Newborn Critical Care Center (NCCC) Clinical Guidelines

Acute Kidney Injury

BACKGROUND

Acute kidney injury (AKI) in the neonate/infant is associated with an increase in morbidity and mortality. Infants who survive AKI are at risk to develop renal dysfunction and chronic kidney disease later in life and therefore require long-term follow up [1-5]. AKI is most common in the first week of life in very low birthweight (VLBW) infants and the prevalence in infants with associated comorbidities is nearly 40% (Figure 1) [6].

	Prevalence (%)	Mortality AKI vs. no AKI (%)
	40	14 vs. 4
VLBW[a]	18	55 vs. 5
ELBW[b]	13	70 vs. 22
Sick near term/term	18	22 vs. 0
Sepsis	26	70 vs. 25
Asphyxiated	38	14 vs. 2
ECMO	71	73 vs. 20[c]

[a]*Very low birth weight (VLBW) infants <1500 g.*
[b]*Extremely low birth weight (ELBW) infants <1000 g.*
[c]*Extracorporeal membrane oxygenation (ECMO).*

Figure 1

Risk factors for AKI include neonates <1500 grams, intrauterine growth restriction [1, 2, 7], hypoxia secondary to respiratory failure or asphyxia [8, 9], hypoperfusion secondary to sepsis, necrotizing enterocolitis, abdominal compartment syndrome, patent ductus arteriosus, cardiac disease, high mean airway pressures impairing venous return, decreased fluid intake or increased losses, nephrotoxic medication exposure, and anomalies of the kidney or urinary tract [10-16]. For these infants it is important to avoid AKI, recognize it promptly if symptoms develop, alter clinical management to prevent disease progression, and appropriately monitor AKI resolution and possible long term sequalae.

Through this guideline, we aim to maximize accurate identification of neonates with AKI, utilize a multidisciplinary team approach to the management of neonates/infants with AKI, and standardize outpatient referral for neonates/infants diagnosed with AKI.

CRITERIA

- AKI is an acute decline in kidney function resulting in fluid and electrolyte imbalances/abnormalities and accumulation of waste products [2]

- AKI is defined as the following:
    - Increase in serum creatinine (SCr) by 300% within 7 days of the lowest recorded value; **or**
    - Urine volume <0.3 mL/kg/hr for 24 hours (after 24 hours of life or after 3 days in VLBW) (KDIGO guidelines) [2, 8, 17, 19] **or**
    - Anuria for > 12 hours; **or**
    - SCr that does not decrease to <1.0 mg/dL by 2 weeks of age and/or is increasing

MANAGEMENT

If the underlying etiology behind the AKI is known, treat the primary condition first while maintaining euvolemia, regularly monitoring renal function (every 24 hour minimum serum creatinine, sodium, potassium, chloride, bicarb, BUN, and urine output), and avoiding nephrotoxic medications to expedite recovery.

Physical Examination

- Assessment of volume status including body weight and vital signs
- Follow strict intake and output (consider foley placement) and monitor daily weights

Laboratory Values

- Obtain serum basic metabolic panel (BMP) and consider urinalysis via bagged specimen
- A single elevated creatinine should be repeated within a minimum of 24 hours

Imaging

- Consider renal ultrasound with doppler to evaluate for congenital renal dysplasia, urinary obstruction, or renal vein thrombosis

Fluid Balance

- A single 10mL/kg normal saline bolus should be considered if prerenal causes are suspected (more IV fluid or blood product (PRBC) may be required if patient is hypovolemic)
- If patient remains oliguric after fluid resuscitation, additional IV fluid or blood product should be used with caution due to the risk of anasarca and pulmonary edema
- Restrict fluid intake if no response to bolus or if intrinsic renal disease is suspected
- If oliguric with volume overload, consider a one-time dose of furosemide 1mg/kg IV and assess urine output [18]
    - Recheck electrolytes within 6 hours if giving furosemide

Limit Risk

- Identify and treat modifiable risk factors such as infectious etiologies, cardiac dysfunction, or impaired venous return [19].
- Correct hypotension if necessary and obtain blood pressure measurements at a minimum of every 3 hours [20]
- Review with NCCC Pharmacist the need for adjusting medications based on renal clearance
- If possible, avoid nephrotoxic medications and consider other alternatives with NCCC Pharmacist consultation [21]

Manage Electrolyte Abnormalities

- Hyperkalemia
    - For all patients with AKI, evaluate need for removal of potassium and phosphorous from IV fluids and/or use formula low in potassium and phosphorus such as Similac PM 60/40 or plain breast milk
    - Correct hyperkalemia as determined by the NCCC Hyperkalemia Guidelines
- Metabolic acidosis
    - Consider maximizing acetate in parental nutrition if metabolic acidosis is present
    - If patient develops refractory metabolic acidosis, discuss with attending physician regarding the use of sodium bicarbonate
- Hyponatremia
    - Consider obtaining plasma and urine osmolality and urine sodium levels to help determine whether hyponatremia is result of fluid overload or total body sodium depletion
    - Restrict fluid intake rather than increasing sodium supplementation
    - If hyponatremia is severe (<120 mEq/L) or the infant is symptomatic (seizing, lethargic, refractory emesis), consider giving normal saline or 3% sodium chloride [18]

Replacement of Deficit (mmol Na needed):
[Desired Serum Na (mmol/L) – Actual Serum Na (mmol/L)] x Weight (kg) x 0.6

        - Correction rate should not exceed 0.5-1 mmol/kg/hr (the slower the rate the better to minimize sudden alterations in serum osmolality)
            - Hypertonic 3% saline (513 mmol/L) infused at a rate of 1.0mL/kg/hr
            - Check serum Na every hour during the first 3 hours of infusion and every 3 hours thereafter

MONITORING

- Obtain a detailed medical history including documentation of presence of risk factors
- If infant meets any of the above criteria for an AKI, a diagnosis of AKI should be made and “Acute Kidney Failure” should be added to the problem list (ICD 10 code: N17.9)
- If the AKI persists beyond 3 days or if the serum creatinine is ≥ 3 mg/dL, a Pediatric Nephrology consult should be considered
- Patients with a diagnosed AKI, should be followed up within 6 months of discharge by either their Special Infant Care Clinic provider or a pediatric nephrologist (unless earlier follow-up is recommended by the Pediatric Nephrologist) to evaluate for new onset or worsening chronic kidney disease [23, 24]

References:

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Acute Kidney Injury Algorithm

Diagnosis:

If patient meets ***ANY*** of the following criteria:

- Urine output <0.3 mL/kg/hr for 24 hours
- Rise in serum creatinine by 300% in 7 days
- Serum creatinine ≥ 1.0 mg/dL after 2 weeks of life
- Anuria for >12 hours

"Acute Kidney Failure" should be added to the problem list (ICD 10 code: N17)

Management:

Limit Risk:

- Avoid nephrotoxins
- Correct electrolyte imbalance
- Treat underlying cause

Monitor:

- Obtain daily BMP
- Consider renal ultrasound and UA
- If AKI > 3 days or serum creatinine > 3 mg/dL, consult Nephrology

Assess volume status:

- Strict I/O
- Daily weights
- Consider test bolus vs. fluid restriction

Follow-up:

If diagnosed with acute kidney injury while inpatient:

Schedule follow-up with Pediatric Nephrology within 6 months

Schedule follow-up with SICC within 6 months