Drug Dosing in CKD Quick Reference

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Overview

Drug dosing in chronic kidney disease requires systematic assessment of renal function (eGFR-based or creatinine clearance), understanding of drug metabolism/elimination, and knowledge of dialyzability [1]. This guide provides practical quick-reference tables for common medications requiring adjustment in CKD, organized by drug class and GFR stage. Principles, contraindications, and special considerations for dialysis dosing are included.

Key Clinical Pearl

"Estimated GFR-based dosing is standard for most drugs; however, actual creatinine clearance (CG equation or measured) may be more accurate for certain drugs (e.g., aminoglycosides, vancomycin). Always verify actual dose in individual patients; extrapolation from tables is a starting point, not absolute."

Part 1: Principles of Drug Dosing in CKD

GFR Estimation Methods

Recommended by KDIGO for drug dosing:

1. **MDRD Study Equation (4-variable):**

$$\text{eGFR} = 175 \times (\text{SCr})^{-1.154} \times (\text{Age})^{-0.203} \times 0.742 \text{ (if female)} \times 1.212 \text{ (if Black)}$$

2. **CKD-EPI 2009 (preferred; more accurate at higher GFR):**

$$\text{eGFR} = 141 \times \min(\text{SCr}/\kappa, 1)^{\alpha} \times \max(\text{SCr}/\kappa, 1)^{-1.209} \times 0.993^{\text{Age}} \times 1.018 \text{ (if female)} \times 1.159 \text{ (if Black)}$$

3. **Cockcroft-Gault (Creatinine clearance estimation):**

$$\text{CCr (mL/min)} = \frac{(140 - \text{Age}) \times \text{Weight (kg)} \times 0.85 \text{ (if female)}}{72 \times \text{SCr (mg/dL)}}$$

Choice of equation: CKD-EPI preferred; Cockcroft-Gault for drugs where actual CCr more predictive (aminoglycosides, vancomycin).

Dosing Adjustment Approaches

Two main strategies:

1. **Dose reduction:** Decrease individual dose; maintain normal dosing interval
   - Preferred for drugs with therapeutic index requiring steady levels
   - Examples: Antimicrobials, cardiac glycosides
2. **Interval prolongation:** Maintain normal dose; increase interval between doses
   - Preferred for drugs where peak serum level important (beta-lactams, fluoroquinolones)
   - Examples: Antibiotics
3. **Combination:** Reduce both dose and interval (for severe renal failure)

Part 2: Antibiotics (GFR-Based Adjustment)

Beta-Lactams (Penicillins, Cephalosporins, Carbapenems)

Agent	Normal Dose	eGFR >50	eGFR 30–50	eGFR 10–30	eGFR <10	Dialyzed
Penicillin G	2–4 million units IV Q4-6h	No change	2M Q6–8h	2M Q8–12h	1–2M Q12h	Yes (15–50%)
Ampicillin	500 mg IV Q6h	No change	500 mg Q6h	250–500 mg Q6–12h	250–500 mg Q12h	Yes
Ceftriaxone	1–2 g IV Q12h	No change	No change	1 g Q12–24h	0.5–1 g Q24h	Minimal
Cefazolin	1 g IV Q8h	No change	0.5–1 g Q12h	0.5 g Q12–24h	0.25–0.5 g Q24h	Yes
Cefepime	1 g IV Q12h	No change	1 g Q12h	0.5 g Q12–24h	0.5 g Q24h	Yes
Meropenem	1 g IV Q8h	No change	0.5–1 g Q8–12h	0.5 g Q12h	0.25–0.5 g Q12h	Yes
Amoxicillin	500 mg PO Q8h	No change	250–500 mg Q8h	250–500 mg Q12h	250–500 mg Q24h	Yes

Aminoglycosides (Nephrotoxic; Use with Caution)

Principle: Accumulates in renal cortex; dose-dependent nephrotoxicity. Use **extended-interval dosing** (more effective, less toxic).

Agent	Extended-Interval Dose	Dosing Interval by eGFR
Gentamicin	5–7 mg/kg IV	eGFR >50: Q24h; >20: Q36–48h; <20: Q48–72h or avoid
Tobramycin	5–7 mg/kg IV	Same as gentamicin

Agent	Extended-Interval Dose	Dosing Interval by eGFR
Amikacin	15 mg/kg IV	eGFR >50: Q24h; >20: Q36–48h; <20: Avoid or prolonged interval

Monitoring: Serum levels required; trough <1 mg/L (gentamicin/tobramycin), <5 mg/L (amikacin); peak 15–30 mg/L (tobramycin).

