

# Urinary Tract Infections in Children

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Handbook for Parents

## Introduction

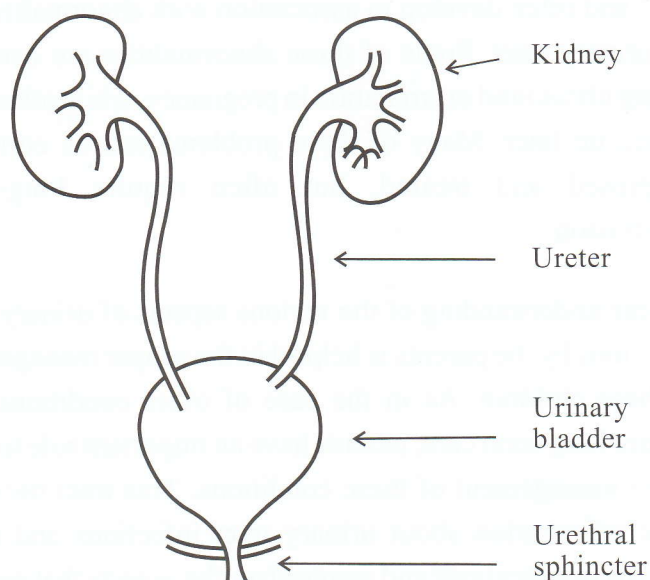
Infections of the kidneys and urinary tract are common in infants and children. Infections affecting the kidneys are serious, because they can cause permanent damage if not treated quickly. A delay in the detection and inadequate treatment of urinary tract infections may lead to serious consequences, including high blood pressure, loss of kidney function, and even renal failure during childhood or adult life.

Infections of the urinary tract may occur repeatedly (recurrent UTI) and often develop in association with abnormalities of the urinary tract. Some of these abnormalities are detected during ultrasound examination in pregnancy, while others are picked up later. Many of these problems can be correctly diagnosed and treated, but often require long-term supervision.

A clear understanding of the various aspects of urinary tract infections by the parents is helpful in the proper management of these children. As in the case of other conditions that require long-term care, parents have an important role to play in the management of these conditions. This tract provides basic information about urinary tract infections and other related complications and emphasizes the aspects that parents should understand for managing such conditions.

## Structure and function of kidneys and the urinary tract

A normal person has two kidneys, each about the size of a fist and located below the ribs, one on each side of the spine. The kidneys filter the blood and produce urine, which is carried into the urinary bladder by long tubes called ureters (**Fig. 1**). The bladder stores the urine until it is 'full', and then the urine is removed from the body by voiding through the urethra. Normally the entire urinary system is sterile, *i.e.*, they do not contain any living bacteria (germs).



**Figure 1.** Normal structure of the urinary system.

Other than making urine, the kidneys also play important roles in the regulation of blood pressure, maintenance of normal structure of the bone and formation of blood.

## Normal Voiding

Each kidney has a central 'pelvis', a hollow muscular structure, where urine collects. The pelvis contracts periodically, squirting urine into the ureter. The muscular walls of the ureter also show a regular squeezing action, passing from above downward, ensuring that urine flows only in one direction, towards the bladder. The passage of urine from the bladder into the urethra is controlled by a 'sphincter', which is normally kept shut but relaxes when the bladder contracts.

