Disclaimer - This guide is intended as an overview with salient details only. In order to provide high quality patient care it is important to maintain close and appropriate supervision.
Chapter 1: Acute Kidney Injury

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- Check out the Core Curriculum AKI
- Review on AKI evaluation, work-up, and staging.
- AKI network (AKIN) classification

<table>
<thead>
<tr>
<th>Stage</th>
<th>Serum creatinine criteria</th>
<th>Urine output criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>↑ to ≥1.5 × base line or ↑ 0.3 mg/dl from base line</td>
<td>&lt;0.5 ml/kg/h ≥6 h</td>
</tr>
<tr>
<td>2</td>
<td>↑ to ≥2 × base line</td>
<td>&lt;0.5 ml/kg/h ≥12 h</td>
</tr>
<tr>
<td>3</td>
<td>↑ to ≥3 × from base line or 4mg/dl with acute ↑ ≥0.5 mg/dl or initiate of RRT irrespective of age at the time of initiation</td>
<td>&lt;0.30 ml/kg/h ≥24 h anuria ≥12 h</td>
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Only one criterion (serum creatinine or urine output) should be fulfilled to qualify for a stage. RRT: Renal replacement therapy; ↑: Increased; X: Times

KDIGO Classification

<table>
<thead>
<tr>
<th>Staging</th>
<th>Serum Creatinine Criteria</th>
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</thead>
<tbody>
<tr>
<td>Stage 1</td>
<td>1.5 – 1.9 times reference value OR Increase ≥ 0.3 mg/dl</td>
</tr>
<tr>
<td>Stage 2</td>
<td>2.0 – 2.9 times reference value</td>
</tr>
<tr>
<td>Stage 3</td>
<td>≥3.0 times reference value OR Increase ≥4.0 mg/dl OR RRT</td>
</tr>
</tbody>
</table>
What to ask and consider when you get a consult?

- What is the baseline serum creatinine?
- Are they making urine? Do they need a foley catheter (i.e. if bladder outlet obstruction is in DDx)
- Triage if you have multiple calls, think who might need kidney replacement therapy sooner.
- Precipitating events: volume/BP, contrast, procedure, infection, or medication change?
- Try to go through the differential diagnosis in an order: post, pre-, intra-renal?
- When you see the patient take a urine sample if possible for microscopy As soon as you receive the consult, ask the admitting team and/or RN to collect the urine, so it can be ready when you get to the room
- Do they have an indication for immediate kidney replacement therapy?
- Do they have access for kidney replacement therapy?
- Is the patient in a center where kidney replacement therapy is available, do they need transfer?
- Which modality of kidney replacement therapy is preferential (HD, CRRT, PIRRT or PD)?

The Evaluation

**Basics:** Complete blood count (CBC), comprehensive metabolic panel (CMP), liver tests (LFTs), urinalysis (UA) with culture, if needed ABG/VBG

**Spinning the Urine:**
- Renal Fellow Network Urine Sediment of the Month
- Spin Urine! - NephSIM
- If needed, start a 24 hour urine collection

**Urine Chemistries:**
- Review of the Clinical Use of Urine Chemistries
- Choosing Wisely in Using Urine Chemistries

**Imaging**
- Kidney Imaging Core Curriculum
- See Kidney Biopsy Chapter 2-3

For other types of AKI, check out the following reviews:

- **RPGN** Rapid progressive glomerulonephritis
- **Anti-GBM:** Anti-GBM nephritis, Goodpasture syndrome
• **Immune Complex**: Acute postinfectious GN, infectious endocarditis, IgA nephropathy, IgA vasculitis (formerly Henoch-Schonlein purpura), MPGN, lupus nephritis
• **Pauci-Immune**: renal-limited vasculitis, granulomatosis with polyangiitis (formerly Wegener), microscopic polyarteritis, eosinophilic granulomatosis with polyangiitis (formerly Churg-Strauss)