Contraindication: eGFR <20 mL/min (alternative antibiotics preferred).

Vancomycin (Glycopeptide Antibiotic)

Principle: Renal elimination only; accumulates in renal failure. Dosed by **actual CCr** (more accurate than eGFR).

Dosing: - **eGFR >50:** 15–20 mg/kg IV Q8–12h - **eGFR 30–50:** 10–15 mg/kg IV Q12–24h - **eGFR 10–30:** 10–15 mg/kg IV Q24–48h - **eGFR <10:** 10–15 mg/kg IV Q48–72h (or continuous infusion in ICU)

Target trough: 15–20 µg/mL (increased for serious infections like CNS meningitis).

Monitoring: Serum levels at steady state (day 3–4); adjust dose to achieve target trough.

Note: NOT significantly removed by dialysis; dose AFTER dialysis if hemodialysis.

Fluoroquinolones

Agent	Normal Dose	eGFR 30–50	eGFR <30	Dialyzed
Ciprofloxacin	500–750 mg PO/IV Q12h	250–500 mg Q12–24h	250 mg Q24h	Yes (minimal)
Levofloxacin	500–750 mg daily	250 mg daily or Q48h	250 mg Q48h	Minimal
Moxifloxacin	400 mg daily	No change	No change (but caution)	Minimal

Note: Fluoroquinolones generally safe in renal failure; dose reduction for quinolone accumulation and CNS toxicity risk.

Macrolides

Agent	Normal Dose	eGFR <30	Note
Azithromycin	500 mg PO daily	No change needed	Hepatic metabolism; minimal renal involvement

Agent	Normal Dose	eGFR <30	Note
Clarithromycin	500 mg PO Q12h	250 mg PO Q12h	Renal elimination; dose reduce to avoid toxicity
Erythromycin	500 mg PO Q6–8h	250 mg Q6–8h	Hepatic; not eliminated by kidneys; caution with QT prolongation

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Part 3: Anticoagulants and Antiplatelet Drugs

Direct Oral Anticoagulants (DOACs)

Principle: Renal clearance varies by agent; eGFR thresholds critical for dose selection.

Agent	Type	Dosing by eGFR	Contraindication
Apixaban	Fxa inhibitor	eGFR ≥30: 5 mg BID; eGFR 15–29: 5 mg BID (caution); <15: Avoid	eGFR <15 (ESRD)
Rivaroxaban	Fxa inhibitor	eGFR ≥30: 20 mg daily; eGFR 15–29: 15 mg daily; <15: Avoid	eGFR <15 (ESRD)
Dabigatran	Direct thrombin inhibitor	eGFR ≥30: 150 mg BID; eGFR <30: REDUCE or avoid	eGFR <15 (ESRD); significant renal clearance (~80%)
Edoxaban	Fxa inhibitor	eGFR ≥50: 60 mg daily; eGFR 30–50: 30 mg daily; <30: Caution	eGFR <15 (no data)

Key point: DOACs removed by dialysis; redose AFTER dialysis session if timing convenient.

Warfarin

No renal adjustment needed (hepatic metabolism). However, CKD patients have enhanced INR sensitivity; monitor INR closely.

Antiplatelet Drugs

Agent	eGFR <30	Notes
Aspirin	No dosage change	Standard dosing; may accumulate metabolites

Agent	eGFR <30	Notes
Clopidogrel (Plavix)	No dosage change	Standard dosing; metabolized hepatically
Prasugrel	Caution	Increased bleeding risk in CKD; use lower loading/maintenance dose if eGFR <30
Ticagrelor	Caution	Monitor for bradycardia, blocks adenosine uptake; dosing unchanged but increased AE risk

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Part 4: Antihypertensives and Cardiac Drugs

ACE Inhibitors and Angiotensin Receptor Blockers

No dosage adjustment based on eGFR; however, monitor SCr and K carefully.

