

Urinary Tract Infection

Urinary tract infection (UTI) is a common bacterial infection causing illness in infants and children, it may be difficult to recognize in children particularly in infants and children younger than 3 years because of the non-specific presenting symptoms and signs.

Definitions

Urinary tract infection

- Infection of the urinary tract is identified by growth of a significant number of organisms of a single specimen of urine, in the presence of symptoms
- UTI cannot be diagnosed by symptoms alone nor by culture of urine from a bag specimen.
- Definitive diagnosis by culture of urine obtained in a sterile fashion- Midstream urine (MSU), supra-pubic aspiration (SPA), catheterized urine specimen (CUS)

Significant bacteriuria

- Colony count of $>10^5$ /ml of a single species in a midstream clean catch sample OR
- Any growth from SPA urine OR
- Growth $>10^4$ cfu/ml from catheterized urine specimen (CSU)

Febrile UTI/Pyelonephritis

- Infection of the upper (kidney) and lower urinary tract with fever

Cystitis

- Infection of the lower urinary tract (bladder) without fever

Atypical UTI

- UTI associated with sepsis or bacteraemia
- Concern regarding obstructive uropathy e.g poor urine flow, abdominal or bladder mass
- Failure to respond to antibiotics within 48 hours
- Associated impaired renal function e.g raised creatinine
- Infection with a non Esch. coli organism

Recurrent UTI

- Two or more episodes of UTI
- One episode of febrile UTI and one or more episodes of cystitis
- Three or more episodes of cystitis

Asymptomatic bacteriuria

- Bacteriuria in the absence of pyuria without symptoms.
- This is most often found in school aged and older girls but can also occur in infancy.

Sterile pyuria

- Presence of inflammatory cells/ white cells on microscopy with negative culture

Diagnosis

- Definitive diagnosis should be based on both urinalysis results that suggest infection (pyuria and/or bacteruria) and positive urine culture.
- UTI may be present in the absence of pyuria if the urine is collected early in the disease before the inflammatory response has developed.

Guidelines for suspecting UTI

- All infants and children with unexplained fever $\geq 38.5^{\circ}\text{C}$
- Infants and children with alternative site of infection who remain unwell
- Infants and children with signs and symptoms suggestive of UTI

Symptoms and signs

Infants present with non-specific signs and symptoms and therefore diagnosis of UTI requires a HIGH INDEX of suspicion

Table 7.4 Guide to the symptoms and signs that infants and children present with possible UTI

Age group		Symptoms and signs		
		Most common ←————→ least common		
Infant younger than 3 months		Fever Vomiting Lethargy Irritability	Poor feeding Failure to thrive	Abdominal pain Jaundice Haematuria Offensive urine
Infant and children 3 months or older	Preverbal	Fever	Abdominal pain Loin tenderness Vomiting Poor feeding	Lethargy Irritability Haematuria Offensive urine Failure to thrive
	Verbal	Frequency Dysuria	Dysfunction voiding Changes to continence Abdominal pain Loin tenderness	Fever Malaise Vomiting Haematuria Offensive urine

Urine collection methods

- A clean catch urine sample is the recommended method for urine collection

If a clean catch urine sample is unobtainable:

- Other non-invasive methods such as urine collection pads should be used. It is important to follow the manufacturers' instructions when using urine collection pads. Cotton wool balls, gauze and sanitary towels should not be used to collect urine in infants and children
- When it is not possible or practical to collect urine by non invasive methods, catheter samples or SPA should be used

- Before SPA is attempted, ultrasound guidance should be used to demonstrate the presence of urine in the bladder

Urine preservation

- If urine is to be cultured but cannot be cultured within 4 hours of collection, the sample should be refrigerated or preserved with boric acid immediately

Investigations

- Infants and children presenting with unexplained fever of 38°C or higher should have a urine sample tested after 48 hrs at the latest.
- Infants and children with signs and symptoms suggestive of urinary tract infection (UTI) should have a urine sample tested for infection.

