Basic Principles of Pediatric Urinary Tract Infection (UTI) & Urinalysis (UA) Interpretation

Supervised by Dr. Amir Naghshzan (AmirNaghshzan@gmail.com)

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1. Definition

Urinary tract infection (UTI) is a bacterial infection involving the urinary tract, usually caused by **Escherichia coli** (>80%). It includes:

- **Lower UTI (Cystitis):** infection limited to the bladder
- **Upper UTI (Pyelonephritis):** infection involving the kidneys (more serious)

Clinical importance: Prompt diagnosis and treatment reduce the risk of renal scarring, hypertension, and chronic kidney disease.

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2. Clinical Presentation

Symptoms by Age

Age	Typical Presentation
Neonates	Fever or hypothermia, poor feeding, lethargy, vomiting, jaundice, irritability, sepsis
Infants (<2 yr)	Fever without source, vomiting, poor feeding, irritability, failure to thrive
Older children	Dysuria, frequency, urgency, suprapubic pain, foul-smelling urine
Pyelonephritis	Fever (>38.5°C), flank pain, vomiting, malaise, CVA tenderness

Important History

Ask about:

- Fever duration
- Dysuria
- Frequency/urgency

- Previous UTI
- Constipation
- Daytime wetting/enuresis
- Urinary stream abnormalities
- Congenital urinary anomalies
- Recent antibiotics
- Sexual activity (adolescents)

Physical Examination

Look for:

- Fever
- Hydration status
- Blood pressure
- Growth parameters
- Costovertebral angle tenderness
- Suprapubic tenderness
- Abdominal mass (hydronephrosis)
- External genital abnormalities
- Signs of spinal dysraphism (neurogenic bladder)

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3. Diagnostic Approach

Step 1. Suspect UTI

Think of UTI in:

✅ Fever without source (especially <2 years)

PLUS one or more:

- Dysuria
- Frequency
- Vomiting
- Abdominal pain
- Flank pain
- Previous UTI

Step 2. Obtain Urine Before Antibiotics

Preferred collection methods:

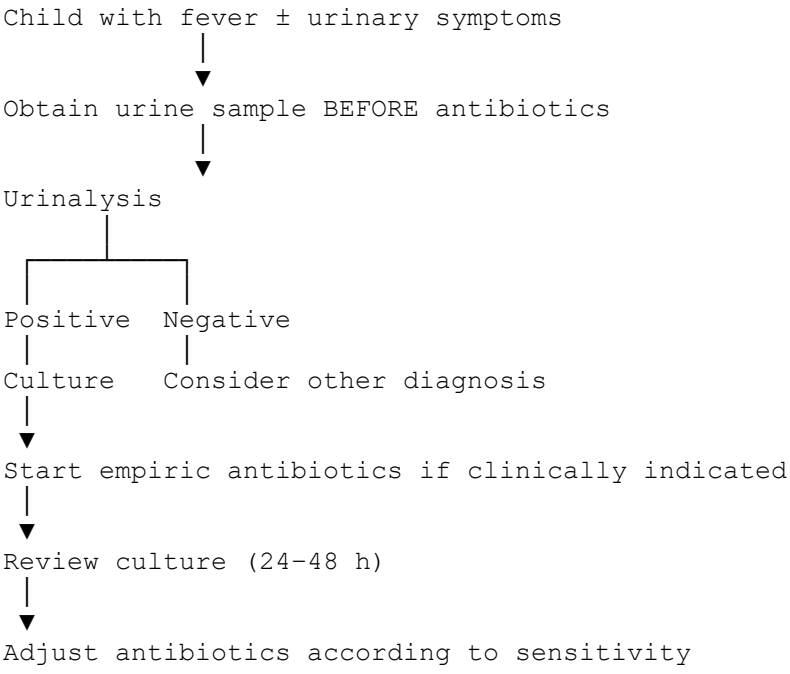
Toilet trained	Clean-catch midstream urine
Infants	Catheter specimen
Sick infant	Suprapubic aspiration (gold standard)

Avoid urine bags for culture (high contamination rate).

Step 3. Urinalysis

Positive UA strongly supports UTI.

