Dosage Adjustment of Medications Eliminated by the Kidneys

**Bacitracin - Selected References**


Dosage Adjustment of Medications Eliminated by the Kidneys

**Bacitracin/BACiiM™**  *{Antibacterial; polypeptide complex derived from Bacillus subtilis}*

<table>
<thead>
<tr>
<th>Dosage</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usual initial dose</td>
<td>50,000 units IM</td>
</tr>
<tr>
<td>Usual maintenance dose</td>
<td>50,000 units IM every 6 h</td>
</tr>
<tr>
<td>Typical maximum dose</td>
<td>200,000 units/day</td>
</tr>
<tr>
<td>Proportion eliminated unchanged</td>
<td>87%</td>
</tr>
</tbody>
</table>

**Adjustment for Kidney Disease**

**FDA-approved product labeling:**

To reduce the development of drug-resistant bacteria and maintain the effectiveness of bacitracin and other antibacterial drugs, bacitracin should be used only to treat or prevent infections that are proven or strongly suspected to be caused by bacteria.

Warning—nephrotoxicity: Bacitracin in parenteral (intramuscular) therapy may cause renal failure due to tubular and glomerular necrosis. Its use should be restricted to infants with staphylococcal pneumonia and empyema when due to organisms shown to be susceptible to bacitracin. It should be used only where adequate laboratory facilities are available and when constant supervision of the patient is possible.

Renal function should be carefully determined prior to and daily during therapy. The recommended daily dose should not be exceeded and fluid intake and urinary output maintained at proper levels to avoid kidney toxicity. If renal toxicity occurs, the drug should be discontinued. The concurrent use of other nephrotoxic drugs, particularly streptomycin, kanamycin, polymyxin B, polymyxin E (colistin), neomycin, and viomycin, should be avoided.

**Alternative adjustment:**

| eGFR < 60 mL/min | Avoid peritoneal lavage and IM/IV administration due to risk of drug accumulation and nephrotoxicity. |
Dosage Adjustment of Medications Eliminated by the Kidneys

Benazepril - Selected References


## Dosage Adjustment of Medications Eliminated by the Kidneys

### Benazepril/Lotensin®

{Antihypertensive; vasodilator; angiotensin-converting enzyme (ACE)/renin inhibitor}

<table>
<thead>
<tr>
<th>Internal Data Type</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usual initial dose</td>
<td>10 mg orally daily</td>
</tr>
<tr>
<td>Usual maintenance dose</td>
<td>20–40 mg/day orally as either a single dose or two equally divided doses</td>
</tr>
<tr>
<td>Typical maximum dose</td>
<td>40 mg/day</td>
</tr>
<tr>
<td>Proportion eliminated unchanged</td>
<td>18 % (as active benazeprilat)</td>
</tr>
</tbody>
</table>

### Adjustment for Kidney Disease

**FDA-approved product labeling:**

- **CrCL < 30 mL/min**  
  Initial dose is 5 mg once daily, increasing as necessary to maximum 40 mg/day

**Alternative adjustment:**

- **GFR > 50 mL/min**  
  20–40 mg orally daily (100 % of usual dose)
- **GFR 10–50 mL/min**  
  15–30 mg orally daily (75 % of usual dose)
- **GFR < 10 mL/min**  
  5–20 mg orally daily (25–50 % of usual dose)
- **Hemodialysis**  
  5–20 mg orally daily (25–50 % of usual dose)
- **CAPD**  
  5–20 mg orally daily (25–50 % of usual dose)
- **CRRT**  
  15–30 mg orally daily (75 % of usual dose)
Bendamustine - Selected References


Dosage Adjustment of Medications Eliminated by the Kidneys

**Bendamustine/Treanda®**  
{Antineoplastic; alkylating agent, mechlorethamine derivative}

<table>
<thead>
<tr>
<th>Dosage Characteristics</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usual initial dose</td>
<td>100 mg/m² IV</td>
</tr>
<tr>
<td>Usual maintenance dose</td>
<td>100 mg/m² administered IV over 30 min on days 1 and 2 of a 28-day cycle, up to 6 cycles</td>
</tr>
<tr>
<td>Typical maximum dose</td>
<td>100 mg/m²</td>
</tr>
<tr>
<td>Proportion eliminated unchanged</td>
<td>~10 %</td>
</tr>
</tbody>
</table>

