# Antimicrobial Dosing in Patients with Renal Dysfunction

## Using Published Guidelines for Dosage Adjustment in Renal Dysfunction

1. Dosage adjustments are based on creatinine clearance (Clcr) values. Studies of dosing in renal dysfunction are generally conducted in adults.

2. To extrapolate to pediatric patients, one must assume that the studies were done in adults of a standard body surface area of 1.73 m^2.

3. Therefore, it is assumed that the published guidelines in mL/min are equivalent to mL/min/1.73 m^2.

4. **One must use a Clcr value in mL/min/1.73 m^2 for pediatric patients when using published guidelines.**

5. Always calculate the dose you would give in normal renal function before applying the recommended adjustment for decreased renal function. The total daily dose should decrease.

## Assessing a Patient’s Renal Function

1. **Estimation using Schwartz equation**

   \[
   \text{Clcr} = K \times \text{ht} \\
   \text{where: } \text{Clcr} \text{ is in mL/min/1.73 m}^2, \text{ht is height in cm}, \text{Scr is serum creatinine in mg/dL} \\
   \text{K is age-based proportionality constant,} \\
   \text{S}_{cr} = \text{Scr (mg/dL)} \\
   \text{K for ages:} \\
   \text{≤ 1 year old: 0.33} \\
   \text{low birth weight: 0.45} \\
   \text{2-12 years old: 0.55} \\
   \text{13-21 years old female: 0.55} \\
   \text{male: 0.7} \\
   \]

2. **24 hour urine creatinine clearance**

   - Children’s Hospital reports the value in mL/min/m^2.
   - To calculate a creatinine clearance in mL/min/m^2, multiply the mL/min/m^2 value by 1.73. This is essential when using published guidelines for dose adjustments.

   - **A proper urine collection should be done as follows:**
     - Patient voids and discards that urine.
     - All urine for 24 hr is collected.
     - At the 24 hr mark, the patient voids and that urine is included.
     - Note: If the baseline Clcr <30% of normal, the clearance by urine collection will overestimate GFR.

   - **Note:** If the patient’s renal function is changing (e.g., acute renal failure), there is little utility in doing collections.

## Antimicrobial Name

### ACY/Clovir IV

- **IV:** 30-60 mg/kg/day Q8h or 750-1500 mg/m^2/day/24h
- **PO:** 80 mg/kg/day/24h in 3-5 divided doses

### Amikacin (RD)

- **IV:** 15-22.5 mg/kg/day/24h or Q24h
- **CF:** 30 mg/kg/day/24h or Q24h

### Amoxicillin/clavulanate (Augmentin^®) tablet

- **PO:** 40-120 mg amoxicillin/kg/day/24h (3 g)
  - May add additional amoxicillin if needed up to 3 g/day

### Augmentin ES^® liquid

- **PO:** 40-90 mg amoxicillin/kg/day/24h (3 g as amoxicillin)

### Ambisome^®

- **IV:** 3-5 mg/kg/day/24h

### Ampicillin

- **IV:** 100-400 mg/kg/day/24h (6 g)

### Amoxicillin

- **IV:** 100-200 mg amoxicillin/kg/day/24h (8 g as amoxicillin)
  - May add additional amoxicillin if needed up to 12 g/day.

### Azithromycin IV (RD)

- **PO:** 10 mg/kg/day/24h (500 mg) Day 1 then 5 mg/kg/day/24h (250 mg) on Day 2-5

### Aztreonam (RD)

- **IV:** 90-120 mg/kg/day/24h (8 g)
- **CF:** 150-200 mg/kg/day/24h (8 g)

### Cefazolin

- **IV:** 50-150 mg/kg/day/24h (12 g)
  - Clcr 5-14 mL/min: Decrease dose by 50% if Clcr 10-20 mL/min: Decrease dose by 25%

### Cefdinir

- **PO:** 14 mg/kg/day/24h (600 mg)

### Cefepime (RD)

- **IV:** Severe Infection: 150 mg/kg/day/24h (6 g)
- **PO:** 8 mg/kg/day/24h-Q24h

