AKI Staging & Classification: KDIGO Framework

Andrew Bland, MD, FACP, FAAP

July 2026

AKI Staging & Classification: KDIGO Framework

> [!note] Updated March 2026 to reflect KDIGO 2026 Clinical Practice Guideline for AKI and AKD

KDIGO 2026 Three-Axis Staging System (C/U/B)

> [!important] KDIGO 2026 replaces the single-axis staging system with **three independent axes**: Creatinine (C), Urine Output (U), and Biomarkers (B). Each axis is staged separately. AKI is present when **any axis is ≥1**.

Creatinine Axis (C0–C3)

Stage	Cr Criteria
C0	No creatinine-based AKI
C1	1.5–1.9× baseline within 7 days OR ≥0.3 mg/dL rise within 48 hours
C2	2.0–2.9× baseline
C3	≥3.0× baseline OR ≥4.0 mg/dL rise OR initiation of RRT

Urine Output Axis (U0–U3)

Stage	UO Criteria
U0	No urine output–based AKI
U1	<0.5 mL/kg/h for 6–12 hours
U2	<0.5 mL/kg/h for ≥12 hours
U3	<0.3 mL/kg/h for ≥24 hours OR anuria ≥12 hours

Biomarker Axis (B0/B1)

Stage	Biomarker Criteria
B0	No biomarker evidence of kidney injury

Stage	Biomarker Criteria
B1	Positive kidney injury/stress biomarker (e.g., TIMP-2·IGFBP7, NGAL) per guideline Rec 2.4.1 (2B)

Subclinical AKI (C0/U0/B1)

A critical new category: kidney injury/stress detected by biomarkers **without** creatinine rise or oliguria. This identifies patients at risk who would have been missed entirely by the 2012 criteria.

Cystatin C as Alternative Functional Criterion

When serum creatinine is **unreliable** (low muscle mass, extremes of body habitus, liver disease, fluid overload), cystatin C may be used: a rise of $\geq$**1.5**$\times$ **baseline within 7 days** satisfies the functional criterion for AKI.

Key Insight

- **Stage each axis independently** — a patient can be C1/U2/B1 (moderate by UO, mild by Cr, biomarker-positive)
- The **highest axis** determines overall severity for clinical decision-making
- **Oliguria** (<0.5 mL/kg/h) indicates severity independent of Cr; use ALL THREE metrics
- Once Stage 3 on any axis, patient stays Stage 3 even if that parameter improves slightly

---

Mechanistic Classification: Prerenal $\rightarrow$ Intrinsic $\rightarrow$ Postrenal

Prerenal AKI (~55% of AKI)

Inadequate renal perfusion; glomerular filtration $\downarrow$ but tubules intact.

Mechanism: Volume depletion $\rightarrow \downarrow$ renal perfusion pressure $\rightarrow \downarrow$ GFR

Reversibility: Excellent if caught early; becomes intrinsic AKI if prolonged

Biomarkers: - **FeNa < 1%** (sodium fractional excretion < 1% suggests volume-responsive) - **FeUrea < 35%** (better in diuretic users, CKD baseline; > prerenal even if FeNa >1%) - **High BUN:Cr ratio** (>20:1 suggests prerenal)

> [!tip] **FeNa pitfalls:** Falsely elevated in: - Diuretic use - CKD (glomerular disease may have FeNa >2% despite prerenal physiology) - Early sepsis (preserved tubular function)
>
> Use FeUrea if diuretics given; measure both.

Clinical clues: Orthostatic hypotension, low JVP, dry mucous membranes, prerenal disease history (cirrhosis, CHF)

Intrinsic AKI (~40% of AKI)

Direct kidney injury: tubule necrosis, glomerulonephritis, interstitial nephritis, vascular injury.

