTI has been studied and compared to the surgical correction of reflux.[90,91] There was no evidence that surgical intervention for correction of VUR improved the outcome for renal function on long-term follow up.[90,91] Surgical correction of reflux of high grades should be reserved for the patient who does not respond to medical management over a period of 2-4 years.[70] The conservative medical treatment of most of reflux grades I-III is satisfactory; while such management is less successful in grade IV and V, and therefore these high-grade refluxes may need surgical intervention if there is no detrusor instability.[92] Long-term continuous prophylaxis prevents formation of new scars in high-grade refluxes.[93] However, the incidence of pyelonephritis was higher in medically treated patients (21%) than in the surgical group (10%).[94]

Scars are usually formed or progress before the age of five. Therefore long-term prophylactic antibiotic therapy is recommended for children under the age of five years with high-grade reflux or preexisting renal scar. The current recommended antimicrobials used as chemoprophylactic agents are:[2]

1. Trimethoprim (TMP) in combination with sulfamethoxazole (SMX), 2 mg of TMP, 10 mg of SMX / kg as a single dose at bed time, or 5 mg TMP, 25 mg SMX / kg twice per week
2. Nitrofurantoin, 1-2 mg per kg as a single daily dose
3. Sulfisoxazole, 10-20 mg per kg in two divided doses
4. Nalidixic acid, 30 mg per kg in two divided doses
5. Methenamine mandelate, 75 mg per kg in two divided doses

Low dose of cefixime (2 mg/kg body weight) has also been used successfully in long- term prophylaxis and is well tolerated.[95] However such a therapy should only be used as an alternative to the standard regimens.

Voiding dysfunctions in pediatrics:

Functional urinary incontinence may be the result of filling phase, the voiding phase or a combination of both phases of the urinary bladder.[9]6 Detrusor overactivity is more common in girls and may cause frequency and urgency with or without incontinence. Children with detrusor instability who use different posturing maneuvers in order to avoid urinary incontinence have a greater incidence of UTI than those who do not obstruct the urinary flow.[97] Constipation is one of the most important causes of detrusor instability. On the other hand lazy bladder occurs with no detrusor contractions resulting in post-void residual urine volume and overflow urinary incontinence.[96] Lazy bladder carries a greater risk for UTI than the detrusor instability.[97] The first line of assessment of children with voiding disorder should include history, clinical examination, voiding diary, ultrasonography and uroflowmetry.[98] Urodynamic studies is the most reliable method of examination of voiding disfunction. However such a study is considered a rather invasive tool, and should be reserved for the patients who have not responded to initial treatment.[99]