### Cefixime

- **PO:** 8 mg/kg/day/24h-Q24h (200 mg)
  - Clcr 30-60: Δ interval to Q12h
  - Clcr <30: Δ interval to Q24h

### Cefotaxime (RD)

- **IV:** 100-200 mg/kg/day/24h (12 g)
  - meningitis: 300 mg/kg/day/24h (12 g)

### Cefotaxim IV

- **IV:** 80-160 mg/kg/day/24h (12 g)
  - Clcr <20 mL/min: Decrease dose by 50%

### Cefpodoxime

- **PO:** 30 mg/kg/day/24h (12 g)

### Ceftazidime (RD)

- **IV:** 100-150 mg/kg/day/24h (6 g)
- **CF:** 150-200 mg/kg/day/24h (6 g)

### Ceftazidime IV

- **IV:** 50-75 mg/kg/day/24h (2 g)
  - meningitis: 80-100 mg/kg/day/24h (4 g)

### Ceftiraxone

- **PO:** Dosage Forms NOT bioequivalent.
  - See Formulary IV 75-150 mg/kg/day/24h (6 g)

### Cefuroxime

- **PO:** Dosage Forms NOT bioequivalent.
  - See Formulary IV 75-150 mg/kg/day/24h (6 g)

<table>
<thead>
<tr>
<th>Antimicrobial Name</th>
<th>Dosage for normal renal function (Daily MAX dose)</th>
<th>( \text{Cr}_{\text{cl}} ) 31-50 mL/min/1.73 m²</th>
<th>( \text{Cr}_{\text{cl}} ) 10-30 mL/min/1.73 m²</th>
<th>( \text{Cr}_{\text{cl}} ) &lt;10 mL/min/1.73 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cephalaxin</strong></td>
<td>PO 25-100 mg/kg/day/Q6h (4 g)</td>
<td>( \text{Cr}_{\text{cl}} ) 10-40: ( \triangle ) interval to Q8-12h</td>
<td>( \text{Cr}_{\text{cl}} ) 10-40: ( \triangle ) interval to Q8-12h</td>
<td>( \text{Cr}_{\text{cl}} ) &lt;10 mL/min/1.73 m²</td>
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<tr>
<td><strong>Chloramphenicol (RD)</strong></td>
<td>IV 75-100 mg/kg/day/Q6h (4 g)</td>
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<tr>
<td><strong>Ciprofloxacin IV (RD)</strong></td>
<td>PO is not restricted IV 20-30 mg/kg/day/Q12h (800 mg)</td>
<td>PO: Decrease dose by 30%</td>
<td>PO: Decrease dose 30% AND ( \triangle ) interval to Q18-24h</td>
<td>( \text{Cr}_{\text{cl}} ) &lt;10 mL/min/1.73 m²</td>
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<tr>
<td><strong>Clarithromycin (RD)</strong></td>
<td>PO 15 mg/kg/day/Q12h (1 g)</td>
<td>no change</td>
<td>50% of daily dose ( \times ) Q12h</td>
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<tr>
<td><strong>Clindamycin</strong></td>
<td>IV 25-40 mg/kg/day/Q6h (2.7 g)</td>
<td>PO 10-30 mg/kg/day/Q6h-8h (1.8 g)</td>
<td>no change</td>
<td></td>
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<tr>
<td><strong>Daptomycin (RD)</strong></td>
<td>IV 6 - 8 mg/kg/day/Q24h</td>
<td>no change</td>
<td>( \triangle ) interval to Q48h</td>
<td></td>
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<tr>
<td><strong>Fluconazole</strong></td>
<td>PO 100-150 mg/kg/day/Q6h</td>
<td>( \text{Cr}_{\text{cl}} ) 20-40: ( \triangle ) interval to Q12h</td>
<td>( \text{Cr}_{\text{cl}} ) 10-19: ( \triangle ) interval to Q24h</td>
<td>( \text{Cr}_{\text{cl}} ) &lt;10 mL/min/1.73 m²</td>
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<tr>
<td><strong>Foscarnet (RD) Induction</strong></td>
<td>IV Induction: 180 mg/kg/day/Q6h</td>