Subcategories: 1. **Acute Tubular Necrosis (ATN)** — 45–50% of intrinsic - Ischemic (shock, sepsis, major surgery) - Nephrotoxic (aminoglycosides, cisplatin, myoglobin, hemoglobin, contrast) - See: ATN Deep Dive

2. **Acute Interstitial Nephritis (AIN)** — 10–15% of intrinsic
    - Drug-induced (most common), infection, autoimmune
    - See: AIN Clinical Review
3. **Glomerulonephritis/Vasculitis** — 5–10% of intrinsic
    - Post-infectious, ANCA, SLE, anti-GBM
4. **Rhabdomyolysis / Hemolysis** — 1–2% of intrinsic
    - myoglobin/hemoglobin cast formation

Biomarkers: - **FeNa > 2–3%** (tubular damage → sodium wasting) - **Urine casts** (granular, RBC, WBC, muddy brown) - **Urine dipstick positive for blood but RBC negative** → myoglobin or hemoglobin - **Urine osmolality < 400 mOsm/L** (tubules cannot concentrate)

Postrenal AKI (~5% of AKI)

Urinary tract obstruction distal to kidney.

Common causes: - BPH (most common in elderly males) - Urinary retention (neurogenic, spinal cord injury) - Stones (bilateral or solitary kidney) - Malignancy (bladder, prostate, retroperitoneal) - Blood clots (post-TURP, tumor lysis)

Diagnosis: - **Ultrasound/CT:** Dilated collecting system, hydronephrosis - **Postvoid residual > 100 mL** suggests urinary retention - Relief of obstruction → rapid Cr improvement (within hours to 1–2 days)

> [!warning] **Postobstructive diuresis:** After relief, patient may diurese aggressively with loss of Na, K, PO4 — monitor and replace carefully.

KDIGO 2026: Temporal Definitions & Course

Transient vs Persistent AKI

Category	Definition	Clinical Significance
Transient AKI	AKI criteria met for $\leq$**48 hours** then resolves	Often prerenal/functional; generally better prognosis
Persistent AKI	AKI criteria met for **>48 hours**	Higher risk of CKD transition, complications, and mortality

Recurrent AKI

A new AKI episode occurring **after complete resolution** of a prior episode. Recurrent AKI is an independent risk factor for CKD progression and carries cumulative nephron loss with each episode.

Acute Kidney Disease (AKD)

AKD bridges the gap between AKI and CKD: - **Definition:** Kidney damage or dysfunction (GFR <60 mL/min, kidney damage markers, or structural abnormalities) persisting for $\leq$**3 months** but not meeting CKD duration criteria - AKI that has not resolved by **7 days** transitions to AKD - AKD that persists beyond **3 months** meets the definition of CKD

Baseline Serum Creatinine: Hierarchical Selection (KDIGO 2026)

When baseline SCr is unknown, use this hierarchy: 1. **Outpatient SCr within prior 365 days** (most reliable, closest to steady state) 2. **Admission SCr** (if no prior values available) 3. **Lowest SCr during the current hospitalization** (if no other values) 4. **Back-calculated from CKD-EPI at eGFR 75 mL/min/1.73 m²** (last resort imputation)

> [!tip] **Clinical Pearl:** The back-calculation approach (eGFR 75) overestimates baseline in patients with pre-existing CKD and underestimates it in young healthy patients. Always prefer a measured value when available.

AKI/AKD Resolution Criteria

Resolution Category	AKI (within 7 days)	AKD (within 3 months)
Complete resolution	SCr returns to **<1.2× baseline**	SCr returns to **<1.2× baseline**
Partial resolution	SCr falls to **1.2–1.5× baseline**	SCr falls to **1.2–1.5× baseline**
No resolution	SCr remains **>1.5× baseline** → transitions to AKD	SCr remains **>1.5× baseline** → meets CKD criteria at 3 months

---

Urine Biomarkers in AKI Differential

Urine Sediment Gold Standards

Finding	Mechanism	Stage
Muddy brown casts	Hemoglobin or myoglobin-laden tubular casts	Intrinsic (ATN)
Granular casts	Desquamated tubule epithelium	Intrinsic
RBC casts + dysmorphic RBCs	Glomerulonephritis	Glomerular intrinsic

Finding	Mechanism	Stage
WBC casts + leukocytes	Interstitial nephritis or infection	AIN
Crystal casts	Crystal-induced AKI (uric acid, calcium oxalate, acyclovir)	Intrinsic/Toxic
Normal or hyaline casts only	Prerenal or postrenal	Prerenal/Postrenal

