National Guidelines on the Empiric Antibiotic Treatment of Urinary Tract Infections in Pediatrics

Version 1: May 2024

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Purpose & Scope

1.1 The National Sub-Committee for Antimicrobial Stewardship has compiled this guideline on the empiric antibiotic management of urinary tract infection (UTI) in pediatrics to provide the healthcare professionals with evidence-based information and recommendations for the antibiotic treatment of pediatric UTI. The guideline is based on the best current clinical evidence, taking into consideration the antimicrobial resistance patterns and trends in the United Arab Emirates (UAE); however, they can never replace clinical expertise when making treatment decisions for individual patients, but rather help to focus decisions. This guideline is subject to revision and will be modified based on changes in international guidelines and UAE's national antibiogram when applicable.

1.2 The National Antimicrobial Stewardship Committee strongly recommends either adopting this guideline or developing/amending a facility-based guideline using this document as a reference tool.

1.3 The committee panel is composed of infectious diseases specialists, infection control practitioners, medical intensivists, epidemiologists, public health specialists, microbiologists, clinical pharmacists, and researchers practicing in government, private and academic sectors. The national multidisciplinary taskforce that complied this guideline composed of members from across different institutions in the UAE with expertise in pediatrics, infectious diseases, nephrology, microbiology, urology, and infectious diseases clinical pharmacy.

Acknowledgment

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Published by: Ministry of Health and Prevention UAE, in electronic format only.

Policy statement

1.1 The guideline is applicable to all pediatric patients (up to 16 years of age) with suspected or confirmed urinary tract infection.

1.2 As the age of the patient at presentation is an important factor regarding clinical management, specific recommendations are, where relevant, stratified by age.

1.3 The guidelines are not applicable to children with known primary or secondary immunodeficiency.

Definitions

1.4 The most widely used international classification systems of urinary tract infection depend of the site, episode, symptoms and complication factors. The site and severity are the most important factors for acute treatment.

1.5 For the purpose of these guidelines, we are using the following definitions/categories:

1.5.1 **Urinary tract infection (UTI):** The presence of clinical signs and symptoms in combination with pyuria and significant bacteriuria.

1.5.2 **Cystitis (lower urinary tract):** Inflammation of the urinary bladder mucosa with symptoms including dysuria, frequency, urgency, malodorous urine, incontinence, hematuria, and suprapubic pain. In neonates and infants, these symptoms are rarely diagnosed accurately. Cystitis is particularly common in girls > 2 years of age.

1.5.3 **Pyelonephritis (upper urinary tract):** Diffuse pyogenic infection of the renal pelvis and parenchyma with symptoms and signs including fever, dysuria, and loin tenderness. Neonates and infants may have nonspecific signs and symptoms such as poor feeding, failure to thrive, lethargy, irritability, jaundice, vomiting or diarrhea, even without fever.

1.5.4 **Differentiating between pyelonephritis and cystitis**: The differentiation between upper (pyelonephritis) and lower (cystitis) UTI is crucial for appropriate management. Infants and young children who have bacteriuria and fever should be considered having acute pyelonephritis rather than cystitis.

1.5.5 **Uncomplicated UTI:** Infection in a child with a normal structure and function of the upper and lower urinary tract, normal renal function, and a competent immune system.

1.5.6 **Complicated UTI:** UTI in neonates; abdominal and/or abdominal mass; kidney or urinary tract anomalies; urosepsis; organisms other than E. coli; atypical clinical course including absence of clinical response to antibiotic within 72 h; and renal abscess.

1.5.7 **Asymptomatic bacteriuria (ABU):** Significant bacteriuria in a child with no symptoms of UTI and irrespective of the presence of pyuria.

1.5.8 **Pyuria:** Defined as the presence of white blood cells in the urine. Pyuria is suggestive of, but not diagnostic for, UTI.

Abbreviations

AAP: American Academy of Pediatrics.

ABU: Asymptomatic bacteriuria.

AST: Antimicrobial sensitivity testing.

BBD: Bladder-bowel dysfunction

CFU: Colony-forming unit.

DMSA: Dimercaptosuccinic acid.

EAU/ESPU: European Association of Urology/ European Society for Paediatric Urology.

LE: Leukocyte esterase.

MSU: Midstream urine.

SPA: Suprapubic aspiration.

UAE: United Arab Emirates.

US-KUB: Ultrasound Kidney and Urinary Bladder.

UTI: Urinary tract infection.

VCUG: Voiding cystourethrogram.

VUR: Vesicoureteric reflux.

WHO: World Health Organization.

