

ACUTE KIDNEY INJURY (AKI)

(Last updated: 07/22/2019; Reviewed by: Catarina Aragon Pinto, MD)

PRESENTING COMPLAINT: Decreased urine output, edema, altered mental status

FINDINGS

- **A** Check Airway
- **B** ↑/N RR, dyspnea
- **C** ↓/↑/N BP, ↑/N HR, N or weak pulse
- **D** Altered variable (V,P,U,D)*
- **E** Edema(especially periorbital edema), rash (Acute Interstitial Nephritis), tetany
- **L_{PC}** ↑ lactate, ↓Na, ↑ K, ↑Mg, ↓Ca, ↑P, ↑BUN, ↑Cr ,Urinalysis-hematuria, proteinuria, ABG
- **U_{PC}** Obstruction (full-bladder, enlarged prostate, renal stone, hydronephrosis), chronic kidney disease (small kidneys ± cortical scarring, increased echogenicity, polycystic kidney)

***V** (verbal), **P** (pain), **U** (unconsciousness), **D** (delirious)

U_{PC} (point of care ultrasound) **L_{PC}** (point of care labs)

DEFINITION: AKI is defined by a rise in the serum creatinine concentration or a decline in urine output that has developed within hours to days. The proposed criteria for AKI include an increase in serum creatinine by ≥ 0.3 mg/dL (27 micromol/L) within 48 hours or an increase to ≥ 1.5 times the presumed baseline value that is known or presumed to have occurred within the prior seven days, or a decrease in urine volume to < 0.5 mL/kg/hour over six hours.

OTHER HISTORY

- Oliguria and/or anuria, nausea and/or vomiting, malaise and/or fatigue.
- **Staging: Stage I:** Serum Creatinine (SCr) is 1.5-1.9 times baseline (within the first 7 days) **OR** by ≥ 0.3 mg/dl (≥ 26.5 mmol/L) (within the first 48 hours) **OR** urine output (UOP) is < 0.5 mL/kg/h for 6-12hr ; **Stage II:** SCr to 2.0-2.9 times baseline **OR** UOP is < 0.5 mL/kg/h for ≥ 12 hr ; **Stage III:** SCr to ≥ 3.0 times baseline **OR** to ≥ 4 mg/dl (≥ 353.6 mmol/L) **OR** UOP is < 0.3 mL/kg/h for ≥ 24 hr **OR** anuria for ≥ 12 hr **OR** initiation of renal replacement therapy (RRT) **OR** if patient < 18 years and eGFR to < 35 mL/min per 1.73m^2

DIFFERENTIAL DIAGNOSIS

- **Prerenal (FeNa < 1 , BUN/Cr > 20 , Uosm > 500) :** Reduction of intravascular volume or cardiac output or plasmatic renal flow; **Renal (FeNa > 1 , BUN/Cr < 15 , Uosm < 350):** Acute tubular necrosis,

interstitial nephritis, vascular diseases, glomerulopathies; **Postrenal (FeNa<1 in mild, >2 in severe, BUN/Cr varies, Uosm<350)** :site of obstruction: Ureter, bladder, urethra

OTHER INVESTIGATIONS

- **Labs:** Hyaline casts or epithelial cells for ATN vs. RBC or WBC casts for glomerular disease, electrolytes, urine culture, CBC, NT-pro BNP; consider blood count with smear, coagulation, inflammatory markers, liver function, CK. Kidney injury biomarkers or furosemide stress test may assist with differential diagnosis or estimation of AKI intensity.
- $FeNa = (Na\ urine \times Cr\ serum) / (Na\ serum \times Cr\ urine)$
- **Monitoring: Urinary catheter:** rule out/relieve obstruction, measure UOP and bladder pressure; **ECG:** if **hyperkalemia** suspected (signs progress with severity): peaked/tented T waves, flattening of the P wave and prolongation of QRS complex, sine waves, and ventricular fibrillation or asystole

THERAPEUTIC INTERVENTIONS

General (see algorithm)

- Optimize hemodynamics: fluid challenge (saline or buffered crystalloids [preferred when chloride is not low]) +/- vasopressors, treat hypertension or seizure if present, **avoid** nephrotoxic agents (or regularly monitor plasma level), **avoid radiocontrast** procedures if possible, avoid fluid overload to relieve intraabdominal hypertension, **avoid hyperglycemia, avoid protein restriction** (1.0gr/kg/d if not on RRT; 1.0-1.5gr/kg/d if on RRT; up to 1.7gr/kg/d if on RRT + hypercatabolic)
- **If stage II/III,** consider renal replacement therapy (RRT) and ICU admission

Specific to complications (indications for RRT)