References

1. Kher KK, Leichter HE: Urinary Tract Infection. Clinical Pediatric Nephrology. Edited by Kher KK, Makker SP, McGraw-Hill Book Co-Singapore, 1992 pp 277-321.
2. Committee on quality Improvement and Subcommittee on Urinary Tract Infection. The Diagnosis, Treatment, and Evaluation of the Initial Urinary Tract Infection in Febrile Infants and Young Children (AC9830). American Academy of Pediatrics. Pediatrics. 1999; 104:843-852.
3. Huicho L, Campos-Sanchez M, Alano C. Metaanalysis of urine screening tests for determining the risk of urinary tract infection in children. Pediatr Infect Dis J.2002; 21:1-11.
4. Craig JC. Urinary tract infection: new perspectives on a common disease. Curr Opin Infect Dis. 2001;14:309-313.
5. Ginsburg CM, McCracken GH Jr. Urinary tract infections in young infants. Pediatrics. 1982;69:409-412.
6. Littlewood JM: 66 infants with urinary tract infection in first month of life. Arch Dis Child. 1972; 47:218-226.
7. Edelmann CM Jr, Ogwo JE, Fine BP, Martinez AB. The prevalence of bacteriuria in full-term and premature newborn infants. J Pediatr. 1973;82:125-132.
8. Maherzi M, Guignard JP, Torrado A. Urinary tract infection in high-risk newborn infants. Pediatrics. 1978;62:521-523.
9. Edwards MS. Postnatal Bacterial Infections. Neonatal –Perinatal Medicine Vol 2 Edited by Fanaroff AA, Martin RJ, Mosby, 2002 pp 730-731.
10. Roberts KB, Charney E, Sweren RJ, Ahonkhai VI, Bergman DA, Coulter MP, Fendrick GM, et al. Urinary tract infection in infants with unexplained fever: a collaborative study. J Pediatr. 1983;103:864-867.
11. Kite P, Millar MR, Gorham P, Congdon P. Comparison of five tests used in diagnosis of neonatal bacteraemia. Arch Dis Child. 1988;63:639-643.
12. Philip AGS. Detection of Neonatal sepsis of late onset. JAMA 1982;247:489-492.
13. Cowles TA, Gonik B. Perinatal Infections. Neonatal –Perinatal Medicine Vol 1 Edited by Fanaroff AA, Martin RJ, Mosby, 2002 pp 371-372.
14. Klein JO & Long SS. Bacterial infections of urinary tract. In: Remington JS & Klein JO (eds) Infections of the Fetus and New-born Infants, 3rd edn. Philadelphia: WB Saunders 1995:924-934.
15. Preles CV, Luders D, Alkan MK. A comparative study of bacterial cultures and colony counts in paired specimens of urine obtained by catheter versus voiding from normal infants and infants with urinary tract infection. Pediatrics. 1961 Jan;27:17-28.
16. Isaacs D, Moxon ER. Urinary Tract Infection. Handbook of Neonatal Infections A Practical Guide. Edited by Isaacs D and Moxon ER, W.B. Saunders, 2000 pp 198 – 210.
17. Guignard JP. Urinary infection after micturating cystography. Lancet 1979;1:103.
18. Abbott GD. Neonatal bacteriuria--the value of bladder puncture in resolving problems of interpretation arising from voided urine specimens. Aust Paediatr J 1978;14:83-86.
19. Bergstrom T, Larson H, Lincoln K, Winberg J. Studies of urinary tract infections in infancy and childhood. XII. Eighty consecutive patients with neonatal infection. J Pediatr. 1972 May;80(5):858-66.
20. Guignard J. Neonatal Nephrology. Pediatric Nephrology (2nd Edition). Edited by Holliday M, Barratt T, Vernier R. William Wilkins, 1987, pp 935.
21. Bensman A, Baudon JJ, Jablonski JP, Lasfargues G. Uropathies diagnosed in the neonatal period: symptomatology and course. Acta Paediatr Scand. 1980;69:499-503.
22. Drew JH, Acton CM. Radiological findings in newborn infants with urinary infection. Arch Dis Child. 1976;51:628-630.
23. International Reflux Study Committee. Medical versus surgical treatment reflux. Pediatrics. 1981;67:392-400.
24. Hutch JA. Theory of maturation of the intravesical ureter. J Urol 1961;86:534-538.
25. Lich R Jr, Howeston LW Jr, Davis LA. Ureteral reflux and vesical neck of the normal newborn. In Kass EH (ed). Progress in Pyelonephritis, FA Davis 1965, pp 645.
26. Alon US, Ganapathy S. Should renal ultrasonography be done routinely in children with first UTI? Clin Pediatr (Phila). 1999;38:21-25.
27. Morin L, Cendron M, Crombleholme RM, Garmel SH, Klauber GT, Alton ME Minimal hydronephrosis in the fetus: clinical significance and implications for management. J Urol. 1996;155:2047-2049.
28. Fine RN. Diagnosis and treatment of fetal urinary tract abnormalities. J Pediatr 1992;121:333-341.
29. Hoberman A, Charron M, Hickey RW, Baskin M, Kearney DH, Wald ER. Imaging studies after a first febrile urinary tract infection in young children. N Engl J Med. 2003;348:195-202.
30. Kangarloo H, Gold RH, Fine RN, Diament MJ, Boechat MI. UTI in infants and children evaluated by ultrasound. Radiology. 1985;154:367-373.
31. Foresman WH, Hulbert WC Jr, Rabinowitz R. Does urinary tract ultrasonography at hospitalization for acute pyelonephritis predict vesicoureteral reflux? J Urol. 2001;165:2232-2234.
32. Rolelston GL, Shannon FT, Utlex WL. Relationship of infantile vesicoureteric reflux to renal damage. Br Med J. 1970;1:460-463.
33. Mahant S, To T, Friedman J. Timing of voiding cystourethrogram in the investigation of UTI in children. J Pediatr 2001;139:568-571.
34. Sreenarasimhaiah V, Alon US. Uroradiologic evaluation of children with urinary tract infection: are both ultrasonography and renal cortical scintigraphy necessary? J Pediatr. 1995;127:373-377.
35. Jakobsson B, Nolstedt L, Svensson L, Soderlundh S, Berg U. 99mTechnetium-dimercaptosuccinic acid scan in the diagnosis of acute pyelonephritis in children: relation to clinical and radiological findings. Pediatr Nephrol. 1992;6:328-334.
36. Crain EF, Gershel JC. Urinary tract infections in febrile infants younger than 8 weeks of age. Pediatrics. 1990;86:363-367.
37. Ashouri N, Butler J, Vargas-Shiraishi M, Singh J, Arrieta A. Urinary Tract infection in neonates: How aggressive a workup and therapy? Infect Med 2003;20:98-102
38. Hoberman A, Wald ER, Reynolds EA, Penchansky L, Charron M. Pyuria and bacteriuria in urine specimens obtained by catheter from young children with fever. J Pediatr. 1994;124:513-519.
39. Wiswell TE, Smith FR, Bass JW. Decreased incidence of urinary tract infections in circumcised male infants. Pediatrics. 1985;75:901-903.
40. Herzog LW. Urinary tract infections and circumcision. A