Procedure and Responsibility

Recommendations		Responsibilities
1.1	**Clinical Suspicion of UTI** • UTI should be ruled out in preverbal children with unexplained fever and in older children with symptoms suggestive of UTI. • A targeted history and physical examination are essential and should include details on pre-existing factors which increase the risk of developing UTI as outlined in attachment 1.	**Physician**
1.2	**Methods of Urine collection and Transport of Urine Samples** • Urine sampling should be performed before administering antibiotic to exclude or confirm UTI. However, treatment should not be delayed if a urine sample cannot be obtained in children with a high risk of serious illness (e.g., septic patients). • In newborns, infants, and non-toilet-trained children: bladder catheterization and SPA are preferred methods of urine collection and are considered the "gold standard" for a reliable UTI diagnosis. • A "clean catch" urine sample is associated with higher contamination rates compared with samples obtained by catheterization and SPA. This method is not endorsed by the AAP. • "Urine collection bags" should not be used to obtain urine for culture due to the high risk of contamination and false-positive results. Bag specimens can be used as an initial screen to rule out UTI when the results of dipstick urinalysis are negative or to proceed with culture with subsequent specimen obtained by catheterization or SPA if the urinalysis result is positive. • In older, toilet-trained children: MSU is the preferred method after cleaning of skin around genital area.	**Physician/ nurse**

	• Urine specimens should be promptly transported and tested in the laboratory within 1 hour after voiding at room temperature. If delay of testing is expected, specimens can be refrigerated or preserved in boric acid to prevent overgrowth of bacteria.	
1.3	**Urinalysis and Urine Culture** • The diagnosis of UTI requires urinalysis and urine culture. Urinalysis/dipstick (LE and nitrite) or microscopy (pyuria and bacteriuria) alone is not sufficient to definitely confirm UTI. • In newborns below 3 weeks: both urinalysis and urine culture should be performed. • In infants older than three weeks: we recommend a two-step procedure where the urine sample is screened by dipstick testing and if positive (LE or nitrite or both), specimen is sent for culture. • Independent of age: we recommend both urinalysis and urine culture in cases of suspected acute pyelonephritis, septic patient, recurrent UTI, no response to treatment within 24-48 hours, clinical signs and symptoms not correlating with urinalysis result.	**Physician**
1.4	**Definition of a Positive Urine Culture** • Minimum colony counts in urine culture that are indicative of urinary tract infection are variable depending on the method of urine collection and type of the international guidelines. • According to the AAP guidelines, the diagnosis of UTI in children aged 2-24 months requires microscopic urinalysis results suggestive of infection (pyuria with or without bacteriuria) and the presence of ≥ 5×10^4 CFU/mL of a single uropathogen cultured from a catheter or SPA urine specimens. • Lower counts are recommended by the EAU/ESPU guidelines in which urine cultures from clean-catch midstream and catheterization can be considered positive at 10^3-10^4 CFU/mL of a single uropathogen and for SPA, any count constitutes a positive culture. This is particularly relevant for younger infants (< 2 months) with frequent urination. Other European countries	**Physician/ Microbiologist**

	such as the UK consider counts of ≥10^5 CFU/mL from midstream clean catch collection as significant. • As the minimum colony count guidelines continue to evolve with the emergence of new studies, we recommend using the AAP guidelines for older children and the EAU/ESPU guidelines for younger infants to define a positive urine culture. • However, urine culture alone should not be used as a single criterion to make a diagnosis of a UTI but should always be considered in the context of clinical situation (previous history, risk factors, clinical findings, and urinalysis results) to make the best possible diagnosis. • Healthcare providers should also be aware of urine culture contamination. • Indicators of urine culture contamination include 1. Mixed growth or growth of multiple organisms. 2. Low bacterial colony count. 3. The presence of high number of squamous epithelial cells in urinalysis. 4. Presence of non uro-pathogens including most coagulase-negative staphylococci, Lactobacillus and Corynebacterium species.	
1.5	**Microbiology of UTI (pathogens in the pediatric population)** • UTI in children is commonly caused by enteric Gram-negative rods (*E. coli* being the principal pathogen, *Klebsiella pneumoniae*, and *Proteus species*). • Less common pathogens include Enterobacter species, Citrobacter species, Serratia species, *Staphylococcus saprophyticus* (in adolescent females) and Enterococcus species. • Organisms such as *Pseudomonas aeruginosa*, group B Streptococcus and *S. aureus* are usually associated with congenital anomalies of the kidney and urinary tract, genitourinary surgery, a foreign body (e.g., catheter) or recent antibiotic treatment. • Urea-splitting organisms such as Proteus species are associated with stone formation. • In the UAE, *E. coli* represents the principal uropathogen (56.4%) followed by *Klebsiella pneumoniae* (12.8%) in children (0-16 years old); Attachment 2 shows the distribution of urinary pathogens among children in the UAE during the period from 2021-2022.	**Physician/ Microbiologist**

	• Attachment 3 demonstrates the national cumulative antibiogram for the two most common UTI pathogens in the pediatric population by age group (a) and location type (b).	