Urinalysis

- Microscopy and nitrite test is most useful test for possible UTI

Urine microscopy

Make a useful contribution to diagnosis, especially when urgent treatment must be initiated without culture results. Urine microscopy should be undertaken with fresh unspun urine

Table 7.5 Guidance on the interpretation of microscopy results

Microscopy results	Pyuria positive (WBC >5/HPF)	Pyuria negative (WBC 0-5/HPF)
Bacteriuria positive	Send for culture Treated as UTI	The infant or child should be regarded as having UTI
Bacteriuria negative	Send for culture Antibiotic treatment should be started if clinically UTI	Not UTI

NB:

- In an infant or children with a high risk of serious illness, treatment should not be delayed if a urine sample is unobtainable. Antibiotic treatment should be started if microscopy is positive pyuria

- Bacteriuria alone should not be regarded as UTI
- When urgent microscopy is not available, dipstick testing may act as a substitute
- The presence of nitrite suggests possibility of infection and antibiotic treatment should be started

For an infant or child with a low risk of serious illness, microscopy and culture should be arranged and antibiotic treatment should be started if microscopy is positive

Table 7.6 Guidance on the interpretation of urine dipstick

	Leucocyte (+)	Leucocyte (-)
Nitrite (+)	Send for urine culture Treat as UTI Start antibiotics	Send for urine culture Start antibiotics (if freshly voided sample was obtained)
Nitrite (-)	Send for microscopy and culture Start antibiotics only if good evidence of UTI	Not UTI Explore other causes of fever Send for microscopy if known structural abnormalities

*Dipstick (positive leucocyte esterase and nitrite) is highly likely to have UTI in children >2 years

Table 7.7 Guidance on the interpretation of urine culture

(Gold standard in diagnosing UTI)

Method of collection	Colony count/ml (pure culture)	Probability of infection (%)*
Suprapubic aspiration	Gram-negative bacilli: any number Gram positive cocci: $>10^3$	$>99\%$
Transurethral catheterization	$>10^5$ $\geq 25 \times 10^4$ $10^3 - < 5 \times 10^4$ $< 10^3$	95% Infection likely Suspicious, repeat Infection unlikely
Clean void		
Boy	$>10^4$	Infection likely
Girl	3 specimens $\geq 10^5$ 2 specimens $\geq 10^5$ 1 specimen 10^5 5×10^4 to 10^5 10^5 to 5×10^4	95% 90% 80% Suspicious, repeat Symptomatic: suspicious, repeat
	$< 10^4$	Asymptomatic: infection unlikely

**Criteria from the American Academy of Pediatrics, 2011*

- The following should be considered intermediate and should be repeated:
 - Significant growth of 2 pathogens
 - A predominant pathogen with a contaminant

Intermediate growth of a single pathogen

Imaging Tests

- Routine imaging of all children after a first UTI is inappropriate because it is neither clinically effective nor cost effective.

General indications for early imaging during UTI

- Failure to improve on appropriate antibiotic treatment; although there are several causes for this; early ultrasound is recommended to look for dilatation of the renal collecting system and ureters which may indicate obstruction
- The presence of an abdominal mass, poor urine flow, septicemia or raised creatinine may indicate obstruction and early ultrasound is recommended
- Children admitted with atypical UTI

Delayed imaging is recommended for

- Who are younger than 6 months
- Had a typical illness
- Recurrent UTIs

Ultrasonography (US)

Gives information on

- Renal size and shape
- Bladder size and configuration, bladder wall thickness
- Presence or absence of pelvicalyceal and ureteral dilatation

Indications

Inpatient

Acute ultrasonography during illness is indicated for:

- Children admitted with atypical UTI
- Children admitted and not responding to treatment within 48 hours
- Infants admitted under 3 months old.

Outpatient

Ultrasonography within 6 weeks of illness (unless done as an inpatient):

- Children under 12 months old with first febrile UTI
- Recurrent febrile UTI
- Atypical history (at discretion of the treating doctor)

Asymptomatic bacteriuria does not require routine imaging.

MCUG

Gives information on

- Bladder lesions
- Urethral lesions especially posterior urethral valves in boys
- Competence of vesicoureteric junction, the grade of vesicoureteric reflux (VUR) if present and classification of VUR

Indications

- Children <3 years with febrile UTI, presumptive upper tract, and especially young infants whose infections were serious at presentation
- Girls 3 to 6 years with febrile UTI + scar on DMSA scan, atypical UTI or recurrent UTI
- Girls ≥6 years with atypical UTI, or recurrent UTI + scar on DMSA scan
- Boys ≥3 years with presumptive upper tract UTI, or lower tract UTI and ultrasound abnormality (to exclude posterior valves)

Technetium Dimercaptosuccinic acid (DMSA) Scan

Gives information on:

- Focal area of decreased uptake indicating acute pyelonephritis in the acute stage
- Differential function of the 2 kidneys
- Established scars can only be diagnosed 3 months after an acute pyelonephritis
- Indications episode

- ***Indications***

- All children age <3 years with febrile UTI
- Children aged >3 years with clinical evidence of acute pyelonephritis or recurrent UTI