case-control study. Am J Dis Child 1989;143:348-350..
41. Circumcision policy statement. American Academy of Pediatrics. Task Force on Circumcision. Pediatrics. 1999;103:686-693.
42. Herzog LW. Urinary tract infections and circumcision. A case-control study. Am J Dis Child. 1989;143:348-350.
43. Wiswell TE, Miller GM, Gelston HM Jr, Jones SK, Clemmings AF. Effect of circumcision status on periurethral bacterial flora during the first year of life. J Pediatr. 1988;113:442-446.
44. Eliakim A, Dolfin T, Korzets Z, et al. Urinary tract infection in premature infants: the role of imaging studies and prophylactic therapy. J Perinatol. 1997;17:305-308
45. Edelman CM, Ogwo JE, Fine BP, et al. The prevalence of bacteriuria in full-term and premature newborn infants. J Pediatr 1973;82:125-132.
46. Mitchell CK, Franco SM, Vogel RL. Incidence of urinary infection in an inner-city outpatient population. J Perinatol 1995;15:131-134.
47. Piscane A, Graziano L, Mazzarella G, et al. Breast-feeding and urinary tract infection. J Pediatr 1992;120:87-89.
48. Gee WF, Ansell JS. Neonatal circumcision: a ten-year overview with comparison of Gomco clamp and Plastibell device. Pediatrics. 1976;58:824-827.
49. Harkavy KL, The circumcision debate. Pediatrics. 1987;79:649-650.
50. Australian College of Pediatrics. Position statement: routine circumcision of normal male infants and boys. 1996.
51. Canadian Paediatric Society, Fetus and Newborn Committee. Neonatal circumcision revisited. Can Med Assoc. 1996;154:769-780.
52. The Australian Association of Paediatric Surgeons. Guidelines for Circumcision. Queensland, Australia: April 1996.
53. Bauchner H, Philipp B, Dashefsky B, Klein JO. Prevalence of bacteriuria in febrile children. Pediatr Infect Dis J. 1987;6:239-242.
54. Leong YY, Tan KW. Bladder aspiration for diagnosis of UTI in infants and young children. J Singapore Paediatr Soc. 1976;18:43-47.
55. Glennon J, Ryan PJ, Keane CT, Rees JP. Circumcision and periurethral carriage of Proteus mirabilis in boys. Arch Dis Child. 1988;63:556-557.
56. Winter Al, Hardy BE, alton DJ, Arbus GS, Churchill BM. Acquired renal scars in children. J Urol. 1983; 129:1190-1194.
57. Smellie JM, Poulton A, Prescod NB. Retrospective study of children with renal scarring associated with reflux and urinary infection. Br Med J 1994; 308:1193-1996.
58. Jodal U. The natural history of bacteriuria in childhood. Infect Dis Clin North Am. 1987; 1:713-29. Review.
59. Larcombe J. Urinary tract infection in children. BMJ. 1999;319:1173-5. Review.
60. Sorensen K, Lose G, Nathan E. Urinary tract infections and diurnal incontinence in girls. Eur J Pediatr. 1988;148:146-147.
61. Bergstrom T. Sex differences in childhood urinary tract infection. Arch Dis Child. 1972; 47:227-232.
62. Ingelfinger JR, Davis AE, Grupe WE. Frequency and etiology of gross hematuria in a general pediatric setting. Pediatrics. 1977;59:557-61
63. Lorentz WB, Iskandar S, Browning MC, Reynolds GD. Acute renal failure due to pyelonephritis. Nephron. 1990;54:256-258.
64. Soylemezoglu O, Kale G, Saatci U, Akcaoren Z. Acute renal failure due to acute pyelonephritis. Int Urol Nephrol. 1995;27:137-139.