**Adjustment for Kidney Disease**

- **FDA-approved product labeling:**
  - CrCL > 40 mL/min  
    100 mg/m² administered IV over 30 min on days 1 and 2 of a 28-day cycle, up to 6 cycles
  - CrCL ≤ 40 mL/min  
    Avoid; safety not established

- **Alternative adjustment:**
  Data not available
Dosage Adjustment of Medications Eliminated by the Kidneys

**Bismuth Subsalicylate - Selected References**


Dosage Adjustment of Medications Eliminated by the Kidneys

**Bismuth Subsalicylate/Pepto-Bismol®** {{Antidiarrheal; antiflatulent}}

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usual initial dose</td>
<td>30 mL (524 mg) orally every 30–60 min PRN upset stomach, indigestion, simple diarrhea, and nausea</td>
</tr>
<tr>
<td>Usual maintenance dose</td>
<td>N/A</td>
</tr>
<tr>
<td>Typical maximum dose</td>
<td>240 mL/day</td>
</tr>
<tr>
<td>Proportion eliminated unchanged</td>
<td>Unknown</td>
</tr>
</tbody>
</table>

**Adjustment for Kidney Disease**

<table>
<thead>
<tr>
<th>Alternative adjustment:</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FDA-approved product labeling:</td>
<td><strong>Data not available</strong></td>
</tr>
<tr>
<td>GFR &lt; 50 mL/min</td>
<td><strong>Preferably avoid due to risk for bismuth and/or salicylic acid accumulation and heavy metal or salicylate toxicity.</strong></td>
</tr>
<tr>
<td>Hemodialysis</td>
<td><strong>Preferably avoid due to risk for bismuth and/or salicylic acid accumulation and heavy metal or salicylate toxicity.</strong></td>
</tr>
<tr>
<td>CAPD</td>
<td><strong>Preferably avoid due to risk for bismuth and/or salicylic acid accumulation and heavy metal or salicylate toxicity.</strong></td>
</tr>
<tr>
<td>CRRT</td>
<td><strong>Preferably avoid due to risk for bismuth and/or salicylic acid accumulation and heavy metal or salicylate toxicity.</strong></td>
</tr>
</tbody>
</table>
Dosage Adjustment of Medications Eliminated by the Kidneys

Bisoprolol - Selected References


Dosage Adjustment of Medications Eliminated by the Kidneys

**Bisoprolol/Zebeta®**  
{Antihypertensive; antianginal; β-adrenergic receptor blocker}

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usual initial dose</td>
<td>5 mg orally once daily</td>
</tr>
<tr>
<td>Usual maintenance dose</td>
<td>10–20 mg orally once daily</td>
</tr>
<tr>
<td>Typical maximum dose</td>
<td>20 mg/day</td>
</tr>
<tr>
<td>Proportion eliminated unchanged</td>
<td>50 %</td>
</tr>
</tbody>
</table>

**Adjustment for Kidney Disease**

<table>
<thead>
<tr>
<th>Adjustment Type</th>
<th>GFR 10–50 mL/min</th>
<th>GFR &lt; 10 mL/min</th>
<th>GFR &gt; 50 mL/min</th>
<th>Hemodialysis</th>
<th>CAPD</th>
<th>CRRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>FDA-approved product labeling:</td>
<td>CrCL &lt; 40 mL/min</td>
<td>The initial daily dose should be 2.5 mg orally and caution should be used in dose titration</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative adjustment:</td>
<td>2.5–5 mg orally every 24 h (~25 % decrease)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.5 mg orally every 24 h (50 % decrease)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.5 mg orally every 24 h (50 % decrease), dose after hemodialysis on dialysis days</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.5 mg orally every 24 h (50 % decrease)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.5 mg orally every 24 h (50 % decrease)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Bivalirudin - Selected References

