ပြည်ထောင်စုမြန်မာနိုင်ငံ၊ အထူးဒေသ(၁) ကျန်းမာရေးဌာန

缅甸联邦第一特区卫生部

The Union of Myanmar, SR(1) Department of Health

Acute Kidney Injury in Children

Standard Operating Procedure (SOP)

Contents

Acute Kidney Injury in Children

Definition

- Rapid decline in glomerular filtration rate, resulting in impairment of excretion of nitrogenous waste products and loss of water and electrolyte regulation as well as acid base regulation.

Diagnosis of AKI

- Abrupt increase in serum creatinine ≥1.5 x base line in 7 days (or)
- Abrupt decrease in urine output <0.5 ml/kg/hr for 6 hours (Kidney Disease Improving Global Outcomes KDIGO, 2012)

RIFLE Criteria

- Defines the severity of AKl- Risk, injury and failure based on changes in serum creatinine or urine output
- pRIFLE criteria for paediatric patients and nRIFLE criteria for neonates are based on estimated GFR and urine output

For AKIN*, the increase in creatinine must occur in <48 hours.

Classification	**Creatinine**	**Urine output criteria (ml/kg/hr)**	
RIFLE(AKIN)	**pRIFLE and nRIFLE**	**pRIFLE**	**nRIFLE**
Risk (1)	Increased creatinine1.5x or eGFR decrease by 25%	<0.5 for 8 hours	<1.5 for 24 hours
Injury (2)	Increased creatinine 2xor GFR decrease >50%	<0.5 for 16 hours	<1.0 for 24 hours
Failure (3)	Increased creatinine3x or GFR decrease>75% or eGFR <35 ml/min/1.73m2	<0.3 for 24 hours or anuria for 12hours	<0.7 for 24 hours or anuria for 12 hours
Loss	Persistent failure >4 weeks		
End stage	Persistent failure >3 months		

For AKIN*, the increase in creatinine must occur in <48 hours.
For RIFLE, AKl should be both abrupt (within 1-7 days) and sustained (>24 hours).
*Acute Kidney Injury Network

Clinical Assessment

Check life threatening features first

Vital signs

- Respiration rate, heart rate, oxygenation (color, respiratory rate, O, saturation)
- Blood pressure
  - Hypertension with cool peripheries-intravascular volume depletion
  - Hypertension with warm peripheries-Fluid overload
- Severe bleeding

Hydration status

- Decreased-Weight loss, decreased skin turgor, impaired capillary refill, dry mucus membrane, depressed anterior fontanellae, tachycardia low BP altered mental state
- Increased-Features of volume overload include hypertension, raised JVP, displaced apex beat, basal crepitation, hepatomegaly and increasing ventilator requirements, pulmonary oedema, respiratory distress.

Abdominal examination

- Tenderness, ascites, palpable kidneys or bladder, renal bruit
- Stigmata of liver disease.

Neurological examination

- Seizure
- Hypertensive encephalopathy
- Examination of fundi for hypertensive changes or retinitis
- Muscle weakness, carpopedal spasm

Skin and musculosketal system

- Rash, vasculitis, petechiae, purpura, arthritis, muscle tenderness

Daily body weight, intake and output

Newborn Infant with Oliguria or Anuria

- Oliguria >72 hours is worrying and should be investigated
- Consider congenital malformations such as posterior urethral valve or genetic kidney disease
- In the sick neonate with haematuria, bilateral renal vein thrombosis should be suspected

Investigations

- **Blood tests**
  - Full blood count
  - Blood urea, electrolytes, creatinine
  - Serum albumin, calcium, phosphate
  - Serum complement levels (C3, C4)
- ***Urine***
  - Microscopy (blood, protein and casts)-Presence of haematuria associated with dysmorphic red cells and red cell casts suggest glomerulonephritis
  - Pyuria suggests pyelonephritis
  - Uric acid crystals in tumour lysis syndrome

  Imaging
    - Renal ultrasound to exclude obstruction and to assess size of kidney and symmetry
    - ECG: tented T waves in hyperkalaemia
    - Other investigations as determined by cause