65. Kostiala AA, Pylkkanen J. Dipslide cultures in the investigation of suprapubic urinary bladder aspirates of infants and children. J Clin Pathol. 1980;33:694-696.
66. Gruneberg RN, Leigh DA, Brumfitt W. Escherichia coli serotypes in urinary tract infection: Studies in domiciliary, antenatal and hospital practice. Urinary Tract Infection. Edited by O'Grady, F, Brumfitt W. Oxford University Press, 1968
67. Verrier J, Asscher AW. Urinary Tract Infection and Vesicoureteral Reflux. Pediatric Kidney Disease (2nd Edition). Edited by Chester M, Edelmann, Jr et al. Little, Brown and Company (Inc.), 1992, pp 1948.
68. Maskell R. Importance of coagulase-negative staphylococci as pathogens in the urinary tract. Lancet. 1974;1:1155-1158.
69. Dickinson JA. Incidence and outcome of symptomatic urinary tract infection in children. Br Med J. 1979;1:1330-1332
70. Tolkoff-Rubin NE, Cotran RS, Rubin RH: Urinary Tract Infection, Pyelonephritis, and Reflux Nephropathy. The Kidney. Edited by Brenner BM, W.B. Saunders Company, 2000 pp 1449-1508.
71. Lohr JA, Donowitz LG, Sadler JE 3rd. Hospital-acquired urinary tract infection. Pediatrics. 1989;83:193-199.
72. Garibaldi RA, Burke JP, Dickman ML, Smith CB. Factors predisposing to bacteriuria during indwelling urethral catheterization. N Engl J Med. 1974;291:215-219.
73. Kunin CM, McCormack RC. Prevention of catheter-induced urinary-tract infections by sterile closed drainage. N Engl J Med. 1966;274:1155-1161.
74. Kreger BE, Craven DE, Carling PC, McCabe WR. Gram-negative bacteremia. III. Reassessment of etiology, epidemiology and ecology in 612 patients. Am J Med. 1980;68:332-343.
75. Warren JW. Catheter-associated urinary tract infections. Infect Dis Clin North Am. 1997; 11:609-22. Review.
76. Kunin CM, Zacha E, Paquin AJ. Urinary-tract infections in schoolchildren: I. Prevalence of bacteriuria and associated urologic findings. N Engl J Med 1962;266:1287.
77. Kunin CM. A ten-year study of bacteriuria in schoolgirls: final report of bacteriologic, urologic, and epidemiologic findings. J Infect Dis. 1970;122:382-393.
78. Savage DC, Wilson MI, McHardy M, Dewar DA, Fee WM. Covert bacteriuria of childhood. A clinical and epidemiological study. Arch Dis Child. 1973;48:8-20.
79. Silverberg DS. City-wide screening for urinary abnormalities in schoolboys. Can Med Assoc J. 1974;111:410-412.
80. Brodeur Ae, Goyer RA, Melick W. A potential hazard of barium cystography Radiology. 1965;85:1080-1084.
81. Amar AD. Calicotubular backflow wit vesico-ureteral reflux. JAMA 1970; 213:293-294.
82. Kunin CM, McCormack RC. An epidemiologic study of bacteriuria and blood pressure among nuns and working women. N Engl J Med. 1968;278:635-642.
83. Hodson CJ, Maling RM, McManamon PJ, Lewis MG. The pathogenesis of reflux nephropathy (chronic atrophic pyelonephritis). Br J Radiol. 1975;Suppl 13:1-26.
84. Loening-Baucke V. Urinary incontinence and urinary tract infection and their resolution with treatment of chronic constipation of childhood. Pediatrics.1997;100:228-232.
85. McGladdery SL, Aparicio S, Verrier-Jones K, Roberts R, Sacks SH. Outcome of pregnancy in an Oxford-Cardiff cohort of women with previous bacteriuria. Q J Med. 1992;83:533-539