“Diethylene-triamine-penta-acetic acid-DTPA (or)” Technetium Mercaptoacetyltriglycine (MAG3) Diuretic renography with

Gives information on:

- Renal perfusion
- Uptake, perfusion and drainage of radio-tracer

- Differential function of both kidneys

Note: to distinguish between a true mechanical obstruction and nonobstructive pelvicalyceal dilatation, T% >20 mins

Indications

- Pelvicayceal dilation ≥ 1 cm on USG examination
- Vesicoureteric stenosis is suspected in the presence of ureteric dilatation or

USG examination and absence of VUR on MCUG

Table 7.8 Recommended imaging schedule for infants <6 months

Test	Responds well to treatment within 48 hours	Atypical UTI ^a	Recurrent UTI ^a
Ultrasound during the acute infection	No	Yes ^c	Yes
Ultrasound within 6 weeks	Yes ^b	No	No
DMSA 4-6 months following the acute	No	Yes	Yes
Infection	No	Yes	Yes
MCUG			
<i>a</i>See definitions bIf abnormal consider MCUG <i>c</i>In an infant or child with a non-Escherichia coli UTI, responding well to antibiotics and with no other features of atypical infection, the ultrasound can be requested on a non-urgent basis to take place within 6 weeks			

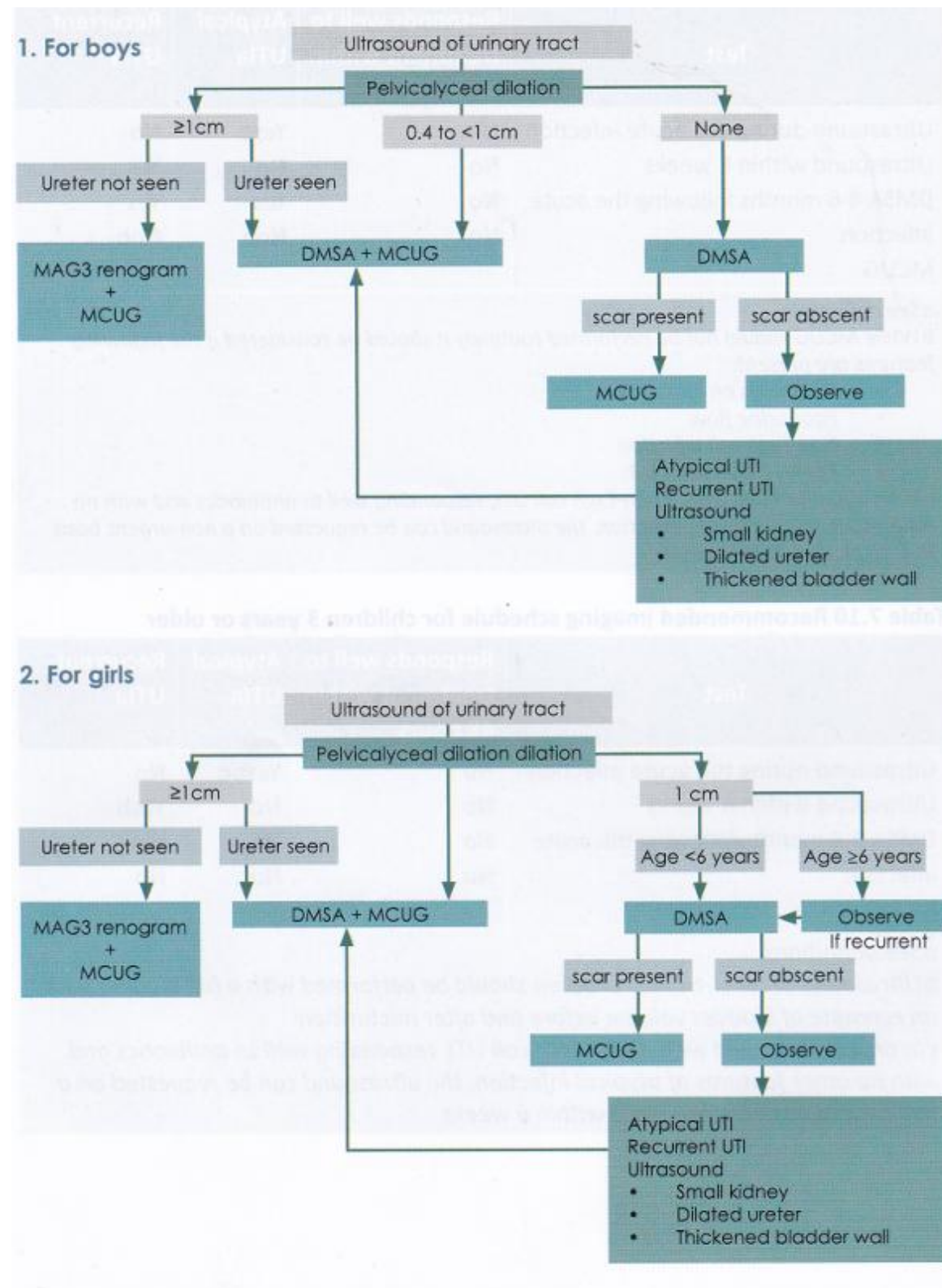
Table 7.9 Recommended imaging schedule for infants and children (6 months - 3 years)