Diagnostic Algorithm



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4. Differential Diagnosis

Consider:

- Viral illness
- Vulvovaginitis
- Urethritis (STIs)
- Appendicitis
- Gastroenteritis
- Constipation
- Kidney stones
- Trauma
- Interstitial nephritis
- Diabetes mellitus (polyuria)

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5. Investigations

A. Urinalysis (UA)

Leukocyte Esterase (LE)

- Indicates **white blood cells**
- Sensitive
- Positive → inflammation

Nitrite

- Indicates gram-negative bacteria
- Highly specific
- Less sensitive
- Negative result **does not exclude UTI**

Pyuria

Microscopy:

≥5 WBC/HPF strongly supports UTI.

Bacteriuria

Presence of bacteria on microscopy supports infection.

Hematuria

May occur in UTI but is nonspecific.

Protein

Small amount may occur with fever or UTI.

Heavy proteinuria suggests renal disease.

UA Interpretation Table

Leukocyte esterase	Nitrite	Interpretation
+	+	Very likely UTI
+	–	Possible UTI (send culture)
–	+	Likely UTI (repeat if uncertain)
–	–	UTI unlikely (unless high clinical suspicion)

Urine Culture

Gold standard

Significant growth:

Collection Method	Significant Growth
Clean catch	≥100,000 CFU/mL
Catheter	≥50,000 CFU/mL (with pyuria)
Suprapubic aspiration	Any bacterial growth

Blood Tests (Only if indicated)

- CBC
- CRP
- Procalcitonin
- Blood culture (toxic infant)
- Electrolytes
- Creatinine

Imaging

Renal-Bladder Ultrasound (RBUS)

Recommended:

- First febrile UTI in infants <24 months
- Recurrent febrile UTIs
- Poor response to therapy
- Abnormal urinary tract examination

VCUG

Only if:

- Abnormal ultrasound
- Recurrent febrile UTIs
- Suspected vesicoureteral reflux (VUR)

Not routinely performed after the first uncomplicated UTI.

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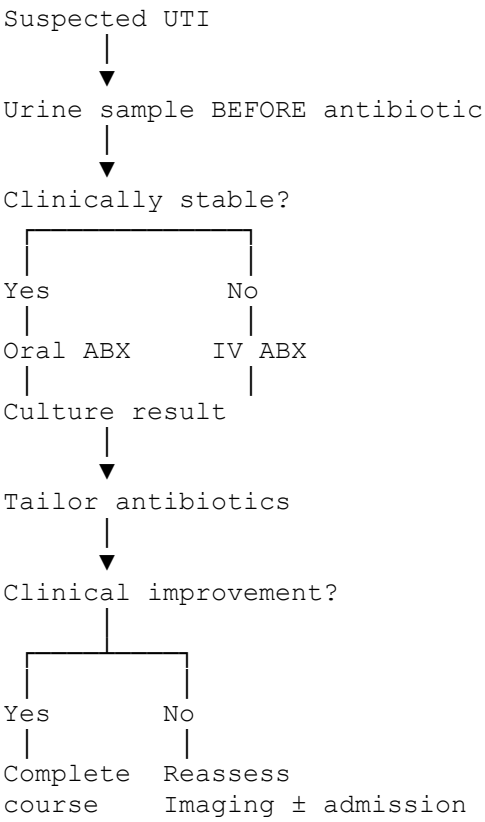
6. Management Algorithm



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7. Drug Summary Table

Drug	Dose	Indication
Cephalexin	50–100 mg/kg/day PO ÷ 3–4 doses	Uncomplicated cystitis
Amoxicillin-clavulanate	25–45 mg/kg/day (amoxicillin component) PO ÷ 2 doses	Alternative oral therapy
Cefixime	8 mg/kg/day PO once daily	Febrile UTI / pyelonephritis (oral)
Ceftriaxone	50–75 mg/kg/day IV/IM once daily	Hospitalized patients
Gentamicin	7 mg/kg IV once daily*	Severe infection (monitor renal function)

*Dose may vary by age and local protocol.