1.6	**Treatment of UTI**
	
	• The choice of empiric antibiotic and route of administration should be based on the age of the child, severity of illness, underlying medical and/or urological problems, patient's previous urine culture (if available) and the local antimicrobial resistance patterns. (Attachments 4, 5,)
	  ○ In ***newborns and infants ≤ 2 months***, we recommend starting with parenteral antibiotic therapy due to the increased risk of urosepsis in this age group.
	  ▪ In the presence of fever in this age group, other invasive infections such as meningitis and sepsis should also be ruled out.
	  ▪ Empiric antibiotic therapy should cover for those invasive infections.
	  ▪ Clinicians need to be familiar with fever guidelines in this age group. Fever guidelines are not included in this document.
	  ○ In ***infants and children older than 2 months*** who are in good general condition (i.e., nontoxic), initiating antibiotic therapy orally or parenterally is equally efficacious. We, therefore, recommend initial treatment with oral antibiotic for febrile UTIs in nontoxic children with no known structural urological abnormality, assuming child will tolerate every oral dose.
	  ○ For children with ***complicated UTIs***, we recommend parenteral antibiotic therapy rather than oral antibiotics until the child is clearly improving.
	• Adjustment of the initial/empiric antibiotic therapy should be done according to the antimicrobial sensitivity testing (AST) of the isolated uropathogen.
	• Aminoglycoside levels and renal function need to be monitored when aminoglycoside is continued > 48 hours.
	• On days 3 to 5 following UTI diagnosis and start of empiric antibiotic therapy, children should be clinically reviewed to assess response to treatment and confirming the diagnosis. Urine
		Physician

	culture results should be reviewed. If there is no significant growth from the urine, the empiric treatment should be stopped and an alternative diagnosis evaluated. • In situations where the isolated uropathogen, is resistant to the empiric antibiotics that were chosen, or if the susceptibility pattern of the isolate is limited to antibiotics that cannot be given orally, we recommend consulting specialist/consultant in pediatric infectious diseases for further guidance on treatment options and infection control measures. • Screening and treatment of asymptomatic bacteriuria (ABU) should be discouraged in pediatric population.	
1.7	**Indications/Choices for Long-Term Antibiotic Prophylaxis** • Antibiotic prophylaxis has modest benefits in reducing the risk of recurrent UTI, increases the risk of antibiotic resistance and therefore should not be routinely used after the first or second UTI in otherwise healthy children. • In certain circumstances, antibiotic prophylaxis may be indicated (only after consultation with pediatric nephrologist, urologist and/or pediatric infectious disease consultant). Examples of potential indications include: o Children with high grade VUR (WHO grades III-V) o Children with congenital anomaly of the kidney and urinary tract undergoing surgery • There are no evidence-based guidelines on the optimal duration of antibiotic prophylaxis. The indication should be reviewed after 6-12 months. • Choices of antibiotic prophylaxis (based on patients antibiogram) include: o Trimethoprim o Trimethoprim/Sulfamethoxazole o Nitrofurantoin	**Physician**
1.8	**Bladder-Bowel Dysfunction (BBD) as Risk Factor for Recurrent UTI** • BBD is a significant UTI risk factor in children, especially those who are toilet-trained.	**Physician**

	• BBD describes a spectrum of lower urinary symptoms (e.g., dysfunctional voiding during daytime and lack of complete bladder emptying (residual urine) accompanied by faecal elimination issues that manifest primarily by constipation and/or encopresis. • We recommend that every child with febrile or recurrent UTI be screened for BBD. If there are signs of BBD during infection-free interval, further diagnosis and treatment including treatment of constipation is recommended.	
1.9	**Surgical referral** • Surgical and endoscopic intervention should be considered in selected cases and on an individual basis. • Common indications for surgical referral include high-grade VUR with recurrent infections despite antibiotics prophylaxis, non-compliance or non-tolerance of prophylactic antibiotics and worsening renal scars on DMSA.	**Physician**
1.10	**Roles and Responsibilities of Pharmacist/Clinical Pharmacist** • Ensure availability of recommended antibiotic agents for the treatment of UTIs. • Review / verify antibiotic order for appropriateness in selection, dose and duration. • Recommend for culture streamline/de-escalation upon release of culture result. • Recommend for intravenous to oral switch when applicable. • Follow up antibiotic therapeutic drug monitoring and recommend dose adjustment, if needed.	**Pharmacist /Clinical pharmacist**

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Key Performance Indicators

Compliance with hospital first line empiric antibiotic for treatment of UTI (In-patient, Out-patient)