Test	Responds well to treatment within 48 hours	Atypical UTI ^a	Recurrent UTI ^a
Ultrasound during the acute infection	No	Yes ^c	No
Ultrasound within 6 weeks	No	No	Yes
DMSA 4-6 months following the acute infection	No	Yes	Yes
MCUG	No	No ^b	No ^b
<i>a</i>See definitions <i>b</i>While MCUG should not be performed routinely it should be considered if the following features are present: • Dilatation on ultrasound • Poor urine flow • Non-Escherichia coli infection • Family history of VUR <i>c</i>In an infant or child with a non-Escherichia coli UTI, responding well to antibiotics and with no other features of atypical infection, the ultrasound can be requested on a non-urgent basis to take place within 6 weeks			

Table 7.10 Recommended imaging schedule for children 3 years or older

Test	Responds well to treatment within 48 hours	Atypical UTI^a	Recurrent UTI^a
Ultrasound during the acute infection	No	Yes ^b	No
Ultrasound within 6 weeks	No	No	Yes ^b
DMSA 4-6 months following the acute infection	No	No	Yes
MCUG	No	No	No
<i>^aSee definitions</i> <i>^bUltrasound in toilet-trained children should be performed with a full bladder with an estimate of bladder volume before and after micturition</i> <i>^cIn an infant or child with a non-Escherichia coli UTI, responding well to antibiotics and with no other features of atypical infection, the ultrasound can be requested on a non-urgent basis to take place within 6 weeks</i>			

Algorithm for Investigation of UTI



Management

Principles of treatment

- The drug of choice should be based on sensitivity patterns of the uropathogens as well as of recent antimicrobial treatment received by the patients
- The drug should have minimal adverse effects on the major organ systems
- A high concentration of the drug should be present in the urine after administration
- Oral antibiotics are efficacious in both lower and upper tract infections
- Urinary antiseptic such as nalidixic acid and nitrofurantoin should not be the initial drug of choice in upper tract UTI

Intravenous antibiotics

Intravenous antibiotics are indicated in

- Infants <3 months of age
- Poor oral intake.
- Dilating vesicoureteric reflux grade III-V
- Atypical or complicated UTI
- Intravenous single high-dose Gentamicin is the treatment of choice in all age groups changing to oral antibiotics depending on culture results
- IV Gentamicin and Ampicillin should be used in neonates until culture results are available
- IV Ceftriazone is the drug of choice in atypical or complicated UTI.
- Ceftriazone should be avoided in the first two weeks of life as it may affect bilirubin transport in the liver

In atypical or complicated UTI, if an aminoglycoside is required based on antibiotic sensitivity results, Amikacin is aminoglycoside of choice as its nephrotoxic potential may be lower than Gentamicin

Table 7.11 Frequency & dosage of antibiotics

Antibiotics (oral)	Frequency	Therapeutic dose (mg/kg/dose)	Prophylactic Dose (mg/kg)
Ampicillin/sulbactam	Q12H	15-25 (Ampicillin) (Maximum 2g)	
Amoxycillin	Q8H	10-25 (Maximum 1 g)	10
Amoxicillin/clavulanic acid	Q12H	10-25 (Amoxicillin) (Maximum 1 g)	
Cefaclor	Q8H	10-15 (Maximum 500 mg)	10
Cephalexin	Q6H Q12H	7.5 (Maximum 250 mg) 15 (Maximum 500 mg)	7.5
Cefuroxime	Q12-24H	10-15 (Maximum 500 mg)	
Ciprofloxacin	Q12H	5-10 (Maximum 500 mg)	
Cotrimoxazole Trimethoprim 80 mg Sulphamethoxazole 400 mg	Q12H	3-4 (TMP)	2
Nalidixic acid*#	Q6H	7.5-15 (maximum 100mg) reduce to 7.5 mg/kg/dose after 2 weeks (Maximum 50 mg)	15 Q12H
Nitrofurantoin*#	Q6H Q8H	1.5 (Maximum 100 mg) 2 (Maximum 100 mg)	1-2 (Maximum 100 mg)