Dosage Adjustment of Medications Eliminated by the Kidneys

**Bivalirudin/Angiomax**

**{Antithrombotic; direct thrombin inhibitor}**

- **Usual initial dose**
  - 0.75 mg/kg IV

- **Usual maintenance dose**
  - Continuous IV infusion of 1.75 mg/kg/h for the duration of the percutaneous coronary intervention procedure

- **Typical maximum dose**
  - As required to attain aPTT 1.5–2.5 times baseline or control value

- **Proportion eliminated unchanged**
  - 20%

### Adjustment for Kidney Disease

**FDA-approved product labeling:**

- For anticoagulation in patients undergoing percutaneous coronary intervention
  - **CrCL ≥ 60 mL/min**
    - 0.75 mg/kg
    - IV followed by infusion of 1.75 mg/kg/h
  - **CrCL 30–59 mL/min**
    - 0.75 mg/kg
    - IV followed by infusion of 1.75 mg/kg/h
  - **CrCL < 30 mL/min**
    - 0.75 mg/kg
    - IV followed by infusion of 1.00 mg/kg/h
  - **Hemodialysis**
    - 0.75 mg/kg
    - IV followed by infusion of 0.25 mg/kg/h

**Alternative adjustment:**

- For anticoagulation in patients with venous thromboembolism
  - **eCrCL ≥ 60 mL/min**
    - Continuous IV infusion of 0.15 mg/kg/h
    - (no initial bolus)
  - **eCrCL 44–60 mL/min**
    - Continuous IV infusion of 0.075 mg/kg/h
    - (no initial bolus)
  - **eCrCL 30–43 mL/min**
    - Continuous IV infusion of 0.05 mg/kg/h
    - (no initial bolus)
  - **eCrCL < 30 mL/min**
    - Continuous IV infusion of 0.025 mg/kg/h
    - (no initial bolus)
  - **CRRT**
    - Continuous IV (prefilter) infusion of 0.02 mg/kg/h
    - (no initial bolus)

  Note: dosage usually should be based on total body weight in normal body weight and obese patients
Dosage Adjustment of Medications Eliminated by the Kidneys

Bleomycin - Selected References


Lewis BM, Izbicki R. Routine pulmonary tests during bleomycin therapy: tests may be ineffective and potentially misleading. JAMA. 1980;243:347–51.


**Bleomycin/Blenoxane®**  
*Antineoplastic; DNA, RNA, and protein synthesis inhibitor*

**Usual initial dose**  
0.25–0.50 units/kg (10–20 units/m²) given IV, IM, or subcutaneously weekly or twice weekly; because of the possibility of an anaphylactoid reaction, lymphoma patients should be given 2 units or less for the first two doses.

**Usual maintenance dose**  
0.25–0.50 units/kg (10–20 units/m²) given IV, IM, or subcutaneously weekly or twice weekly. After a 50% response, a maintenance dose of 1 unit daily or 5 units weekly intravenously or intramuscularly should be given.

**Typical maximum dose**  
400 units (total dose)

**Proportion eliminated unchanged**  
65%

**Adjustment for Kidney Disease**

**FDA-approved product labeling:**  
Bleomycin clearance may be reduced in patients with impaired renal function. Bleomycin should be used with extreme caution in patients with significant renal impairment.