- **Hyperkalemia (>6.5 mmol/L or EKG changes):** Risk of cardiac arrhythmias; 10% calcium gluconate/chloride IV bolus only when QRS is widened (10-20 mL, slow infusion if on glycosides); fast acting insulin + glucose (except if hyperglycemia); beta2-adrenergic agonists (if no cardiac contraindication); increase potassium loss: oral/rectal ion exchange resins or loop or thiazide diuretics; hemodialysis (if refractory); consider sodium bicarbonate to correct concomitant non-anion-gap metabolic acidosis (careful not to over-correct)
- Pulmonary edema: Ventilator assistance and diuretics; consider hemofiltration if diuresis fails
- Severe acidosis (blood pH <7.2): Cautious use of sodium bicarbonate (risk of sodium and fluid overload); renal replacement therapy (RRT) if oliguria or anuria and metabolic abnormalities
- Uremia-elevated BUN with clinical signs of pericardial rub, uremic frost, or encephalopathy

ONGOING TREATMENT

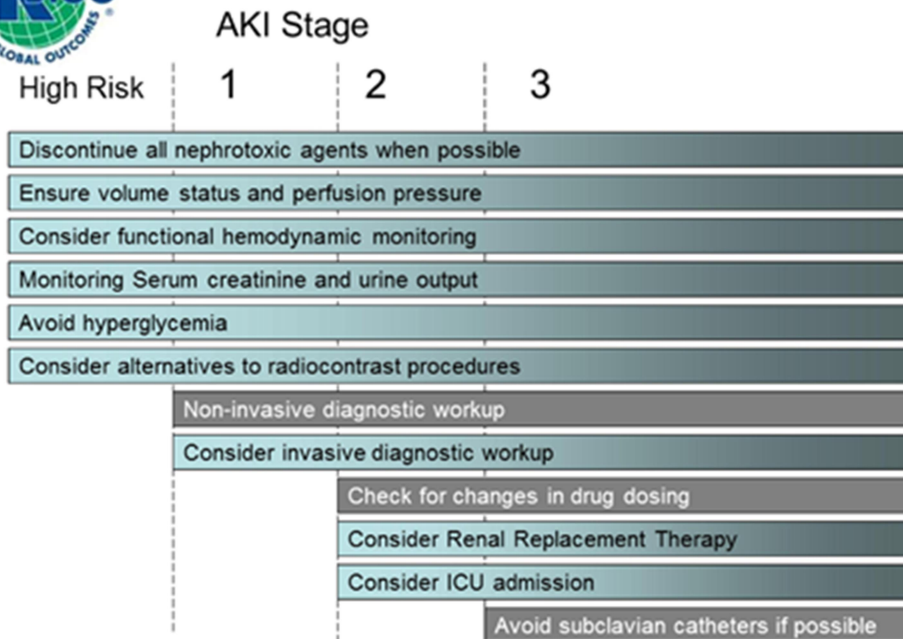
- **Further diagnostic workup**

- Investigate etiology: sepsis, hypovolemia, heart failure, shock; **nephrotoxins**: NSAIDs, ACE-I, ARBs, antimicrobials (aminoglycosides, glycopeptides...), phenytoin, cimetidine, omeprazole, allopurinol, overuse of thiazide diuretics and furosemide, alternative medicines; radiocontrast agent injection; rhabdomyolysis (high CK); myeloma (bone pain); vasculitis signs (rash, arthralgia); glomerulonephritis (hematuria and proteinuria), interstitial nephritis (beta-lactams, urine eosinophils); bilateral urinary tract obstruction (hydronephrosis)
- Assess comorbidities: chronic renal insufficiency, diabetes, hypertension, liver cirrhosis and CHF; cystoscopy, retrograde ureteropyelography; renal biopsy and specific labs according to intrinsic renal cause (immunoglobulin, serologies, etc.)
- Furosemide-Stress-Test in stage I/II: UOP <200ml in 2hr (progression to stage III)
- **Further treatment:** Low potassium/phosphorus diet, adjust pharmacological treatment doses to the estimated GFR, strictly limit fluid input if UOP is impaired (to avoid fluid overload after achieving euvolemia), and **do not use** low-dose dopamine, fenoldopam, ANP, rhIGF-1.
- **Consider:** Percutaneous nephrostomy or cystoscopy or retrograde ureteral catheterization (ureteric stenting) if non-removable obstruction, Renal Replacement Therapy(indications mentioned earlier), peritoneal dialysis if hemodialysis is not available or feasible, nutrition and water-soluble vitamin therapy according to RRT prescription, no need for urine volume replacement if BUN and creatinine improving, immunosuppression (steroids, plasmapheresis) for vasculitis, glomerulonephritis, interstitial nephritis, pre-hydration (if contrast imagery is needed)

CAUTIONS

- **Complications:** Fluid overload (pulmonary edema), severe acidosis (pH<7.1), severe uremia with complications (encephalopathy, pericarditis), severe hyperkalemia, low blood urea if associated severe liver disease, high serum creatinine if muscle necrosis, polyuria on post-obstruction relief (monitor diuresis and electrolytes), increased bleeding risk due to uremia, risk of drug overdose if non-adjusted doses.

ALGORITHM



REFERENCES & ACKNOWLEDGMENTS

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