*Contraindicated in patients with G6PD deficiency

#Avoid in infants <3 months

Table 7.12 Commonly used parenteral antibiotics

Antibiotics	Route	Frequency	Dose (mg/kg/dose)	Comment
Amikacin	IV, IM	Single daily dose	Term neonate; 15 1 W to 10 yrs: 25 (D1), then 18 >10 yrs: 20 (D1), then 15 (Maximum 1.5 g/day)	Renal adjustment
Ampicillin	I, IM	Q12H (W1) Q6H (W2-4) Q4-6H (W4+)	10-25 Severe:50 (Maximum 2 g)	Renal adjustment
Coamoxiclav	I, IM	Q8H	25-50	Renal adjustment
Ceftazidime	I, IM	Q8H	10-25 Severe:50	Renal adjustment
Ceftriaxone	I, IM	Q12-24	25-50	
Gentamicin	I, IM	Q24	Term neonate to 1:5 W 1 to 10 years: 8 (D 1), then 6 >10 years: 7 (D 1) then 5 (Maximum 240-360 mg/day)	Renal adjustment
Meropenem	IV	Q8 Q12H (W 1) Q8H (>W 1)	10-20 (Adult 0.5-1) Severe :20-40 (Maximum 2 g)	Renal adjustment

W-Week oflife, D1-Day 1 dose (Loading dose)

Infant less than 3 months with a possible UTI (High risk of serious illness- high fever of $>39^{\circ}\text{C}$, irritability, vomiting, moderate to severe dehydration)

- Give IV Inj Ceftriazone 50-75 mg/kg/ day BD (not $>2\text{ G}$) OR
- Inj ampicillin /Cefuroxime for 7-10 days.

For infants and children >3 months or older with acute pyelonephritis/ Upper UTI

- Oral Cephalosporin Dose: 25 mg/kg 8H for 7-10 days
- Oral Co-amoxiclav >1 year 5 ml (125/31 suspension),

>7 years 5 ml (250/62 suspension) 8H for 7-10 days

- If oral antibiotic cannot be used, give IV/IM Cefotaxime (or) Ceftriaxone 50-75 mg/kg/day/24 hr 2-4 days (Followed by oral antibiotics for total of 10 days)
- If there is clinical improvement and antibiotics was given according to definite sensitivity result do not need to repeat urine culture after completing treatment.
- If there is clinical improvement and antibiotics was given according to definite sensitivity result do not need to repeat urine culture after completing treatment.
- If the patient's clinical condition is not improved or there is no definite antibiotics to ensure infection has been eradicated, should repeat urine culture.

Infant and children >3 months or older with cystitis/ Lower UTI

- Give oral antibiotics for 3 days
 - Trimethoprim
 - Amoxicillin
 - Cephalosporin
- If the patient is unwell after 24-48 hours, give IV or IM Inj Gentamicin/ Amikacin once daily.
- For infants and children is receiving prophylactic medication and develops an infection; treatment should be a different antibiotics.
- If urine culture and sensitivity is obtained, treat UTI according to sensitivity

General Measures

- Timed voiding
- Prevent constipation
- perineal hygiene involving: proper wiping of perineum from front to back in girls
- keep perineal region dry
- wear cotton underwear

Prophylaxis

- Antibiotic prophylaxis should not be routinely recommended in infants and children following first-time UTI.
- Antibiotic prophylaxis may be considered in infants and children with recurrent UTI.
- Asymptomatic bacteriuria in infants and children should not be treated with prophylactic antibiotics
- Antibiotic prophylaxis is indicated in young children age <3 years with VUR grade III to V until age 3 years or at least 2 years after a febrile UTI
- Give as single dose **at night time**
 - Cotrimoxazole 1-2 mg /kg
 - Nitrofurantoin 1-2 mg/kg
 - Cephalosporin 12.5 mg/kg
 - Cefaclor 5-10 mg/kg

Follow Up

- Infants and children who do not undergo imaging investigations should not routinely be followed up.
- When results are normal, a follow-up outpatient appointment is not routinely required
- Infants and children who are asymptomatic following an episode of UTI should not routinely have their urine re-tested for infection
- Asymptomatic bacteriuria is not an indication for follow-up.

Children who required long term follow up

- Infants and children who have bilateral renal abnormalities, impaired kidney function, raised blood pressure and/or proteinuria should receive monitoring and appropriate management by a paediatric nephrologist to slow the progression of chronic kidney disease.