- (In-patient) Numerator/Denominator: Number of in-patients diagnosed with UTIs receiving appropriate empiric antibiotic(s) as per UTI guidelines in a calendar month/Total number of in-patients diagnosed with UTIs in the same calendar month X 100
- (Out-patient) Numerator/Denominator: Number of out-patients diagnosed with UTIs receiving appropriate empiric antibiotic(s) as per UTI guidelines in a calendar month/Total number of out-patients diagnosed with UTIs in the same calendar month X 100

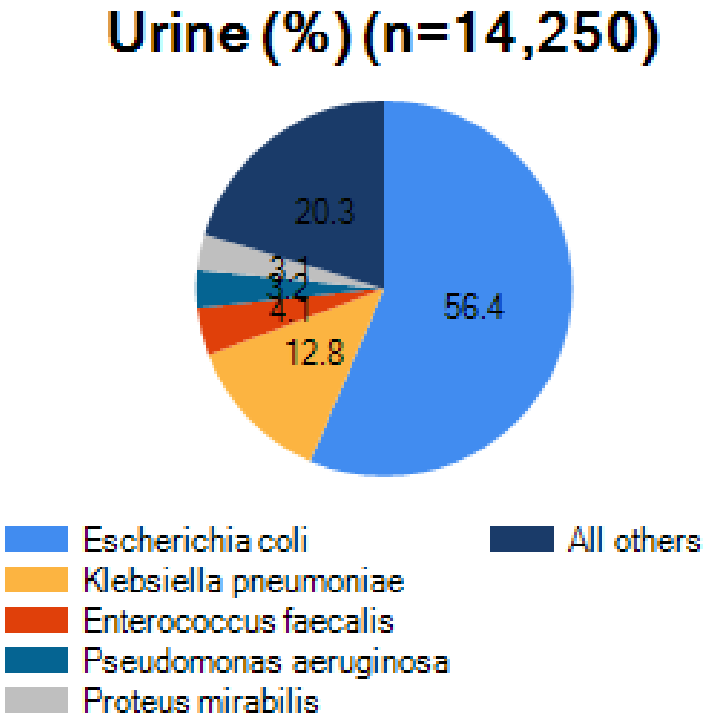
Compliance with duration of antibiotic for treatment of UTI

- (In-patient) Numerator/Denominator: Number of in-patients diagnosed with UTIs receiving appropriate duration of antibiotic(s) as per UTI guidelines in a calendar month/Total number of in-patients diagnosed with UTIs in the same calendar month X 100
- (Out-patient) Numerator/Denominator: Number of out-patients diagnosed with UTIs receiving appropriate duration of antibiotic(s) as per UTI guidelines in a calendar month/Total number of out-patients diagnosed with UTIs in the same calendar month X 100

Attachment 1: Medical Evaluation of a Child with Suspected Urinary Tract Infection (UTI)

Important information to obtain in history	Important findings on physical examination
• Age and sex • Fever (≥38 °C) or hypothermia (in neonates) • Urinary symptoms (dysuria, frequency, urgency, withholding, new onset incontinence, hematuria, urine odor and color) in older and verbal children • Abdominal, flank or back pain • Oral intake, nausea and vomiting • Constipation and diarrhea • Activity level • History of UTI (History should be carefully confirmed to ensure that UTI was properly diagnosed and managed and urine sample was properly collected) • History of antibiotic use • Antenatally diagnosed genitourinary abnormality • Circumcision status	• General condition, level of consciousness and hydration status • Vital signs • Growth and development • Lower abdominal or flank tenderness • External genitalia examination (vulvovaginitis, balanitis, phimosis and circumcision status in male) • Evidence of urinary tract obstruction (abdominal distension or mass, flank swelling and palpable bladder, particularly after voiding)
Risk factors for the development of UTI	
• Uncircumcised boys and female sex • History of UTI • Family history of UTI • Congenital anomalies of the genitourinary system • Vesicoureteral reflux (VUR) • Constipation and bladder bowel dysfunction (BBD) • Urethral instrumentation (e.g., indwelling bladder catheterization) • Poor personal hygiene and inappropriate and/or prolonged use of diapers • Sexual abuse • Nephrolithiasis • Diabetes mellitus • Immune compromised children	

Attachment 2: Most Common Organisms Causing Pediatric UTI in UAE (2021-2022)
(Numbers Represent the Percentage of Isolates)



Attachment 3A: National Cumulative Antibiogram for UTI pathogens in the pediatric population (0-16 years): Percent susceptible isolates (%S) for Escherichia coli (isolates from urinary tract), by age category, United Arab Emirates, 1/1/2021-31/12/2022