### Serology of RPGN and other causes of AKI

<table>
<thead>
<tr>
<th>Disease</th>
<th>Laboratory data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lupus</strong></td>
<td><strong>ANA, Anti-dsDNA</strong></td>
</tr>
<tr>
<td>Light Chain Disease, Myeloma</td>
<td>Serum free light chains, serum protein and urine immunofixation</td>
</tr>
<tr>
<td>Anti-GBM Antibodies</td>
<td>Cytoplasmic-Antinuclear Antibody (C-ANCA)</td>
</tr>
<tr>
<td>Anti-GBM disease (Goodpasture syndrome) or Anti-GBM glomerulonephritis (Goodpasture disease)</td>
<td>Against neutrophil proteinase 3 (PR3)</td>
</tr>
<tr>
<td>Active Granulomatosis with Polyangiitis (GPA)</td>
<td>Perinuclear-Anti-Nuclear Antibody (P-ANCA)</td>
</tr>
<tr>
<td>Active Microscopic Polyangiitis (MPA, systemic and kidney limited)</td>
<td>Against myeloperoxidase (MPO)</td>
</tr>
<tr>
<td>Eosinophilic Granulomatosis with Polyangiitis (EGPA)</td>
<td></td>
</tr>
<tr>
<td><strong>Cryoglobulins</strong></td>
<td>Type I, II, III Cryoglobulinemia, associated with myeloma, Waldenstrom macroglobulinemia, viral infection (Hep B and Hep C), and connective tissue disease (eg. SLE, Sjogren syndrome, or rheumatoid arthritis)</td>
</tr>
</tbody>
</table>

### Complement levels can help us to differentiate certain RPGNs

• **Mnemonic**: Low Serum Complement Levels (**CHAMPS**):
• **Cryoglobulinemia**, C3 glomerulopathy (usually normal C4 and low C3)
• **Heavy chain deposition**
Athero-embolic disease, also cholesterol emboli
  - History of cardiac catheterization or vascular intervention
  - See eosinophilia
  - Can see low compliments

MPGN

Post-infectious glomerulonephritis (GN) or called PIGN, Infectious Endocarditis

SLE (lupus)

Indications for urgent kidney replacement therapy (caveat- refractory to medical management)

- Acidosis- typically if severe and refractory to medical management - read BICAR-ICU trial (Lancet 2018)
- Electrolyte imbalance, particularly potassium - *be cautious when dialyzing someone with severe hyponatremia*
- Ingestion of toxic compound - *remember to check for osmolar gap*
- Overload of fluid - *often overlooked, keep an eye (and POCUS) out for it*
- Uremia
- Friday, think practically of the services available at nights/weekends and if access needed earlier

The Consult Note

Mention the following in your note:

- History and Exam:
  - Appropriate time-sensitive history, date kidney replacement initiated and when access placed
  - Blood pressure/volume: assessment via physical exam and point of care ultrasound (POCUS)
- Investigations
  - Follow up labs including kidney indices and electrolytes
  - Acid/Base: see acid/base section.
  - Urine microscopy of patients with AKI.
  - Consider kidney ultrasound to rule out obstructive nephropathy
  - *Consider loop diuretic challenge if volume overloaded*
- Assessment:
  - AKI: baseline serum creatinine and whether patient oliguric (<400 cc’s/day) or non-oliguric
  - Most likely etiology
- Plan:
  - Does the patient need urgent kidney replacement therapy or not?
Review Medications for dosing and contraindications in kidney failure: Especially antibiotics, pain medications, and muscle relaxants (baclofen)

Medications should be dosed based on kidney function (caveat - when severe AKI ie AKIN stage 3, medications should be dosed as if patient has minimal to no kidney function (eGFR <10) regardless of serum creatinine and calculated eGFR)

Recommendations on the cause of AKI - can we stop/reduce further kidney injury?

Talk to the primary team, communication is key!

Special Acute kidney injury

- Review of Onco-nephrology including AKI:
  - Onco-Nephrology review in CJASN: AKI in the Cancer Patient.
  - Onco-Nephrology: Core Curriculum
- Review of non-kidney solid organ transplant AKI:
  - Liver and heart
  - Hematopoietic stem cell transplantation