Caution thresholds: - Hold if Cr rise >30% from baseline within 4 weeks of initiation - Hold if K >6.0 mEq/L (hyperkalemia)

Beta-Blockers

Agent	eGFR <30	Normal Dose	Adjusted Dose
Metoprolol	Safe	25–50 mg BID	25 mg daily (start low)
Atenolol	Caution	25–50 mg daily	12.5–25 mg daily
Propranolol	Safe	10–20 mg Q6–8h	No change (hepatic)
Carvedilol	Safe	3.125–25 mg BID	No change (hepatic)

Monitoring: Heart rate, blood pressure, fatigue, bradycardia in advanced CKD.

Calcium Channel Blockers

No significant renal adjustment (hepatically metabolized).

Agent	eGFR <30	Normal Dose	Note
Amlodipine	Safe	2.5–10 mg daily	Hepatic metabolism; no dose change
Diltiazem	Safe	120–240 mg daily	Hepatic; no change needed

Agent	eGFR <30	Normal Dose	Note
Verapamil	Safe	120–240 mg daily	Hepatic; caution with constipation in CKD

Diuretics

Agent	eGFR <30	Dosing Adjustment
Furosemide	Decreased efficacy	Higher doses needed; eGFR <30 may need 40–80 mg BID to TID
Hydrochlorothiazide	Reduced efficacy	May add loop diuretic if eGFR <30
Spironolactone	CAUTION	Higher hyperkalemia risk; eGFR <30 generally avoid; if use, monitor K closely Q2–4 weeks
Potassium-sparing (amiloride, triamterene)	AVOID	High hyperkalemia risk; contraindicated eGFR <30

Digoxin (Cardiac Glycoside)

Principle: Entirely renally eliminated; significant accumulation risk.

Dosing: - **eGFR >50:** 0.25–0.5 mg daily - **eGFR 30–50:** 0.25 mg daily or Q48h - **eGFR 10–30:** 0.125 mg daily or Q48h - **eGFR <10:** 0.125 mg Q48–72h or avoid

Monitoring: Serum digoxin level (target 0.5–1.5 ng/mL); toxicity more common in CKD due to hypokalemia and hypermagnesemia interactions.

Part 5: Antidiabetic Medications

Metformin

CONTRAINDICATION: eGFR <30 mL/min/1.73 m²

Rationale: Lactic acidosis risk from accumulation.

Dosing: - **eGFR ≥60:** Standard dosing (500–1000 mg BID–TID) - **eGFR 45–60:** Use standard dosing; monitor closely - **eGFR 30–45:** Reduce to 500 mg BID; caution - **eGFR <30:** CONTRAINDICATED; discontinue

Hold metformin in acute situations: Surgery, acute illness, contrast administration.

Sulfonylureas (Glyburide, Glipizide, Glimepiride)

Significant renal clearance; hypoglycemia risk in CKD.

Agent	eGFR <30	Normal Dose	Adjusted Dose
Glyburide	Caution	5–10 mg daily–BID	Avoid; use alternatives
Glipizide	Safer	5–10 mg daily–BID	2.5–5 mg daily (metabolized hepatically)
Glimepiride	Caution	1–4 mg daily	0.5–1 mg daily; increase gradually

Monitoring: Glucose monitoring; risk of hypoglycemia increases as eGFR declines.

GLP-1 Receptor Agonists

Generally safe; some dosing considerations:

Agent	eGFR <30	Normal Dose	Adjusted Dose
Liraglutide	Safe	1.8 mg daily SQ	No change
Semaglutide	Safe	1 mg weekly SQ	No change
Dulaglutide	Safe	0.75–1.5 mg weekly SQ	No change
Exenatide	Caution	10 µg BID or 2 mg weekly	eGFR <30: avoid immediate-release; use extended-release carefully

SGLT2 Inhibitors

Safe in CKD; continue even as eGFR declines (per KDIGO 2024).

Agent	eGFR <45	eGFR <20	Note
Dapagliflozin	10 mg daily	Continue if eGFR ≥20	No change; approved for eGFR ≥20
Empagliflozin	10 mg daily	Continue if eGFR ≥20	No change; beneficial even at G5
Canagliflozin	100 mg daily	Caution; limit to 100 mg if eGFR <30	No change but limit max dose

DPP-4 Inhibitors

Generally safe; some renal clearance.