	E. coli (N=8,473)				
			Age category		
Antibiotic	N (All)	%S (All)	%S ≤30 days N=177	%S 31-90 days N=334	%S 4 m-16 yrs N=7,962
Ampicillin	8,116	**40**	35	29	41
Ampicillin + Gentamicin	7,733	**92**	90	88	92
Ampicillin + Amikacin	6,633	**100**	100	99	100
Ampicillin + Cefotaxime	5,148	**71**	64	61	72
Ampicillin + Ceftriaxone	3,343	**69**	71	63	69
Amoxicillin/Clavulanic acid	8,322	**77**	78	73	78
Amoxicillin/Clavulanic acid + Gentamicin	7,952	**96**	94	95	96
Amoxicillin/Clavulanic acid + Amikacin	6,872	**100**	100	99	100
Piperacillin/Tazobactam	8,473	**95**	96	94	95
Cefuroxime (II.)[A]	4,220	**60**	54	53	61
Cefoxitin (II.)	912	**89**	77	93	89
Cefotaxime (III.)	5,339	**71**	64	60	71
Cefpodoxime (III.)	831	**69**	67	61	69
Ceftriaxone (III.)	4,273	**69**	74	64	69
Ceftriaxone (III.) + Gentamicin	3,613	**94**	98	93	94
Ceftriaxone (III.) + Amikacin	3,461	**100**	100	100	100
Ceftazidime (III.)	6,765	**82**	84	74	83
Ceftazidime (III.) + Gentamicin	6,457	**96**	95	94	97
Ceftazidime (III.) + Amikacin	5,434	**100**	100	99	100
Cefepime (IV.)	7,270	**81**	83	76	82
Cefepime (IV.) + Gentamicin	6,951	**96**	94	95	96
Cefepime (IV.) + Amikacin	6,789	**100**	100	99	100
Cefepime (IV.) + Tobramycin	209	**98**	-	-	99
Meropenem	7,374	**99**	98	98	99
Meropenem + Tobramycin	873	**100**	100	100	100
Imipenem	6,822	**98**	99	97	98
Ertapenem	6,215	**98**	96	97	98
Amikacin	7,161	**100**	100	99	100
Gentamicin	8,386	**92**	89	88	92
Ciprofloxacin	7,320	**69**	69	59	70
Trimethoprim/Sulfamethoxazole	8,244	**66**	68	59	66
Fosfomycin	3,834	**N/A**[B]	N/A[B]	N/A[B]	N/A[B]
Nitrofurantoin	8,247	**95**	98	95	95

[A] Cefuroxime: oral breakpoints [B] *E. coli* is usually susceptible to fosfomycin, while *K. pneumoniae* shows moderate susceptibility (Pal T, 2017) (Al-Zarouni M, 2012) (Abdullah AA, 2005) (Falagas ME, 2016) (Linsenmeyer K, 2016) (Matthews PC, 2016). *Data source: UAE National AMR Surveillance System. Data shown is from 341 surveillance sites (90 hospitals, 251 centers/clinics), 1/1/2021-31/12-/2022. Data is from non-duplicate urinary tract isolates only, children 0-16 years (first isolate per patient). Note: The Antibiogram with %S for Antimicrobial Agent Combinations is included to indicate the increased coverage with the combination over the individual drugs alone. The susceptibility estimates obtained in this manner are not derived from in-vitro synergy testing and do not consider potential synergistic or antagonistic interactions between the compounds. These statistics in no way imply that two drugs are necessarily better than one for treatment of patients with infection caused by the organism*

Attachment 3B: National Cumulative Antibiogram for UTI pathogens in the pediatric population (0-16 years): Percent susceptible isolates (%S) for Klebsiella pneumoniae (isolates from urinary tract), by age category, United Arab Emirates, 1/1/2021-31/12/2022

K. pneumoniae (N=1,912)				
		Age category		
N (All)	**%S (All)**	**%S ≤30 days** N=161	**%S 31-90 days** N=228	**%S 4 m-16 yrs** N=1,523
N/A	**R**	R	R	R
N/A	**-**	**-**	**-**	**-**
N/A	**-**	-	-	-
N/A	**-**	**-**	**-**	**-**
N/A	**-**	-	-	-
1,887	**80**	78	100	80
1,809	**97**	94	97	97
1,569	**100**	100	100	100
1,827	**90**	89	91	90
982	**68**	66	67	68
207	**92**	100	100	90
1,185	**81**	71	78	83
194	**76**	79	81	75
996	**77**	69	80	78
845	**96**	80	97	97
806	**100**	100	100	100
1,479	**82**	75	81	83
1,407	**96**	88	95	97
1,167	**100**	100	100	100
1,666	**88**	82	88	88
1,595	**97**	88	97	98
1,564	**100**	100	100	100
40	**97**	-	-	97
1,644	**97**	98	97	97
203	**100**	100	100	99
1,522	**97**	99	97	97
1,384	**95**	98	96	94
1,615	**100**	100	100	100
1,902	**95**	87	94	95
1,653	**81**	79	85	81
1,876	**83**	78	87	82
2,852	**N/A**[B]	N/A[B]	N/A[B]	N/A[B]
1,836	**36**	31	34	37