Serum Biomarkers (Emerging)

- **Neutrophil gelatinase-associated lipocalin (NGAL)** — peaks 2–4h post-injury
- **Tissue inhibitor of metalloproteinases (TIMP2)** · **Insulin-like growth factor binding protein 7 (IGFBP7)** — TIMP2•IGFBP7 risk calculator for Stage 3 AKI
- **Creatinine kinase (CK)** — myoglobinuria (CK >5,000)
- **Myoglobin** — darker urine, dipstick+/RBC–, precipitation risk at pH <5.6 and low urine output
- **Hemoglobin, LDH, indirect bilirubin** — hemolysis markers

> [!tip] **Clinical Pearl (KDIGO 2026 Update):** NGAL and TIMP-2·IGFBP7 are now **guideline-recommended** biomarkers (Rec 2.4.1, 2B) and form the B axis of the three-axis staging system. In high-risk settings (cardiac surgery, ICU, sepsis), they should be considered alongside urine sediment + electrolytes + clinical assessment.

AKI → CKD Transition: Critical Window

> [!warning] **30% of AKI Stage 3 patients develop CKD or ESRD despite apparent recovery of Cr to baseline.**

Mechanism of CKD risk post-AKI: - Loss of functional nephron mass despite Cr normalization - Maladaptive repair: fibrosis, glomerulosclerosis - Glomerular hyperfiltration in remnant nephrons → progressive GFR loss - Persistent inflammation, oxidative stress

Mitigating strategies: 1. **Early recognition & intervention** — prevent progression to Stage 3 2. **Avoid nephrotoxins during recovery** — NSAIDs, ACE-I withdrawal, volume swings 3. **Tight BP control** — especially if baseline CKD or diabetes 4. **Follow-up serum Cr at 3, 6, 12 months** — if any elevation, refer to nephrology 5. **Minimize ICU duration** — multiorgan failure amplifies CKD risk

---

Clinical Decision Tree: AKI Workup

```
AKI Identified (↑Cr or ↓UO)
    |
    ├─ HISTORY & EXAM FIRST
    |   ├─ Volume status (JVP, skin turgor, orthostatics)
    |   ├─ Medications (ACE–I, NSAIDs, diuretics, aminoglycosides)
    |   ├─ Recent contrast, rhabdo symptoms, hemolysis signs
```

```
│  └─ Dysuria, flank pain (obstruction)
│
├─ LABS: Urine osmolality, FeNa, FeUrea, casts, dip
│
├─ IMAGING: Renal ultrasound (hydronephrosis?, size, echogenicity)
│
└─ CLASSIFY:
   ├─ FeNa <1% + exam findings → PRERENAL → fluid challenge
   ├─ FeNa >2% + casts → INTRINSIC → identify cause (ATN? AIN? GN?)
   └─ Dilated system on US → POSTRENAL → urology consult
```

Related Resources

- Detailed AKI Review
- Acute Tubular Necrosis
- Acute Interstitial Nephritis
- AKI Workup & Management Summary
- Prerenal AKI Deep Dive

Board-Style Questions to Self-Test

1. **50-year-old with Cr 0.8 → 1.6 (×2 rise) in 24h; UO 0.3 mL/kg/h; FeNa 0.5%; BUN:Cr 28:1**
   - Most likely: Prerenal AKI → tx volume
2. **72-year-old post-cardiac surgery; muddy brown casts; FeNa 4%**
   - Most likely: ATN (ischemic) → supportive care
3. **Cr ↑ to Stage 3 after clarithromycin course; rash, eosinophilia, pyuria; urine eosinophils + WBC cast**
   - Most likely: AIN → steroids + d/c drug
4. **BPH patient, Cr 2.4, U/S shows bilateral hydronephrosis**
   - Postrenal AKI → Foley or urology → postobstructive diuresis risk

---

Version 2.0 | PA/Medical student level | Updated 2026-03-29 for KDIGO 2026 AKI/AKD Guideline