**Alternative adjustment:**

<table>
<thead>
<tr>
<th>GFR &gt; 50 mL/min</th>
<th>10–20 units/m² IV, IM, or subcutaneously weekly or twice weekly</th>
</tr>
</thead>
<tbody>
<tr>
<td>GFR 10–50 mL/min</td>
<td>7.5–15 units/m² IV, IM, or subcutaneously weekly or twice weekly (25% decrease)</td>
</tr>
<tr>
<td>GFR &lt; 10 mL/min</td>
<td>5–10 units/m² IV, IM, or subcutaneously weekly or twice weekly (50% decrease)</td>
</tr>
</tbody>
</table>

**Hemodialysis**  
Minimal data available, effective dose unclear

**CAPD**  
Data not available

**CRRT**  
7.5–15 units/m² IV, IM, or subcutaneously weekly or twice weekly (25% decrease)
Dosage Adjustment of Medications Eliminated by the Kidneys

**Buspirone - Selected References**


Dosage Adjustment of Medications Eliminated by the Kidneys

**Buspirone/BuSpar®** {Anxiolytic; serotonin 5-HT$_{1A}$ and D$_2$ dopamine receptor modifier}

**Usual initial dose**
7.5 mg orally twice daily

**Usual maintenance dose**
10–15 mg orally twice daily

**Typical maximum dose**
60 mg/day

**Proportion eliminated unchanged**
Minimal

**Adjustment for Kidney Disease**

**FDA-approved product labeling:**

- **Severe renal impairment**
  Not recommended; after multiple-dose administration of buspirone to renally impaired (CrCL = 10–70 mL/min/1.73 m$^2$) patients, steady state AUC of buspirone increased 4-fold compared with healthy (CrCL ≥ 80 mL/min/1.73 m$^2$) subjects.

**Alternative adjustment:**

- **GFR > 50 mL/min**
  10–15 mg orally twice daily

- **GFR 10–50 mL/min**
  5–10 mg orally twice daily (~25 % decrease)

- **GFR < 10 mL/min**
  2.5–7.5 mg orally twice daily (~50 % decrease)

- **Hemodialysis**
  2.5–7.5 mg orally twice daily

- **CAPD**
  2.5–7.5 mg orally twice daily

- **CRRT**
  5–10 mg enterally twice daily
Dosage Adjustment of Medications Eliminated by the Kidneys

Butorphanol - Selected References


Dosage Adjustment of Medications Eliminated by the Kidneys

**Butorphanol/Stadol®**  
*{Analgesic; opioid µ-receptor partial agonist}*

**Usual initial dose**  
1 mg IV or IM or 1 mg (1 spray in 1 nostril) intranasally

**Usual maintenance dose**  
1–2 mg IV or IM every 4 h as necessary or 1–2 mg (1 spray in 1 or 2 nostrils) intranasally every 4 h PRN

**Typical maximum dose**  
4 mg/dose

**Proportion eliminated unchanged**  
4 %

**Adjustment for Kidney Disease**

<table>
<thead>
<tr>
<th>CrCL &lt; 30 mL/min</th>
<th>0.5–1 mg IV or IM every 6 h as necessary (50 % decrease) or 1 mg (1 spray in 1 nostril) followed, if needed, by 1 mg (1 spray in 1 nostril) in 90–120 min; repeat doses should be determined by response but given at intervals of no less than 6 h</th>
</tr>
</thead>
</table>

**Alternative adjustment:**

<table>
<thead>
<tr>
<th>GFR &gt; 50 mL/min</th>
<th>0.5–1 mg IV or IM every 6 h PRN</th>
</tr>
</thead>
<tbody>
<tr>
<td>GFR 10–50 mL/min</td>
<td>0.375–0.75 mg IV or IM every 6 h PRN (25 % decrease)</td>
</tr>
<tr>
<td>GFR &lt; 10 mL/min</td>
<td>0.25–0.5 mg IV or IM every 6 h PRN (50 % decrease)</td>
</tr>
</tbody>
</table>

**Hemodialysis**  
Data not available

**CAPD**  
Data not available

**CRRT**  
0.375–0.75 mg IV or IM every 6 h PRN (25 % decrease)
Renal Pharmacotherapy
Dosage Adjustment of Medications Eliminated by the Kidneys
Golightly, L.K.; Teitelbaum, I.; Kiser, T.H.; Levin, D.A.; Barber, G.R.; Jones, M.A.; Stolpman, N.M.; Lundin, K.S. (Eds.)
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