<td>Adjustments are based on ( \text{Cr}_{\text{cl}} ) values in mL/min/kg, adjustments are in Online Formulary</td>
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<tr>
<td><strong>Gentamicin</strong></td>
<td>IV &gt;1 mo and &lt;10 yrs: 7.5 mg/kg/day/Q8h or Q4h</td>
<td>Synergy Dosing: 1 mg/kg dose 8h</td>
<td>( \text{Cr}_{\text{cl}} ) 41-70: 50% of daily dose and ( \times ) Q6h</td>
<td>( \text{Cr}_{\text{cl}} ) 6-20: 25% of daily dose and ( \times ) Q12h</td>
</tr>
<tr>
<td><strong>Imipenem/cilastatin (RD)</strong></td>
<td>IV &lt;3 mo 100 mg/kg/day/Q6h (4 g)</td>
<td>( \text{Cr}_{\text{cl}} ) &lt;10: ( \triangle ) interval to Q24h</td>
<td>( \text{Cr}_{\text{cl}} ) 21-40: 37% of daily dose and ( \times ) Q8h</td>
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<tr>
<td><strong>Itraconazole (RD)</strong></td>
<td>PO 2-10 mg/kg/day/Q12h (400 mg)</td>
<td>no change</td>
<td>no change</td>
<td></td>
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<tr>
<td><strong>Linezolid (RD)</strong></td>
<td>IV/PO &lt;12yo: 30mg/kg/day/Q8h (1200mg)</td>
<td>Cl(_{\text{cr}}) 26-50: ( \triangle ) interval to Q12h</td>
<td>Cl(_{\text{cr}}) 10-25: ( \frac{50}{2} ) each dose Q12h</td>
<td>Cl(_{\text{cr}}) &lt;10: ( \frac{50}{2} ) each dose Q48h</td>
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<tr>
<td><strong>Meropenem (RD)</strong></td>
<td>IV 60 mg/kg/day/Q8h (3 g)</td>
<td>no change</td>
<td>no change</td>
<td>15 mg/kg/day/Q6h OR ( \triangle ) interval to Q12h</td>
</tr>
<tr>
<td><strong>Metronidazole</strong></td>
<td>IV/PO 30 mg/kg/day/Q6h (3 g)</td>
<td>**** dose adjust based on hepatic impairment - reduce to 33-50% of daily dose and ( \times ) Q6h</td>
<td>no change</td>
<td></td>
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<tr>
<td><strong>Micafungin (RD)</strong></td>
<td>IV 3-6 mg/kg/day/Q24h (150 mg) - see Formulary</td>
<td>no change</td>
<td>no change</td>
<td></td>
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<tr>
<td><strong>Moxifloxacin (RD)</strong></td>
<td>IV/PO 10 mg/kg/day/Q24h (400mg)</td>
<td>no change</td>
<td>no change</td>
<td></td>
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<tr>
<td><strong>Nitrofurantoin</strong></td>
<td>PO &gt;7 days old: 5-7 mg/kg/day/Q8h (400 mg)</td>
<td>no change</td>
<td>no change</td>
<td>use lower range of usual dosing</td>
</tr>
<tr>
<td><strong>Oxacillin</strong></td>
<td>IV 150-200 mg/kg/day/Q4-6h (12 g)</td>
<td>( \text{Cr}_{\text{cl}} ) &lt;60: Avoid use due to lack of therapeutic concentrations unattainable in urine</td>
<td>no change</td>
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<tr>
<td><strong>Penicillin</strong></td>
<td>IV 100,000-400,000 units/kg/day/Q4-6h (24 million Units)</td>
<td>IV: no change</td>
<td>IV: ( \triangle ) interval to Q6-12h</td>
<td>IV: ( \triangle ) interval to Q8-18h</td>
</tr>
<tr>
<td><strong>Piperacillin/Tazobactam (Zosyn\textsuperscript{3}) (RD)</strong></td>