Agent	eGFR <30	Normal Dose	Adjusted Dose
Sitagliptin	Reduce dose	100 mg daily	50 mg daily (eGFR 30–50); 25 mg daily (eGFR <30)
Saxagliptin	Reduce dose	5 mg daily	2.5 mg daily if eGFR <50

Agent	eGFR <30	Normal Dose	Adjusted Dose
Linagliptin	Safe	5 mg daily	No change (hepatic metabolism)
Alogliptin	Reduce dose	25 mg daily	12.5–25 mg daily if eGFR <30

Part 6: Analgesics and NSAIDs (CONTRAINDICATED in CKD)

NSAIDs (Nonsteroidal Anti-Inflammatory Drugs)

GENERAL CONTRAINDICATION: eGFR <60 mL/min/1.73 m² (especially <30)

Mechanism: Inhibit prostaglandin-mediated renal vasodilation; cause acute kidney injury; increase cardiovascular risk.

Absolute avoidance: eGFR <30, acute decompensation, polyuric renal disease, volume depletion.

Caution if used in eGFR 30–60: Shorter duration (<7 days preferred); adequate hydration; avoid in acute illness.

Safer alternatives: - **Acetaminophen:** Up to 3 g/day (eGFR >30) - **Tramadol:** 50–100 mg Q4–6h (reduce to 50–100 mg Q12h if eGFR <30) - **Opioids:** Morphine, hydromorphone (see below)

Opioid Analgesics (Dose by Renal Function)

Agent	Normal Dose	eGFR 30–50	eGFR <30	Avoidance
Morphine	10–30 mg PO Q4–6h	50% dose reduction	50% dose reduction + longer interval	Metabolite accumulation
Hydromorphone	2–4 mg PO Q4–6h	50% reduction	50% reduction	M6G metabolite toxic
Codeine	15–60 mg Q4–6h	Reduce 25–50%	Avoid (codeine-6-glucuronide accumulation)	Neurotoxicity risk
Tramadol	50–100 mg Q4–6h	50–100 mg Q12h	50–100 mg Q24h or avoid	Seizure risk; accumulation
Fentanyl	Variable (patch, lozenge)	Safe (hepatic)	Safe (hepatic)	No renal adjustment
Oxycodone	5–10 mg Q4–6h	50% reduction	50% reduction + longer interval	Noroxycodone accumulation

Key principle: Opioid metabolites accumulate in renal failure; use long-acting opioids (fentanyl) or non-accumulating agents (hydromorphone with caution).

Part 7: Drugs to AVOID or Use with EXTREME CAUTION in CKD

Absolute Contraindications

Drug	Reason	Threshold
Metformin	Lactic acidosis	eGFR <30
NSAIDs	Acute kidney injury; GI bleed risk	eGFR <60 (avoid); <30 contraindicated
ACE-I/ARB in acute setting	Can precipitate acute renal failure	Use only if chronic HTN indication; monitor Cr closely
Potassium-sparing diuretics	Hyperkalemia	eGFR <30
Lithium	Accumulates; neurotoxicity; kidney damage	eGFR <60 (avoid most); requires therapeutic drug monitoring
Gadolinium (contrast agent)	Nephrogenic systemic fibrosis (NSF)	eGFR <30 (use only if essential; avoid gadolinium-based)
Iodinated contrast agents	Contrast-induced nephropathy (CIN)	eGFR <30 (use iso/low-osmolar; hydrate; hold metformin)

Relative Contraindications (Use with Caution)

Drug	Reason	Adjustment
Aminoglycosides	Nephrotoxicity; ototoxicity	eGFR <20: avoid or extended-interval dosing
Vancomycin	Accumulation	Dose reduce; monitor trough level
NSAIDs (if eGFR 30–60)	Renal injury risk	Use lowest dose, shortest duration; ensure hydration
Codeine	Metabolite accumulation	Reduce dose or avoid eGFR <30
Thiazolidinediones (pioglitazone)	Fluid retention; heart failure exacerbation	Use cautiously in advanced CKD; monitor for edema
Finasteride, dutasteride	Renal clearance; accumulation risk	eGFR <30: consider dose reduction

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Part 8: Dialysis-Specific Dosing

Hemodialysis (HD)

Principles: - **Removed by HD:** Small water-soluble molecules (urea, creatinine, small MW drugs) - **NOT removed:** Protein-bound drugs, large molecules, highly lipophilic agents - **Timing:** Dose AFTER HD if drug significantly removed

Peritoneal Dialysis (PD)

Generally: Less drug clearance than HD; similar dosing principles as nondialyzed CKD patients.