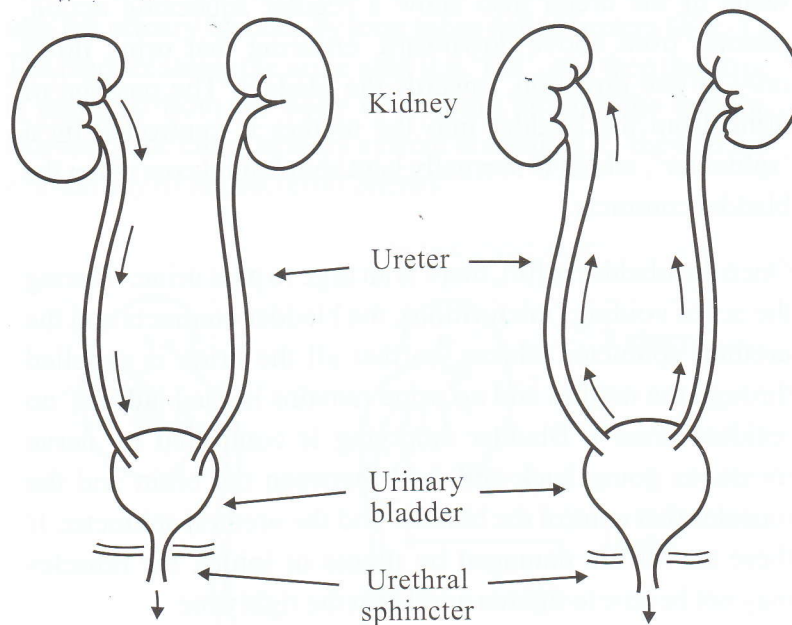
Once the bladder is full, there is an urge to pass urine. During the act of voiding (micturition), the bladder contracts and the urethral sphincter relaxes, so that all the urine is expelled through the urethra and no urine remains in the bladder ('no residual urine'). Bladder emptying is controlled by nerve messages going back and forth between the brain and the muscles that control the bladder and the urethral sphincter. If these nerves are damaged by illness or injury, the muscles may not be able to tighten or relax at the right time.

At the junction of ureter and the bladder, there is a valve-like mechanism. When the bladder contracts, the segment of ureter entering the bladder is pinched shut so that no urine escapes into the ureter (**Fig. 2**). If this valve mechanism is inadequate, urine is pushed up or 'refluxes' into the ureter when the bladder contracts. This phenomenon is called vesico- (for bladder) ureteric reflux. Reflux of urine is usually sterile, and should not cause any injury. However, severe reflux reaching up to the kidneys and reflux occurring during urinary tract infections may lead to renal scarring.

### Normal flow of urine

### Urine flowing the wrong way

(Vesicoureteric reflux)



**Figure 2.** Mechanism of urine flow from kidneys through ureters, bladder and urethra in normal persons (indicated by arrows in the panel on the left), and in individuals with vesicoureteric reflux (indicated by arrows in the panel on the right side).

The presence of vesicoureteric reflux predisposes to urinary tract infections. In presence of reflux, infected urine from the bladder might ascend into the kidneys and cause pyelonephritis.

## **Urinary Tract Infections**

### **What is urinary tract infection?**

A urinary tract infection (or UTI) is an infection of the urinary tract usually caused by bacteria. An infection can occur anywhere along the tract, but the lower parts, i.e., the urethra and the urinary bladder are commonly involved. This is called cystitis. If the infection travels up the ureters to involve the kidneys, it is termed pyelonephritis. Pyelonephritis is a more serious infection.

### **Where do the bacteria come from?**

Normally there are no bacteria in the urinary tract. However, bacteria may travel from the genital area up through the urethra. If these bacteria multiply in the urinary bladder or reach up to the kidneys, they can cause urinary infections. Therefore, in a majority of cases, the bacteria are those that are present in the stools, such as *Escherichia coli*, and those in the surrounding anal and genital skin.

In very small infants, bacteria may reach the kidney from the bloodstream as it flows through the kidneys. In this situation, the child is usually running a fever, and constitutes a particularly serious situation.

### **What are the symptoms of urinary tract infection?**

Children older than 2-3 years complain of burning or pain during passage of urine. Patients may complain of pain over the lower abdomen or sides of the back. They pass urine more frequently, in small amounts each time. The urine may be foul smelling. These features suggest that the infection is confined to the bladder and urethra. The presence of fever (higher than 100.4°F or 38°C) with or without chills or toxic appearance suggests infection of the kidneys.