Duration

Diagnosis	Duration
Simple cystitis	3–5 days (older children); 5–7 days in younger children
Febrile UTI/Pyelonephritis	7–10 days (up to 14 days in complicated cases)

Supportive Care

- Adequate hydration
- Antipyretics
- Pain control
- Treat constipation
- Encourage regular voiding

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8. Admission Criteria

Admit if:

- Neonate (<28 days) with suspected UTI
- Toxic appearance
- Sepsis
- Persistent vomiting
- Unable to tolerate oral medications
- Severe dehydration
- Urinary obstruction
- Renal abscess suspected
- Immunocompromised child
- Poor social support or unreliable follow-up
- Failure of outpatient treatment

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9. Referral Criteria

Refer to Pediatrics/Urology/Nephrology if:

- Recurrent febrile UTIs
- Abnormal renal ultrasound
- Vesicoureteral reflux
- Hydronephrosis

- Obstructive uropathy
- Renal scarring
- Poor growth
- Resistant organisms
- Neurogenic bladder
- Suspected urinary tract anomaly

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10. Follow-Up

- Review urine culture within **24–48 hours** and adjust antibiotics if needed.
- Reassess if fever persists beyond **48–72 hours**.
- Reinforce hydration, timed voiding, and constipation management.
- Routine repeat urine culture is **not needed** after clinical recovery in uncomplicated cases.
- Arrange imaging when indicated (e.g., RBUS after first febrile UTI in young children).

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11. Clinical Pearls

- **Fever without source in infants is UTI until proven otherwise.**
- Obtain urine **before antibiotics** whenever possible.
- Positive **nitrite** is highly specific for bacterial UTI.
- Negative nitrite **does not exclude** UTI.
- **Pyuria + positive culture** confirms infection.
- Most UTIs are caused by **E. coli**.
- Treat constipation and bladder dysfunction to reduce recurrence.
- Avoid treating **asymptomatic bacteriuria** in otherwise healthy children.

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12. Common Mistakes in Exams and Practice

❌ Starting antibiotics before obtaining urine.

❌ Using bag urine for culture.

❌ Assuming a negative nitrite excludes UTI.

❌ Missing UTI in an infant with unexplained fever.

❌ Forgetting to review culture and tailor antibiotics.

❌ Performing VCUG after every first UTI.

❌ Treating asymptomatic bacteriuria unnecessarily.

❌ Ignoring bowel and bladder dysfunction as a cause of recurrent UTI.

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13. Key Take-Home Messages

1. UTI is one of the most common serious bacterial infections in children.
2. Fever without a source in infants should prompt evaluation for UTI.
3. Always collect urine **before** antibiotic therapy.
4. Urinalysis supports diagnosis, but **urine culture is the gold standard**.
5. Positive leukocyte esterase and nitrite strongly suggest UTI.
6. Start empiric antibiotics promptly in children with suspected febrile UTI after urine collection.
7. Tailor antibiotic therapy according to culture and susceptibility results.
8. Admit infants, toxic children, or those unable to tolerate oral therapy.
9. Renal-bladder ultrasound is indicated after the first febrile UTI in young children; VCUG is reserved for selected cases.
10. Early diagnosis and appropriate treatment help prevent renal scarring and recurrent infections.

High-Yield Examination Box

Finding	Clinical Significance
LE (+) + Nitrite (+)	Strong evidence for bacterial UTI
Pyuria without bacteriuria	Consider partially treated UTI or noninfectious inflammation
Positive nitrite alone	Highly specific for gram-negative UTI
Fever >38.5°C + flank pain	Suggests pyelonephritis
Persistent fever after 48–72 h of therapy	Reassess diagnosis, resistance, adherence, or urinary tract obstruction
Bag urine culture	Not reliable for diagnosis due to contamination

Suggested References

1. American Academy of Pediatrics. Clinical Practice Guideline for the Diagnosis and Management of the Initial Febrile UTI in Febrile Infants and Young Children (updated recommendations).
2. National Institute for Health and Care Excellence (NICE). *Urinary tract infection in under 16s: diagnosis and management*.
3. European Association of Urology (EAU) & European Society for Paediatric Urology (ESPU). *Guidelines on Paediatric Urology*.
4. Infectious Diseases Society of America (IDSA). Principles of antimicrobial therapy and urinary tract infection management.
5. Nelson Textbook of Pediatrics, 22nd edition.
6. UpToDate. *Urinary tract infections in infants and children: Clinical features, diagnosis, treatment, and imaging*.