[A] Cefuroxime: oral breakpoints [B] *E. coli* is usually susceptible to fosfomycin, while *K. pneumoniae* shows moderate susceptibility (Pal T, 2017) (Al-Zarouni M, 2012) (Abdullah AA, 2005) (Falagas ME, 2016) (Linsenmeyer K, 2016) (Matthews PC, 2016). *Data source: UAE National AMR Surveillance System. Data shown is from 341 surveillance sites (90 hospitals, 251 centers/clinics), 1/1/2021-31/12-/2022. Data is from non-duplicate urinary tract isolates only, children 0-16 years (first isolate per patient). Note: The Antibiogram with %S for Antimicrobial Agent Combinations is included to indicate the increased coverage with the combination over the individual drugs alone. The susceptibility estimates obtained in this manner are not derived from in-vitro synergy testing and do not consider potential synergistic or antagonistic interactions between the compounds. These statistics in no way imply that two drugs are necessarily better than one for treatment of patients with infection caused by the organism*

Attachment 4: Empiric Antibiotic Therapy for Uncomplicated and Complicated Pyelonephritis in Pediatrics

< 30 days[1]	31-90 days[1]	Older than 91 days (> 3 months)
➢ Ampicillin + Gentamicin IV **OR** ➢ Ampicillin + Ceftazidime IV pending culture and AST results. ➢ 7-10 days total and longer if associated with sepsis/meningitis (consult pediatric infectious diseases)	➢ Ceftazidime + Gentamicin or Ceftazidime alone ➢ Switch to oral therapy (in line with AST) is acceptable if good clinical response and tolerating oral feeding. ➢ 7-10 days total and longer if associated with sepsis/meningitis (consult pediatric infectious diseases)	➢ Acute **Uncomplicated Upper UTI** (Pyelonephritis): not sick, tolerating oral feeding, up to date immunization and normal inflammatory markers. o Oral Amoxicillin Clavulanate o Oral Cefixime ➢ Acute **Complicated Upper UTI**: (Pyelonephritis with comorbid medical conditions, clinically unwell, not tolerating oral feeding) o Ceftazidime IV o Cefepime IV o Ceftazidime IV + Gentamicin IV o Cefepime IV + Gentamicin IV ➢ Acute **Complicated Upper UTI**: (Pyelonephritis with comorbid medical conditions AND documented or suspected ceftriaxone-resistant ESBL-positive strains based on previous urine culture results) o Ertapenem IV, Meropenem IV, Imipenem / Cilastatin IV OR Piperacillin / Tazobactam (*consultation with pediatric infectious disease is highly recommended in these cases*) ➢ Switch to oral therapy (in line with AST) is acceptable if good clinical response and tolerating oral feeding. ➢ 7-10 days total

[1] *In the presence of fever in this age group, other invasive infections such as meningitis and sepsis should be ruled out. The suggested empiric antibiotic therapy takes into consideration the coverage of those invasive infections as well as the most common UTI pathogens. Nevertheless, clinicians need to be familiar with fever guidelines for this age group.* ***Fever guidelines are NOT included in this document and institutions are highly encouraged to develop their own fever in neonates and infants' guidelines or adopt existing guidelines.***

Attachment 5: Empiric Antibiotic Therapy for Bacterial Cystitis in Children Older Than 2 Years

(**Important Note:** Diagnosis of cystitis (lower UTI) should only be considered in children older than 2 years as it is difficult to distinguish cystitis from pyelonephritis on clinical grounds in the younger children. Young children with suspected UTI are usually assumed to have upper UTI/pyelonephritis)

Uncomplicated cystitis (afebrile and tolerating oral feeding)	• Oral Nitrofurantoin • Oral Amoxicillin Clavulanate • Oral third generation cephalosporin (Cefdinir, Cefixime) • Duration: 2-4 days
Complicated cystitis (coexisting upper UTI, multiple-drug resistant uropathogens, or hosts with special considerations (e.g., anatomic or physiologic abnormality of the urinary tract, indwelling bladder catheter)	Treatment recommendations are individualized according to clinical status, underlying problem(s), and previous culture results and susceptibilities. Please consult pediatric infectious diseases for optimal treatment recommendation.