The diagnosis of urinary tract infections is difficult in younger children and newborn babies (less than 4 weeks old). Fever, may be the only symptom. Hence, occurrence of fever during infancy without an obvious explanation should lead to suspicion of a urinary tract infection. Other presenting features include irritability or fussiness, poor feeding, diarrhea, jaundice and failure to gain weight. Rarely, frank symptoms are noted, such as dribbling of urine, feeble urinary stream, straining and crying when passing urine, foul smelling urine and bed wetting in the older child.

Occasionally, there may not be any complaints, or the symptoms are so mild that they may be ignored. This happens particularly if antibiotics have been given without supervision such that the urinary infection is partially treated.

### **Are there situations which predispose to occurrence of UTI ?**

One in 5-10 children (10-20%) have recurrent urinary tract infections. Some conditions are associated with an increased risk of developing these infections. Important risk factors are:

*Young age:* Infants are at increased risk of having urinary infections than older children due to poor immune defenses, and higher chances of bacterial infection in the bloodstream (bacteremia). During infancy, boys have a higher risk of developing urinary tract infections. The risk of having urinary infections is highest in boys younger than one year old, and girls younger than four years of age.

*Girls:* Urinary infections are more common in girls because they have a *short urethra* and a wide opening of the urethra. Therefore, the urethral opening is more easily contaminated by fecal matter than in boys. The risk of contamination is increased if local hygiene is poor.

*Vesicoureteric reflux:* The tendency of urine to return to ureters from the bladder during micturition is associated with an increased risk of infections.

*Obstruction* to the normal flow of urine anywhere along its route causes urine to collect and allows bacteria to multiply. Obstruction is usually present at birth, due to an abnormality in structure of the urinary tract, or presence of stones. It is important to detect obstruction, because the kidney can get damaged by the pressure exerted by urine that cannot drain out.

*Placing a urinary catheter* in the bladder for prolonged periods, often to drain the urine, increases the chances of UTI. The risk is especially increased if the catheter is passed into the bladder without observing strict aseptic precautions.

*An abnormal bladder* that does not empty properly, due to obstruction to urine flow or abnormalities in nerves that control bladder emptying, can predispose to urinary tract infections.

*The risk of UTI* is 4-10 times higher in boys that are uncircumcised than in circumcised boys.

Children who have had a single urinary infection are at risk for recurrences.

### **How is urinary tract infection diagnosed?**

The diagnosis of urinary tract infection is made by culture and microscopic examination of the urine. A careful examination of fresh urine with the microscope can detect white blood cells (neutrophils or polymorphonuclear cells) and/or bacteria which suggest urinary tract infection. Recently, strip tests have become available that check for presence of substances made by white blood cells or bacteria. A negative result is very useful in ruling out an infection. However, the most important test in diagnosing urinary tract



infection is testing for growth of bacteria in urine, known as urine culture. This test confirms whether bacteria are present in the urine and their type. In addition, the results inform regarding the most effective drugs to treat them. *Hence, a urine culture must be done whenever urinary tract infection is suspected.*

### **How and when is a urine specimen obtained for examination? What precautions are necessary?**

If you are concerned that your child has a urinary tract infection, you should see the child's doctor within 24 hours of symptoms, since delay in start of treatment can increase the risk of damage to the kidneys. Urine for culture should be collected in a sterile plastic or glass container given by the laboratory. The method of collecting urine specimen varies by the child's age.

*Mid-stream, clean catch urine:* Older children who can use the toilet are asked to urinate into the container. After local cleaning with water, and with the foreskin retracted in boys, the child is asked to pass urine. After some urine has been voided, a sample is collected in the sterile container.

*Catheter specimen:* In young children who are not toilet trained, a thin sterile tube (a catheter) is passed into the bladder to obtain a urine sample. This method is avoided as far as possible, but is safe and definitive if carried out using proper aseptic precautions. This method is used in newborn babies and infants and is safe and relatively simple. After careful cleaning of the skin over the lower part of abdomen, the urinary bladder is pierced with a needle and the urine aspirated into a syringe.

