

Pediatrics – Dr. Bakr – Lecture 5 – Acute Renal Failure

Acute renal failure is a clinical syndrome in which sudden deterioration in renal function results in the inability of the kidneys to maintain fluid and electrolyte homeostasis. If treated within a proper time it is reversible.

Criteria has been developed to characterize the pattern of acute kidney injury in critically ill children. The criteria were given the acronym of pRIFLE. This criteria depend on glomerular filtrations rate.

CRITERIA	ESTIMATED CCI	URINE OUTPUT
Risk	eCCI decreased by 25%	<0.5ml/kg/hr for 8 hr
Injury	eCCI decreased by 50%	<0.5ml/kg/hr for 16 hr
Failure	eCCI decreased by 75% or < 35ml/min/1.73 m ²	<0.3ml/kg/hr for 24 hr Or anuric for 12 hr
Loss	Persistent failure for > 4wk.	
End-stage	End-stage renal disease. Persistent failure for >3 months.	

The severity of acute renal failure can be classified in to three stages on the base of rise in serum creatinine:

1. -stage I >150% rise in serum creatinine.
2. -stage II >200% rise in serum creatinine.
3. -stage III >300% rise in serum creatinine.

Common causes of acute renal failure:

ARF HAS BEEN CLASSIFIED IN TO 3 MAIN TYPES:

1-Prerenal ARF:is characterized by diminished effective circulating arterial volume, which leads to inadequate renal perfusion and a decreased glomerular filtration rate. Common causes are:

1. -Dehydration.
2. -Hemorrhage.
3. -Sepsis.
4. -Hypoalbuminemia.
5. -Heart failure.

2-Intrinsic ARF: characterized by renal parenchymal damage common causes are:

1. -Post infectious glomerulonephritis.
2. -Lupus nephritis.
3. -Hemolytic uremic syndrome.
4. -Henochschonline purpura.
5. -Acute tubular necrosis.
6. -Acute interstitial nephritis.
7. -Tumor lysis syndrome.

3-Post renal ARF: characterized by obstruction of urinary tract. Common causes are:

1. -Posterior urethral valve.
2. -Bilateral ureteropelvic junction obstruction.
3. -Urolithiasis.
4. -Tumor.
5. -Hemorrhagic cystitis.
6. -Neurogenic bladder.

--Obstruction must be bilateral to cause ARF. Relieve of the obstruction usually results in recovery of renal function except in patients with associated renal dysplasia or prolonged obstruction.

CLINICAL MANIFESTATION

-Clinical presentation depends on the underlying causes, in patients with prerenal causes there are features of volume depletion.

-patients with renal parenchymal causes present with features of the underlying causes with volume overload, hypertension and edema.

-patients with post renal causes present with volume overload and abdominal mass.

LABORATORY FINDING

-Elevated concentration of blood urea and creatinine.

-There is hyperkalemia, hyperphosphatemia, increased serum concentration of uric acid, hypocalcaemia, hyponatremia and metabolic acidosis.

-there is anemia, leukopenia, thrombocytopenia.

-Urine exam shows hematuria, proteinuria, RBC or WBC cast.

-Renal ultrasonography may show hydronephrosis, hydro ureter or abdominal mass.

-CXR may show cardiomegaly, pulmonary congestion.

Urine indices can differentiate between prerenal and renal causes of ARF.

Patient with prerenal ARF urine indices shows:

1. -elevated urine specific gravity >1.020 .
2. -elevated urine osmolality $>500\text{mOsm/kg}$.
3. -Low urinary sodium concentration $<20\text{mEq/L}$.
4. -Fractional excretion of sodium $<1\%$.

While patient with intrinsic renal causes of ARF:

1. -urine specific gravity <1.010 .
2. -urine osmolality $<350\text{mOsm/kg}$.
3. -fractional excretion of sodium $>2\%$.
4. -High urinary sodium excretion $>40\text{mEq/L}$.

----Renal biopsy may ultimately be required to determine the precise cause of ARF.

TREATMENT

Treatment is according to the underlying causes:

-in infant and children with obstruction a bladder catheter should be placed to ensure adequate drainage, surgery should be done to remove the obstruction.

-in patient with hypovolemic pre renal ARF: intravascular volume should be expanded by intravenous administration of isotonic saline 20ml/kg over 30min.after volume resuscitation patient generally void urine within 2hr.failure to do so points toward the presence of intrinsic or post renal ARF.

After correction of hypovolemic ,if there is no urine output ,diuretic therapy should be considered.