86. Savage DC, Howie G, Adler K, Wilson MI. Controlled trial of therapy in covert bacteriuria of childhood. Lancet. 1975;1:358-361.
87. Lindberg U, Claesson I, Hanson LA, Jodal U. Asymptomatic bacteriuria in schoolgirls. VIII. Clinical course during a 3-year follow-up. J Pediatr. 1978;92:194-199.
88. Verrier Jones K, Asscher AW, Verrier Jones ER, Mattholie K, Leach K, Thomson GM. Glomerular filtration rate in schoolgirls with covert bacteriuria. Br Med J (Clin Res Ed). 1982 ;285:1307-1310.
89. Cardiff-Oxford Bacteriuria Study Group: Sequelae of covert bacteriuria in schoolgirls. A four- year follow-up study. Lancet 1978;1:889-893.
90. Weiss R, Tamminen-Mobius T, Koskimies O, Olbing H, Smellie JM, Hirche H, Lax-Gross H. Characteristics at entry of children with severe primary vesicoureteral reflux recruited for a multicenter, international therapeutic trial comparing medical and surgical management. The International Reflux Study in Children. J Urol 1992;148:1644-1649.
91. Smellie JM, Barratt TM, Chantler C, Gordon I, Prescod NP, Ransley PG, Woolf AS. Medical versus surgical treatment in children with severe bilateral vesicoureteric reflux and bilateral nephropathy: a randomised trial. Lancet. 2001;357:1329-1333.
92. Scholtmeijer RJ. Treatment of vesicoureteric reflux. Results of a prospective study. Br J Urol. 1993;71:346-349.
93. Greenfield SP. Ng M, Wan J. Experience with vesicoureteral reflux in children: clinical characteristics. J Urol. 1997;158:574-577.
94. Jodal U, Koskimies O, Hanson E, Lohr G, Olbing H, Smellie J, Tamminen-Mobius T. Infection pattern in children with vesicoureteral reflux randomly allocated to operation or long-term antibacterial prophylaxis. The International Reflux Study in Children. J Urol. 1992;148:1650-1652.
95. Lettgen B, Troster K. [Prophylaxis of recurrent urinary tract infections in children. Results of an open, controlled and randomized study about the efficacy and tolerance of cefixime compared to nitrofurantoin] Klin Padiatr. 2002;214:353-358. German
96. Nijman RJ. Classification and treatment of functional incontinence in children. BJU Int. 2000;85 Suppl 3:37-42; discussion 45-46. Review.
97. Hellerstein S, Linebarger JS. Voiding dysfunction in pediatric patients. Clin Pediatr (Phila). 2003;42:43-49
98. Hoebeke P, Van Laecke E, Van Camp C, Raes A, Van De Walle J. One thousand video- urodynamic studies in children with non-neurogenic bladder sphincter dysfunction. BJU Int. 2001;87:575-580.
99. Schewe J, Brands FH, Pannek J. Voiding dysfunction in children: role of urodynamic studies. Urol Int. 2002;69:297-301.