*Bag collection:* This is another method used in young infants. After local cleaning, a sterile plastic bag is strapped around the urethral opening. As soon as the baby voids, the bag is removed and the urine collected into a sterile container. While convenient, the results are often unsatisfactory.

### **Can the sample be stored for a while before sending to the laboratory?**

The urine specimen should be promptly sent to the laboratory. If delay in sending the sample cannot be avoided, it can be stored in the refrigerator for a few hours before transport.

### **What findings on urine culture suggest UTI?**

Normally, urine does not contain bacteria and is 'sterile'. In UTI, urine contains a large number of bacteria. The number of bacteria can be calculated by examining the growth of bacteria in a tiny measured amount of urine over 48 hours. The result is expressed as number of bacteria per milliliter of urine ('colony count'). A count of more than 100,000 ( $10^5$ ) bacteria per ml of urine indicates UTI. Fewer bacteria (10,000 or  $10^4$  and 1,000 or  $10^3$  per ml) may or may not be significant, and your doctor shall consider other factors before deciding if UTI is present. You may be asked to repeat the culture to confirm these findings.

### **How soon can therapy for UTI be started?**

The results of urine dipstick test and microscopy are usually available in the clinic or lab within a short while. While a sample is sent for culture to confirm the diagnosis, the results of this test are available only after 48 hours, the time required for the bacteria to grow. Based on clinical features and results of the dipstick or microscopy, your doctor shall decide whether the suspicion of UTI is high and if antibiotics should be started before the results of urine culture are available.

### **What is the treatment of UTI?**

If UTI is suspected, treatment should be started immediately after collecting the sample for urine culture. The choice of antibiotic, and whether it is to be given by mouth or as an injection, depends on the age of the child and severity of clinical signs and symptoms.

Young infants (below 3 months of age) and older children with signs of severe illness require admission to the hospital and treatment with intravenous antibiotics, usually cephalosporins, amoxicillin with clavulanic acid or gentamicin. Most older children have less severe symptoms, and can be treated at home with oral agents such as amoxicillin with clavulanic acid or cotrimoxazole (Septran). The most common antibiotics used are listed at the end of this Booklet. You shall be explained the dosing schedule and the duration of treatment.

Your child should begin to feel better within 24 to 48 hours of starting antibiotics. Your doctor may decide to change the antibiotic after 48 hours of treatment if the symptoms are not improving or if the urine culture shows that the bacteria grown are not sensitive to the antibiotic being used.

### **For how long is the treatment to be given?**

The treatment should be continued for 7 to 10 days. While an improvement in symptoms is noted within 2 days and all discomfort may disappear very shortly, failure to treat for the required period may lead to recurrence of UTI due to incomplete eradication of bacteria from the urinary tract.

### **What other precautions are necessary during treatment?**

The child should receive liberal amounts of fluids, in the form of water and other liquids throughout the day. Symptoms such as burning and pain during micturition are rapidly relieved after increased fluid intake. In addition, bacteria do not multiply rapidly in dilute urine, and thus a large fluid intake helps the treatment of UTI. If the child has fever, paracetamol or ibuprofen may be prescribed. The child should have his usual diet. There is no restriction on his activity or schooling if he is otherwise well.

### **What is antibiotic prophylaxis?**

In case further radiological investigations are required or the risk of recurrence of UTI is high, your doctor may decide to continue to administer one antibiotic in a small daily dose to prevent recurrence of symptoms. This strategy, termed antibiotic prophylaxis, is more commonly used in children below 1 year of age. Common medications used for this purpose are listed at the end of this booklet.

### **Are further investigations required?**

Every child with a confirmed UTI should undergo evaluation in order to ensure that the kidneys and the urinary tract do not have a structural abnormality that predisposes to recurrent infections, such as severe vesicoureteric reflux, obstruction to the flow of urine or abnormalities of voiding.

All children detected to have UTI should undergo ultrasound of the kidneys, ureters and urinary bladder. Based on the age of the child, number of infections, and findings on ultrasound, your doctor may advise further investigations, such as a micturating or voiding cystourethrography (MCU or VCUG) or a radionuclide renal scan.