<td>IV 200-300 mg piperacillin/kg/day/Q6h (18 g as pip)</td>
<td>Cl(_{\text{cr}}) 20-40: 70% of daily dose and ( \times ) Q6h</td>
<td>Cl(_{\text{cr}}) &lt;20: 70% of daily dose and ( \times ) Q8h</td>
<td></td>
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<tr>
<td><strong>Rifampin</strong></td>
<td>IV/PO 10-20 mg/kg/day/Q12-24h (1.2 g)</td>
<td>no change</td>
<td>no change</td>
<td></td>
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<tr>
<td><strong>Tigecycline (RD)</strong></td>
<td>IV Loading Dose: 1.5 mg/kg/dose x1 (100 mg)</td>
<td>no change</td>
<td>no change</td>
<td></td>
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<tr>
<td><strong>Tobramycin</strong></td>
<td>IV Non-CF: same as gentamicin</td>
<td>no change</td>
<td>no change</td>
<td>CF patients Q8h peak 8-12 mcg/mL; CF patients Q24h peak 20-40 mcg/mL; trough &lt; 2 mcg/mL</td>
</tr>
<tr>
<td><strong>Trimepram/ Sulfamethoxazole</strong></td>
<td>IV/PO 6-12 mg/kg/day/Q12h (as trimethoprim)</td>
<td>no change</td>
<td>no change</td>
<td>Use IV ganciclovir OR use ( \frac{50}{2} ) of each dose 3 times per week</td>
</tr>
<tr>
<td><strong>ValACIClovir Herpes Zoster ONLY</strong></td>
<td>PO Infants/Children: 60 mg/kg/day/Q6h (3g)</td>
<td>See Formulary for other indications</td>
<td>Cl(_{\text{cr}}) 30-49: ( \triangle ) interval to Q12h</td>
<td>Cl(_{\text{cr}}) &lt;15: not recommended</td>
</tr>
<tr>
<td><strong>ValGANCiclovir Induction Therapy</strong></td>
<td>PO Adults: 900 mg Q12h PO Children \geq 15 kg: 1000 mg/m(^2)/day/Q12h PO infants/children &lt;15 kg: 30-40 mg/kg/day/Q12h</td>
<td>Cl(_{\text{cr}}) 40-59: (\textit{induction}) 50% of each dose Q12h</td>
<td>Cl(_{\text{cr}}) 10-24: (\textit{induction}) 50% of each dose Q48h</td>
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<tr>
<td><strong>Vancomycin</strong></td>
<td>IV 45-60 mg/kg/day/Q6-8h (usual adult start: 1 g Q12h) PO 125-250 mg Q6h or 40 mg/kg/day/Q6h (1 g)</td>
<td>IV generally requires adjustment at Cl(_{\text{cr}}) &lt;90. Adjust dose frequency based on pre (trough) level. Target 10-20 mcg/mL PO is not absorbed, therefore does not need adjustment</td>
<td>Cl(_{\text{cr}}) &lt;50, avoid IV voriconazole and use oral preparation. The vehicle in the IV preparation (sulfobutyl ether beta-cyclodextrin sodium) accumulates in patients with renal impairment and may cause toxicity.</td>
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<tr>
<td><strong>Voriconazole (RD)</strong></td>
<td>IV/PO Loading Dose: 12-14 mg/kg/day/Q12h x 2 doses, then 8-14 mg/kg/day/Q12h</td>
<td>Oral Prep: No adjustment required. If Cl(_{\text{cr}}) &lt;50, avoid IV voriconazole and use oral preparation. The vehicle in the IV preparation (sulfobutyl ether beta-cyclodextrin sodium) accumulates in patients with renal impairment and may cause toxicity.</td>
<td>( \text{Cr}_{\text{cl}} ) 50-100 mL/min/1.73 m²</td>
<td></td>
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