Manitol (0.5gm/kg) and ferosemide (2-4mg/kg) can be use.

If there is no response to diuretic challenge ,diuretic should be discontinued and fluid intake should be restricted to insensible loss (400ml/m²/24hr) pulse daily urine out put and extra renal fluid loss like GIT fluid or blood loss.

Fluid intake, urine and stool out put, body weight and serum chemistries should be monitored on daily basis.

Hyperkalemia: should be corrected to prevent cardiac arrhythmia. Line of management include:

1. intake of potassium should be eliminated.
2. Kayexalate can be giving orally or by enema. This resin exchange sodium for potassium.
3. Calcium gluconate 10% solution 1ml/kg IV over 3-5 min.
4. Sodium bicarbonate,1-2meq/kg,over 5-10min.
5. Regular insuline,0.1U/kg,with glucose 50% solution,1ml/kg over 1 hr.
6. The duration of action of these emergency measure is just a few hours , persistent hyperkalemia should be treated by dialysis.

Metabolic acidosis: metabolic acidosis is common in ARF due to retention of hydrogen ions,phosphate,and sulfate.mild acidosis need no treatment,severe acidosis when arteria blood PH<7.15 ,serum bicarbonate <8mEq/L needs treatment by IV and oral bicarbonate.

Hypocalcemia:should be treated by lowering serum phosphorus level by low phosphate intake, eliminating the ingested phosphate by oral intake of phosphate binder like calcium carbonate or calcium citrate. Aluminum based binder should be avoided because of aluminum toxicity.

In severe hypocalcaemia with tetani calcium can be giving intravenously.

Hyponatremia:is most commonly dilutional should be treated by fluid restriction. Administration of hypertonic saline(3%) is indicated in the following condition:

1-symtomatic hyponatremia like seizure, lethargy.

2-serum sodium less than 120mEq/L.

Acute correction of serum sodium to 125mEq/L should be accomplished using the following formula:

Required NACL=0.6 x weight(kg) x (125-serum sodium)

Hypertension: is more common in ARF patient with acute glomerulonephritis, HUS. Can be treated by :

- 1-salt and water restriction.
- 2-diuretic
- 3-calcium channel blocker like amlodipin, or B-blocker like propranolol can be use.
- 4-severe symptomatic hypertension should be treated by continuous infusion of sodium nitropruside ,labetelol or esmolol.

Seizure: patient with ARF may develop CNS manifestation like headache, lethargy, confusion, convulsion because of :

- 1-hyponatremia
- 2-hypocalcemia
- 3-hypertension
- 4-Cerebral hemorrhage
- 5-cerebralvasculitis
- 6- uremia.

Diazepam is the most effective agent in controlling of seizure.

Anemia: anemia in ARF is generally mild and is due to hemodilution. patient with HUS ,SLE or bleeding require packed cell transfusion when hemoglobin level falls below 7gm/dL.

GIT bleeding: patient with ARF may develop GIT bleeding because of:

- 1-uremic platelet dysfunction.
- 2-increased stress.
- 3-exposure to heparin.

--oral or intravenous H2 blocker like ranitidine is commonly used to prevent this complication.

Nutrition:

Nutrition is of critical importance in children who develop ARF. In most cases sodium, potassium and phosphorus should be restricted. Protein intake should be restricted moderately while maximizing caloric intake to minimize the accumulation of nitrogenous wastes. In critically ill patients with ARF parenteral hyperalimentation with essential amino acid should be considered.

DIALYSIS:

Indications for dialysis in ARF include:

- 1-Volume overload with hypertension and /or pulmonary edema refractory to diuretic.
- 2-Persistent hyperkalemia.
- 3-Severe metabolic acidosis unresponsive to medical management.
- 4-Neurologic symptoms like seizure, altered mental status.
- 5-Blood urea nitrogen greater than 100-150mg/dL.
- 6-hypocalcemic tetani not responding to medical treatment.

In patients with ARF dialysis may be necessary for days or for up to 12 wk. Most patient require dialysis for 1-3 wk. There are 3 main types of dialysis:

1- Intermittent hemodialysis.

2-peritoneal dialysis.

3-Continuous renal replacement therapy.

PROGNOSIS:

The mortality rate depends on the nature of the underlying causes. Patient with ARF due to post infectious glomerulonephritis has a mortality rate <1% while patient with multiorgan failure has a mortality rate >90%.

The prognosis for recovery of renal function depend on the disorder that cause ARF.Recovery of renal function is likely in patient with prerenal causes,HUS,ATN..

In others ARF progress to chronic renal failure and needs medical management for long period.