### **How does an ultrasound help? Is any preparation required?**

An ultrasound shows the size, shape, and position of the kidneys, ureters and the bladder. Gross abnormalities in their structure can be detected easily. However, this method cannot detect all cases of vesicoureteric reflux in a reliable manner. An ultrasound examination is simple and convenient. It is best carried out by a doctor who is experienced in examining young children. Your child will need to lie still on a padded table. The doctor will put a jelly on the abdomen and move the

ultrasound probe up and down the abdomen to get images of the urinary system. The entire evaluation takes about 15-30 minutes and does not hurt. No special preparation is required and it can take place at any time of the day. The procedure does not expose the child to any radiation and has no side effects.

### **What is a micturating or voiding cystourethrogram?**

A micturating or voiding cystourethrogram (MCU or VCU) refers to an image of the bladder and urethra while passing urine.

This test is done to examine the flow of urine from bladder into the urethra and ureters, while the bladder is contracting during passage of urine. This study helps diagnose vesicoureteric reflux and any obstruction to the flow of urine from the bladder (such as posterior urethral valve, sometimes found in boys).

The test does not require any fasting. Older children feel more comfortable if they are explained the procedure before the test begins. After lubricating with a jelly, the doctor shall pass a thin plastic tube through the urethra into the bladder. The doctor shall fill up the bladder with a liquid (radiocontrast dye) that can be seen by the X-ray machines. Once the bladder is full, your child will be asked to pass urine, while on the table, into a bedpan. X-rays are taken while the bladder fills and when the child is passing urine.

There is a small chance of introducing an infection with the catheter. To prevent this, your doctor shall prescribe the child one dose of an antibiotic, usually amoxicillin, to be given 1 hour before the procedure and 6 hours later. You should encourage your child to take plenty of fluids after the test.

The micturating cystourethrogram should be done at least 2 weeks following treatment of a UTI. Your physician may delay the micturating cystourethrogram if your child has an untreated urinary infection or undiagnosed fever.

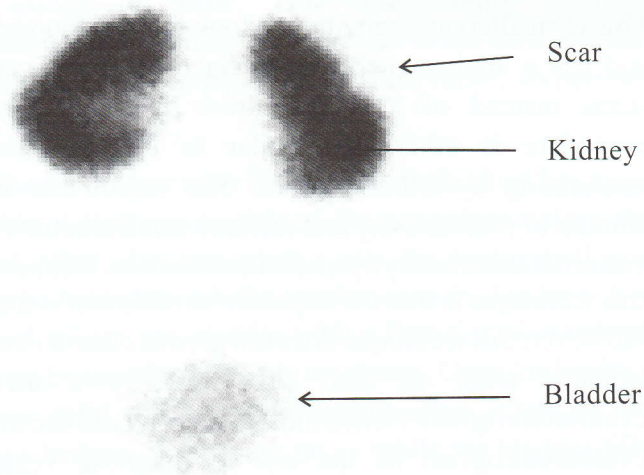
The micturating cystourethrogram test exposes your child to radiation, the amount of which depends on how long the examination takes, but is generally equal to that received after about 20-50 chest X-rays, or a year of natural exposure. If you accompany your child for the test, you shall have to wear a special apron lined with lead to reduce your exposure to X-rays.

### **What is a direct radionuclide cystogram?**

This is an alternative method to look for vesicoureteric reflux and use a nuclear medicine tracer drug (radioisotope) and scans instead of a radiocontrast dye and X-rays. The procedure is otherwise similar to the one used for a micturating cystourethrogram. The radiotracer has small amount of radioactivity and releases small amounts of energy that is detected easily by a sensitive camera. The advantage of this technique is that the exposure to radiation is much lower. However, this technique does not give as clear an image of the urinary tract as that provided by a micturating cystourethrogram. Hence most centers would use micturating cystourethrogram as the test to diagnose vesicoureteric reflux, and the direct radionuclide cystogram during later follow up to check whether the reflux is persisting.