Attachment 6: Treatment Dose of Antibiotic in Infant and Children with UTI (Normal Renal Function)

Antibiotic	Dose	Remarks
PARENTERAL		
Ampicillin	IM, IV: 50 to 200 mg/kg/day divided every 6 hours; higher doses 300 to 400 mg/kg/day; recommended for some infections (e.g. meningitis) maximum per day 12 g	
Amoxicillin/ Clavulanate	Dose based on amoxicillin **<3 months or weighing <4Kg** 5:1 Formulation IV 25 mg/Kg/dose every 12 hours 10:1 Formulation IV 50 mg/Kg/dose every 12 hours **≥3months or weighing ≥4Kg** Formulation (5:1) IV 25 mg/Kg/dose every 8 hours; maximum per dose 1g amoxicillin Formulation (10:1) IV 50 mg/kg/dose every 8 hours; maximum per dose 2g amoxicillin weighing ≥40 kg: 2g amoxicillin every 8 to 12 hours	5:1 formulation -amoxicillin 500mg/ clavulanate 100 mg -amoxicillin 1000mg/ clavulanate 200 mg 10:1 formulation -amoxicillin 2000mg/ clavulanate 200mg Daily doses of clavulanic acid over 10 mg/kg/day or 125 mg/dose are linked with higher risk of excessive diarrhea
Ceftazidime	IV: 150 mg/kg/day divided every 8 hours	
Cefepime	IV: 150 mg/kg/day divided every 8 hours	
Gentamicin	IV: 5 to 7.5 mg/kg/dose every 24 hours	In obese pediatric patients, consider use of adjusted body weight
Piperacillin/ Tazobactam	Dose based on the piperacillin **<2 months** IV: 240 to 300 mg/kg/day divided in 3 to 4 doses; maximum per day 16g **≥2 months** IV: 240 to 300 mg/kg/day divided in 3 to 4 doses; maximum per day 16g	8:1 formulation -piperacillin1000mg / tazobactam 125mg
Meropenem	IV: 20 mg/kg/dose every 8 hours; maximum per dose 2g	
Imipenem / Cilastatin	Dosage based on imipenem IV: 60 to 100 mg/kg/day divided every 6 hours; maximum per day 4g	1:1 formulation -Imipenem 250 mg /cilastatin 250 mg -Imipenem 500 mg /cilastatin 500 mg
Ertapenem	**≥3 months** IM, IV: 15 mg/kg/dose every 12 hours; maximum per dose 0.5g	
ORAL		
Amoxicillin Clavulanate	Dose based on amoxicillin **≥2 months** 4:1 formulation: Oral: 20 to 40 mg/kg/day in divided doses every 8 hours; maximum per day 1.5g	4:1 formulation: - amoxicillin 125 mg/clavulanate 31.25 mg -amoxicillin 250 mg/clavulanate 62.5

	7:1 formulation: Oral: 25 to 45 mg/kg/day in divided doses every 12 hours; maximum per day 1.75g	mg - amoxicillin 500 mg/clavulanate 125 mg. 7:1 formulation: -amoxicillin 200 mg/clavulanate 28.5 mg -amoxicillin 400 mg/clavulanate 57 mg -amoxicillin 875 mg/clavulanate 125 mg. Daily doses of clavulanic acid over 10 mg/kg/day or 125 mg/dose are linked with higher risk of excessive diarrhea
Cefixime	**≥6 months** Oral: 8 mg/kg/day once daily or in divided doses every 12 hours; maximum per day 400mg	
Cefdinir	**≥6 months** Oral;14 mg/kg/day in divided doses every 12 to 24 hours; maximum per day 600mg	
Nitrofurantoin	Oral; 5 to 7 mg/kg/day divided every 6 hours, maximum per dose 100mg	

Attachment 7: Treatment Dose of Antibiotic in Neonate with UTI (Normal Renal Function)