Specific Drug Adjustments for Dialysis

Drug	HD Removal	Dosing Strategy	Timing
Gentamicin	Significant (70–90%)	Extended-interval dosing; usual dose Q36–48h	Dose after HD
Vancomycin	Minimal (<10%)	10–15 mg/kg per HD session (NOT post-HD redose; allow level to drop 10–15 µg/mL/day)	Dose after HD or per serum level
Penicillins/cephalosporins	Significant	Standard dosing; Q8–12h dosing in nondialyzed; Q12–24h in HD	Dose after HD
Warfarin	Minimal	No change; monitor INR	Standard
DOAC	Variable (apixaban 25%, dabigatran 80%)	Standard dosing; redose after HD if timing convenient	Post-HD redose
Digoxin	Minimal	No change; maintain low level (avoid toxicity)	Standard
Metoprolol	Minimal	25–50 mg post-HD	Post-HD
Acetaminophen	Significant	Standard dosing	Standard

Part 9: Special Considerations

Contrast-Induced Nephropathy (CIN) Prevention

Risk factors: - eGFR <30 mL/min/1.73 m² - Diabetes - Volume depletion - Repeated contrast exposure

Prevention strategy: - **Hydration:** IV isotonic saline 1 L over 12 hours before and after contrast (or 0.5 L if CHF) - **Hold nephrotoxic drugs:** Metformin (restart 48 hours post-contrast if Cr stable), NSAIDs, ACE-I/ARB (optional) - **Use low-osmolar or iso-osmolar contrast** (LOCM, IOCM) - **Acetylcysteine:** 600 mg PO BID (day before and day after); evidence mixed but low risk - **Monitor:** Serum Cr at baseline, 48–72 hours post-contrast

Drug-Drug Interactions in CKD

Common problematic interactions:

Combination	Problem	Management
ACE-I/ARB + NSAID + diuretic	"Triple whammy" → acute renal failure	Avoid; use SGLT2i instead of NSAID
ACE-I/ARB + potassium-sparing diuretic	Hyperkalemia	Monitor K; reduce diuretic dose
Digoxin + diuretics (loop, thiazide)	Hypokalemia → digoxin toxicity	Ensure K >3.5 mEq/L; add K-sparing diuretic
NSAIDs + ACE-I/ARB	Acute renal failure	Avoid; separate if possible; monitor Cr

Combination	Problem	Management
Metformin + iodinated contrast	Lactic acidosis (contrast-induced AKI)	Hold metformin; restart 48 hours post-contrast if Cr normal

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Part 10: Key Warnings

Warning 1: Metformin Accumulation Lactic Acidosis

Metformin is cleared renally; at eGFR <30, accumulation increases lactate production and acidosis risk. **Absolute contraindication: eGFR <30**. Hold in acute illness, dehydration, sepsis, or before contrast administration.

Warning 2: NSAIDs Cause "Silent" Renal Failure

NSAIDs rarely cause obvious symptoms; patient may not realize declining renal function. Especially dangerous in elderly, diabetic, or volume-depleted patients. **Educate patients to avoid OTC NSAIDs; recommend acetaminophen or tramadol.**

Warning 3: Opioid Metabolite Neurotoxicity

Morphine-6-glucuronide, codeine-6-glucuronide, and other opioid metabolites accumulate in renal failure and cause sedation, confusion, myoclonus, and seizures. **Prefer fentanyl (hepatically metabolized) or non-accumulating opioids in advanced CKD.**

Warning 4: Hyperkalemia from Drug Combinations

ACE-I/ARB + SGLT2i + NSAIDs + potassium-sparing diuretics = dangerous hyperkalemia (K >6.0 mEq/L with arrythmias). **Monitor K closely; educate on low-K diet; remove one agent if K trending up.**

Warning 5: Vancomycin Dosing by Level, Not By eGFR

Unlike other antibiotics with fixed eGFR-based adjustments, vancomycin requires **serum level monitoring**. Goal trough 15–20 μg/mL (higher for serious infections). Dose AFTER dialysis in HD patients; therapeutic drug monitoring essential.

Related Resources

- ← Back to CKD Management Hub
- ← Back to Nephrology Hub
- Back to Medical Education Dashboard

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