Management of Acute Kidney injury

Maintain adequate renal perfusion

Dehydration or shock

- Fluid resuscitation regardless of oliguric/anuric state
  - Give crystalloids e.g. lsotonic 0.9% saline/Ringer's lactate 10 to 20 ml/kg fast (in <20 minutes) after obtaining vascular access
  - Transfuse blood if haemorrhage is the cause of shock
  - Hydrate to normal volume status
  - If urine output increases, continue fluid replacement

Established renal failure with fluid overload

Hypervolaemia /Fluid overload

  - Fluid restriction
- Insensible water loss (400 ml/m?/day or 30 ml/kg in neonates) + urine output + other loss (e.g. drain, nasogastric tube, GI loss)
- IV Frusemide 2 mg/kg/dose (over 10-15 minutes), maximum of 5 mg/kg/dose or
- IV Frusemide infusion 0.1-0.5 mg/kg/hour (should be stopped if there is no response after 2 doses or after 12 hours of infusion)
- If severe overload and pulmonary oedema
- Give IV Frusemide 1 mg/kg stat, intubate, ventilate and start dialysis
- Dialysis if no response or if volume overload is life-threatening

Euvolaemia

- Once normal volume status is achieved, give insensible loss plus obvious losses (urine /extrarenal)

Monitor fluid status: weight, BP, heart rate, nutritional needs, intake/output

Clinical assessment	Hypovolaemic or dehydrated	Euvolaemic	Fluid overload
Initial management	Fluid bolus 10 ml/kg 0.9% saline thenreassess	Fluid bolus 10 ml/kg 0.9% saline	Furosemide 3-5 mg/kg
Further management	Repeat bolusup to twicemore if clinically hypovolaemic	Consider – Furosemide 3-5 mg/kg	Needs dialysis ifsymptomatic withpulmonary oedema

- Treatment of Hypertension
- Treatment of Hyponatraemia
- Treatment of Hypernatraemia
- Acidosis

Management of Electrolyte Abnormalities

Hypocalcaemia

- Treat if symptomatic (usually serum Ca^{2+}<1.8 mmol/L) and if sodium bicarbonate is required for hyperkalaemia, with IV 10% Calcium gluconate0.5 ml/kg, given over 10-20 minutes, with ECG monitoring

Hyperkelemia **(K^+ >6 mmol/l or with cardiac conduction abnormalities)**

- Continuous ECG monitoring-Tall peaked 'T' wave (K^+ 5-5.6 mmol/l)
  - Prologation of PR interval (K^+ 6-7 mmol/l)
  - Widening of 'ARS' complex (K^+6-7 mmol/l)
  - Flattening of 'P' wave (K^+ 7-7.5 mmol/l)
  - Ventricular tachycardia and fibrillation, Asystole (K^+ >7.5-8 mmol/l)
- Stop all potassium input

Mild or Moderate hyperkalemia without ECG changes:

- Nebulised Salbutamol 2.5-5 mg can be repeat 3 times maximum 2 hourly OR
- IV Sodium bicarbonate with glucose OR
- IV Polystyrene sulphonate Resins (Calcium resonium)
  - Per oral (Child 1 month-18 years): 125-250 mg/kg (max: 15 g) 3-4 times daily
  - Per rectal (Neonates-18 years): 125-250 mg/kg repeated as necessary every 6-8 hours
  - Irrigate colon to remove resin after 6-12 hours

Contraindication: Obstructive bowel disease; neonates with reduce gut motility.

Acute severe hyperkalemia (>7 mmol/l)

- Urgent treatment with IV infusion of soluble insulin (0.3-0.6 units/kg/hour in neonates and 0.05-0.2 units/kg/hour in children over 1 month) + 10% glucose2.5-5 ml/kg OR
- If insulin cannot be used
  - Salbutamol: IV 4 µg/kg (preferred) as a single dose; repeated if necessary OR
  - Nebulised 2.5-5 mg as a single dose; repeat if necessary
  - Also give Calcium gluconate, slow IV injection (0.5 ml/kg over 5-10 minutes to manage cardiac excitability