The *INTERNATIONAL PEDIATRICS*
Quarterly CME Program
Sponsored by
Miami Children's Hospital

CME Exam Available in This Issue:

Urinary Tract Infection in Different Pediatric Age Groups:
An Overview of Diagnosis, Investigation, Management and Outcome
By Iradj Amirlak* MD, FAAP, Bardia Amirlak¶ MD
Department of Pediatrics, Faculty of Medicine and Health Sciences, United Arab Emirates University, P.O. Box 17666, Al Ain, United Arab Emirates.

Program Pricing
All responses must be prepaid: $15 per exam.

Objectives
After evaluating a specific article published in International Pediatrics, participants in the International Pediatrics Quarterly CME Program should be able to demonstrate an increase in, or affirmation of, their knowledge of clinical pediatrics. Participants should be able to evaluate the appropriateness of the clinical information as it applies to the provision of patient care.

Participants
This program is designed for physicians who are involved in providing primary pediatric care and who wish to advance their current knowledge of clinical pediatrics.

Accreditation Statement
The Miami Children's Hospital is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians.

Designation Statement
The Miami Children's Hospital designates this educational activity for a maximum of 1 CME hour in category 1 credit towards the AMA Physician's Recognition Award. Each physician should claim only those hours of credit that he/she actually spent on the educational activity.

CONTINUING MEDICAL EDUCATION

September 2007

EXAM POSTMARK DEADLINE: Dec. 30, 2007

Urinary Tract Infection in Different Pediatric Age Groups: An Overview of Diagnosis, Investigation, Management and Outcome, Amirlak I, Amirlak B, *Int Pediatr* 2007;22(3): 138-151.

QUESTIONS

1. Surgical reimplantation of ureters is to be considered for cases of vesicoureteric reflux in cases in which
   A. High grades reflux does not respond to medical management over a period of 2-4 years
   B. Recurrent asymptomatic infection occurs despite prophylaxis
   C. There is associated renal scarring
   D. The patient is under 2 years of age
   E. The patient is hypertensive

2. Which of the following investigations is not recommended for newborns with proven UTI?
   A. An ultrasound of the genitourinary system
   B. KUB in the first 48 hours after diagnosis of UTI
   C. Micturating (voiding) cysto-urethrogram (VCUG)
   D. Review the prenatal ultrasounds
   E. Isotope renal scanning using 99mTechnetium-dimercaptosuccinic acid (DMSA)

3. All of the following statements are correct except:
   A. Vesicoureteric reflux affects up to 0.5% of all normal newborns.
   B. Up to 30% of UTI in neonates may be missed if diagnosis is based on the criterion of urinalysis alone showing >10 WBC/HPF in unspun urine.
   C. The absolute risk of developing UTI in uncircumcised male infants is about 1%.
   D. Below the age of 1 year, the infection rate of UTI in girls is twice that of the boys.
   E. In an infant 2 months to 2 years of age, repeated UTI increases the risk of kidney damage.

4. All of the following statements are correct in UTI in children Two years to five years of age except:
   A. Microscopic hematuria has been reported in 26% of patients having UTI, more frequently in girls (43%) than in boys (9%).
   B. The presence of the renal scar and/or repeated urinary tract infection with no apparent anatomical defect of the urinary system indicates a careful evaluation of bladder function.
   C. *Proteus mirabilis* infection is only 5% in girls and up to 45% in boys.
   D. The nitrite test to identify bacterial infection has a sensitivity of 53% and a specificity of 98%.
   E. Association of kidney stone with UTI may suggest recurrent UTI with *proteus* species.

5. Which of the following statement is correct?
   A. About 15% to 20% of schoolgirls between the age of 5 and 18 years will experience at least one episode of UTI.
   B. Incidence of hospital-acquired UTI (nosocomial) is about 14.2 per 10,000 hospital admissions in the pediatric age group.
   C. Asymptomatic bacteriuria is common to school-age girls with an incidence of about 1%, compared to 0.04% to 0.14%, in schoolboys
   D. Long-term follow up of schoolgirls with history of bacteriuria and renal scarring has shown a 10-fold increase risk of hypertension in their adulthood.
   E. Detrusor overactivity is more common in boys and may cause frequency and urgency with or without inconti nence.

CME PROGRAM PAYMENT INFORMATION

All responses must be prepaid with a credit card only: $15 per exam

Credit Card Type

American Express
MasterCard
Visa

Each participant will receive a confidential report of his or her results and the correct answer to each question. Participants who successfully complete the exam will receive a letter stating achievement of CME credit.

CUSTOMER INFORMATION

_____
NAME

_____
MAILING ADDRESS

_____
CITY STATE/PROVINCE ZIP/POSTAL CODE

_____
COUNTRY (IF OUTSIDE UNITED STATES)

_____
E-MAIL ADDRESS

_____
MEDICAL SPECIALTY

PROGRAM/EXAMINATION EVALUATION

1. Were the stated program objectives successfully met?

A. Yes
B. No
C. Partially (please explain)

2. Were the selected article and related questions relevant to your practice?

A. Yes
B. No (please explain)

3. Do you anticipate that participation in this program will result in any behavioral change in your delivery of patient care?

A. Yes (please indicate the behavioral change that you anticipate)
B. No

Please fax the completed forms to (305) 663-8446 or mail to International Pediatrics Quarterly CME Program, Miami Children's Hospital, 3100 SW 62nd Avenue, Miami, FL 33155 (USA). All responses must be prepaid.