### What is DMSA scan?

Like the direct radionuclide cystogram, the DMSA is a nuclear medicine scan which uses a tracer drug (radioisotope) called dimercaptosuccinic acid or DMSA. This tracer is injected into the blood and serial images are taken while the tracer passes through the kidneys. The images show the functioning areas of the kidneys. Hence, the test is useful in picking up a renal 'scar', *i.e.*, part of the kidney that is not working, since this will show up as a 'cold spot', a place where there is no radioactivity (**Fig. 3**). The test gives an idea of differential renal function and distribution of renal scarring. The radiation exposure with intravenous pyelography (IVP) is higher.



**Figure 3.** DMSA scan showing a scar in one kidney

No special preparation is required. A tiny amount of radiotracer DMSA will be injected through a small needle inserted into the vein of the arm. After 2-4 hours, your child will lie on a table below which is a special ('gamma') camera that detects the tracer and takes pictures of the kidneys.

The exposure to radiation in a DMSA scan is lower than that received by a micturating cystourethrogram. The quality of images is better than that obtained by ultrasonography or intravenous pyelography.

### **What happens if these examinations show no abnormality?**

The finding that the structure of the kidney and urinary tract is normal is very reassuring. In such a situation, UTI is unlikely to recur. After the drug treatment for UTI, no further therapy is required. However, urine examination should be repeated promptly if any symptoms of UTI develop.

### **Can recurrent infections be prevented?**

There are a few precautions that help prevent the recurrence of UTI. The following general measures are useful:

- Voiding every 2-3 hours to keep the bladder empty
- Avoiding constipation and ensuring regular bowel habits
- Maintenance of local hygiene and use of a front-to-back movement when cleaning after defecation.

If radiological tests pick up a predisposing condition or if UTI are recurrent even in absence of an abnormality, your doctor may prescribe a small dose of an antibiotic daily, known as antibiotic prophylaxis. Such therapy helps prevent UTI and is not associated with significant side effects. However, nitrofurantoin has a bitter taste and should be given along with a sweetener such as honey or with meals. You should report to the doctor if therapy with this or another agent is associated with recurrent vomiting or development of rash.



## Vesicoureteric Reflux

### What is vesicoureteric reflux?

Normally, urine made by the kidneys flows to the bladder through tubes called ureters. Urine only flows in one direction *i.e.*, from kidney to the ureter to the bladder and out through the urethra. Vesicoureteric reflux (VUR) refers to the flow of urine in the wrong direction, from the urinary bladder into one or both ureters, during voiding when bladder contracts (**Fig. 2**).

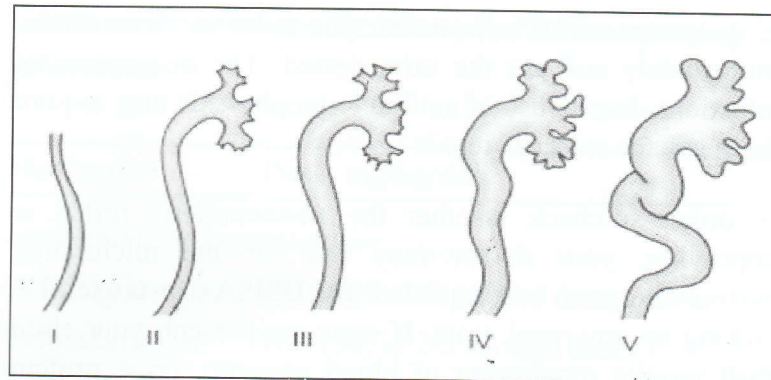
### Why do some children have VUR?

Normally, the ureter enters the bladder wall obliquely, so that a short segment of the ureter is actually inside the muscular wall of the bladder. During micturition, when the bladder contracts, this segment of the ureter is pinched tightly with the result that urine does not go back into the ureter.