<table>
<tr><th>Antibiotic</th><th>Dose</th><th>Remarks</th></tr>
<tr><td>PARENTERAL</td><td></td><td></td></tr>
<tr><td>Ampicillin</td><td>
<table>
<tr><th>PMA (weeks)</th><th>Postnatal (days)</th><th>Dose</th><th>Interval (hours)</th></tr>
<tr><td rowspan="2">≤29</td><td>0 to 28</td><td>25 to 50 mg/kg</td><td>12</td></tr>
<tr><td>>28</td><td>25 to 50 mg/kg</td><td>8</td></tr>
<tr><td rowspan="2">30 to 36</td><td>0 to 14</td><td>25 to 50 mg/kg</td><td>12</td></tr>
<tr><td>>14</td><td>25 to 50 mg/kg</td><td>8</td></tr>
<tr><td rowspan="2">37 to 44</td><td>0 to 7</td><td>25 to 50 mg/kg</td><td>12</td></tr>
<tr><td>>7</td><td>25 to 50 mg/kg</td><td>8</td></tr>
<tr><td>≥45</td><td>ALL</td><td>25 to 50 mg/kg</td><td>6</td></tr>
</table>
</td><td></td></tr>
<tr><td>Ceftazidime</td><td>
<table>
<tr><th>Body weight</th><th>Postnatal (days)</th><th>Dose</th><th>Interval (hours)</th></tr>
<tr><td rowspan="2">≤ 2000 g</td><td>0 to 7</td><td>50 mg/kg</td><td>12</td></tr>
<tr><td>8 to 28</td><td>50 mg/kg</td><td>8</td></tr>
<tr><td rowspan="2">>2000 g</td><td>0 to 7</td><td>50 mg/kg</td><td>12</td></tr>
<tr><td>8 to 28</td><td>50 mg/kg</td><td>8</td></tr>
</table>
</td><td></td></tr>
<tr><td>Gentamicin</td><td>
<table>
<tr><th>PMA (weeks)</th><th>Postnatal (days)</th><th>Dose</th><th>Interval (hours)</th></tr>
<tr><td rowspan="3">≤29*</td><td>0 to 7</td><td>5 mg/kg</td><td>48</td></tr>
<tr><td>8 to 28</td><td>4 mg/kg</td><td>36</td></tr>
<tr><td>≥29</td><td>4 mg/kg</td><td>24</td></tr>
<tr><td rowspan="2">30 to 34</td><td>0 to 7</td><td>4.5 mg/kg</td><td>36</td></tr>
<tr><td>≥8</td><td>4 mg/kg</td><td>24</td></tr>
<tr><td>≥35</td><td>ALL</td><td>4 mg/kg</td><td>24</td></tr>
</table>
* or significant asphyxia, PDA, or treatment with indomethacin
</td><td>In obese pediatric patients, consider use of adjusted body weight</td></tr>
</table>

<table>
<tr>
<td>Piperacillin/ Tazobactam</td>
<td>Dose based on the piperacillin
<table>
<tr><th>PMA (weeks)</th><th>Postnatal (days)</th><th>Dose</th><th>Interval (hours)</th></tr>
<tr><td rowspan="2">≤29</td><td>0 to 28</td><td>100 mg/kg</td><td>12</td></tr>
<tr><td>>28</td><td>100 mg/kg</td><td>8</td></tr>
<tr><td rowspan="2">30 to 36</td><td>0 to 14</td><td>100 mg/kg</td><td>12</td></tr>
<tr><td>>14</td><td>100 mg/kg</td><td>8</td></tr>
<tr><td rowspan="2">37 to 44</td><td>0 to 7</td><td>100 mg/kg</td><td>12</td></tr>
<tr><td>>7</td><td>100 mg/kg</td><td>8</td></tr>
<tr><td>≥45</td><td>ALL</td><td>100 mg/kg</td><td>8</td></tr>
</table>
</td>
<td>8:1 formulation
-
piperacillin1000mg / tazobactam 125mg</td>
</tr>
<tr>
<td>Meropenem</td>
<td>
<table>
<tr><th>Gestational age (weeks)</th><th>Postnatal (days)</th><th>Dose</th><th>Interval (hours)</th></tr>
<tr><td rowspan="2">32 weeks gestational age to full-term (With concern of meningitis)</td><td>0 to 7</td><td>20 mg/kg</td><td>8</td></tr>
<tr><td>8 to 28</td><td>30 mg/kg</td><td>8</td></tr>
</table>
</td>
<td></td>
</tr>
<tr>
<td>Imipenem / Cilastatin</td>
<td>Dosage based on imipenem
<table>
<tr><th>Weight</th><th>Postnatal (days)</th><th>Dose</th><th>Interval (hours)</th></tr>
<tr><td rowspan="2">≥1.5Kg</td><td>0 to 6</td><td>25 mg/kg</td><td>12</td></tr>
<tr><td>≥ 7</td><td>25 mg/kg</td><td>8</td></tr>
</table>
</td>
<td>1:1 formulation
-Imipenem 250 mg /cilastatin 250 mg
-Imipenem 500 mg /cilastatin 500 mg</td>
</tr>
</table>

PMA: Postmenstrual age (PMA equivalent to gestational age plus postnatal age).

Attachment 8: Prophylaxis Dose of Antibiotic for Infant and Children (Normal Renal Function)

Antibiotic	Dose
ORAL	
Trimethoprim	**≥2 months of age** 2 mg/kg/dose once daily at night (maximum per dose 100mg)
Trimethoprim/Sulfamethoxazole	**≥2 months of age** 2 to 3 mg TMP/kg/dose once daily at night
Nitrofurantoin	1 to 2 mg/kg/day; divided every 12 to 24 hours

TMP: Trimethoprim

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