Correction of causal or compounding acidosis with $NaHCO_3$, infusion (1 mmol/ kg daily should also be considered)

Table 6.3 Treatment of hyperkalaemia

Type	Dose	Onset of action	Duration	Mode of action	Complications
IV 10% Calcium gluconate	0.5-1.0 ml/kg over 2-10 mins	Immediate	Minutes	Antagonize the effect of potassium Stabalise membrane	Bradycardia Hypercalcemia
IV 8.4% $NaHCO_3$	2-3 ml/kg	5 minutes	1-2 hours	Shifts potassium into cells	Hypernatraemia Fluid overload Alkalosis
10% glucose with insulin	0.5 gm/kg plus Insulin 0.05-0.2 units/ kg/hr IV	30 minutes	1-2 hours	Shifts potassium into cells	Hyperglycemia
Salbutamol (Nebulised)	1.25-10 mg	30 minutes	2 hours	Shifts potassium into cells	Tachycardia Hypertension
PO/PR Ion exchange resins	Na/Ca (resonium A or calcium resonium) 125-25 mg/kg (max: 15 g) 3-4 times daily	2 hours when given orally/ 30 minutes PR	4-6 hours	Remove potassium from the body	Constipation
Dialysis/ Haemofiltration	Haemodialysis Peritoneal dialysis	Rapid Gradual		Remove potassium from the body	

Dialysis

Indications for Dialysis in AKI

Traditional indications

- Severe hyperkalemia unresponsive to conservative therapy
- Uncontrolled acidosis that cannot be safely corrected because of risk of sodium or volume overload
- Severe volume overload with uncontrolled hypertension, pulmonary edema or cardiac failure
- Progressive uremia with deterioration in the general condition
- Hypercatabolic state with increase in blood urea by >10 mmol/L/day

Early institution of dialysis in the critically ill child with AKl in order to maintain homeostasis and create enough volume space so that the nutritional and therapeutic needs may be met, as severe fluid restriction can result in:

- Inadequate nutrition
- Propensity to hypoglycemia
- Insufficient volume space for blood products
- Difficulty in drug delivery, such as inotropic support and antibiotic infusions

Contraindications for Peritoneal Dialysis (PD)

- Major abdominal surgery
- Severe scaring of the peritoneum from previous surgery
- Peritonitis
- Abdominal wall burns/ crush injury

Nutrition

- Avoiding excessive protein intake
- Minimizing phosphorus and potassium intake
- Avoiding excessive fluid intake (if applicable)
- If the gastro-intestinal tract is functional, start oral feeds as soon as possible

Calorie Management

- ARF is hypercatabolic state and requires aggressive nutritional support
- Unlike adults, there is no indication for diatery protein restriction
- Amino acid or protein of high biological value
- Add carbohydrates
    - Calories 1400 kcals/m^2/day (Maintenance calories 120-140 Kcals/kg/day)
    - Protein 0.6 gm/kg/day (1.5 g if dialysis)0
- Folate and Vitamins supplementation

Careful Drug Dosing and Avoidance of Nephrotoxic Drugs

- Doses must be adjusted according to the serum creatinine level and calculated creatinine clearance using formula
- Nephrotoxic drugs, such as NSAlDS and aminoglycosides, should be avoided

Traditional Schwartz Formula

$$\text{Calculated creatinine clearance (ml/min/1.73 m}^2\text{)} = \frac{\text{Height (cm) x K}}{\text{Serum creatinine(umol/l)}}$$

	K value
Low birth weight infants <2.5 kg (0-12 months)	29.1
Full term infant (0-12 months)	39.7
Girls (2-21 years)	48.6
Boys (2-12 years)	48.6
Boys (13-21 years): Tanner 23 or bone age 213 years	61.7

Treatment of Underlying Cause and Sepsis Control

Prevention

- Prevention of infection by means of strict sepsis control
- Prevention of gastrointestinal haemorrhage-Ranitidine, Omeprazole
- Identification of patients at risk
- Maintain adequate blood pressure and volume status

Avoid potentially nephrotoxic agents, especially NS AlDS, ACE inhibitors