When the ureter enters the bladder more directly or vertically, a very small portion of the ureter is in the bladder wall. This segment of the ureter does not get pinched during contraction of the bladder. Due to the high pressure within the bladder during its contraction, urine may go up into the ureter, resulting in vesicoureteric reflux. As the child grows older, the ureter grows and its entry into the bladder becomes increasingly oblique. Hence, the vesicoureteric reflux tends to become milder and often goes away with age.

### What are the 'grades' of VUR?

Based on findings of micturating cystourethrography, vesicoureteric reflux is classified into five grades. As shown in **Fig. 4**, mild reflux involves reflux of urine into the ureter, while severe reflux involves severe dilatation of the upper urinary tract.



**Figure 4.** Grades of vesicoureteric reflux. Gr. I reflux into non dilated ureter; Gr. II reflux into ureter and pelvis; Gr. III and Gr. IV reflux occurs into dilated ureter; Gr. V is characterized by severe reflux, gross dilated pelvis and calyces.

### **What is the significance of VUR?**

Mild vesicoureteric reflux is perhaps not harmful. However, when infected urine is 'refluxed' and reaches the kidney, the bacteria may infect the kidney and lead to its injury, also known as renal scarring. Severe forms of such injury are called 'reflux nephropathy', which is an important cause of high blood pressure and renal failure in children.

### **What is the treatment of VUR?**

The treatment depends upon the severity of vesicoureteric reflux and the presence of other abnormalities. The aim of the treatment is to prevent UTI and keep the urine sterile until vesicoureteric reflux disappears spontaneously. For this purpose, your doctor may prescribe a small dose of antibiotic, such as cotrimoxazole or nitrofurantoin, to be taken by your child daily at bedtime. Such therapy is safe and unlikely to be associated with side effects. Nitrofurantoin has an unpleasant taste and should be given with honey or sweet juice. You should report to the doctor if your child has nausea, vomiting or skin rash with such medications.

If symptoms of UTI are noted, you must see your doctor immediately and get the urine tested. The occurrence of infections despite use of antibiotic prophylaxis may require the need for surgical repair.

In order to check whether the vesicoureteric reflux is improving, your doctor may ask for the micturating cystourethrogram to be repeated. The DMSA scan is useful in picking up any renal scars. If scars are present, your child shall require monitoring of blood pressure, urine protein estimation and periodic testing of renal function.

Vesicoureteric reflux may run in families. Therefore siblings (brother, sisters) should undergo an ultrasound examination. Further testing may be required if the ultrasound is abnormal.

## Commonly used medications for urinary tract infections

Medication	Dose, mg/kg/day
<i>Intravenous or Intramuscular</i>	
Ceftriaxone	75-100, in 1-2 divided doses
Cefotaxime	100-150, in 2-3 divided doses
Amikacin	10-15, single dose
Gentamicin	5-6, single dose
Coamoxiclav	50 of amoxicillin, in 2 divided doses
<hr/>	
<i>Oral</i>	
Cefixime	8-10, in 2 divided doses
Coamoxiclav	30-35 of amoxicillin, in 2 divided doses
Ciprofloxacin	10-20, in 2 divided doses
Ofloxacin	15-20, in 2 divided doses
Cephalexin	30-50, in 2-3 divided doses

## Drugs used to prevent UTI

Drug	Dose (mg/kg/day)
Cotrimoxazole	1-2 of trimethoprim
Nitrofurantoin	1-2
Cephalexin	10
Cefadroxil	5

## Key Messages

- Urinary tract infections (UTI) are common in infants and children.
- Any child with unexplained fever should be evaluated for UTI by urine microscopy and culture.
- Prompt treatment of UTI is necessary to prevent renal injury.
- UTI and associated renal injury are more common if vesicoureteric reflux is also present.
- All children with UTI should undergo an ultrasound examination to screen for significant abnormality of the urinary tract.
- Infants are at increased risk of urinary infections and its complications, and should undergo detailed evaluation.
- Attention to regular voiding and bowel habits are important measures in preventing recurrent UTI.

Supported by an unrestricted educational grant  
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