RENAL FAILURE IN CHILDREN
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OBJECTIVES

By the end of this lecture each student should be able to:

- Define acute & chronic kidney disease (CKD)
- Classify causes of ARF
- Discuss the clinical presentation of ARF & CRD.
- Discuss the pathophysiology of anemia & renal osteodystrophy in CKD.
- List the clinical & biochemical indicators of dialysis.
- List the complications of Acute & CKD
Acute renal failure (ARF)

- It is a clinical syndrome in which a sudden deterioration in renal function results in the inability of the kidneys to maintain fluid & electrolytes homeostasis.
Pathogenesis

Classified into:

1. Prerenal
2. Intrinsic renal
3. Post renal
PRERENAL ARF

Due to inadequate renal perfusion & decreased GFR, common causes include:

- Dehydration
- Sepsis
- Hemorrhage
- Severe hypoalbuminemia
- Heart failure

If hypo perfusion is sustained intrinsic renal parenchyma damage may occur.
Intrinsic Renal ARF

*Characterized by renal parenchymal damage including*

- sustained hypo perfusion.
- Post infectious glomerulonephritis
- Membranoproliferative GN
- Lupus Nephritis
- Henoch Schonlein purpura
- Hemolytic Uremic Syndrome
- Acute Tubular Necrosis (nephrotoxic/ischemic insults)
- Tumor Lysis syndrome ?????
- Acute Interstitial Nephritis
Postrenal ARF

- Posterior urethral valve
- Bilateral uteropelvic obstruction
- Stones
- Tumor
- Others
Clinical Manifestations

- Accurate detailed history
- Thorough physical examination (volume status)
- Signs of dehydration
- Edema
- Skin rash
- Arthritis
- Flank masses
Laboratory diagnosis

- CBC
- Urine analysis
- Blood urea, K, phosphate & calcium
- Serum creatinine
- C3 level—SLE--GN

*How to differentiate between prerenal & intrinsic renal failure?*
- CXR
- Renal US
Treatment---ARF

- Pediatric ICU management
  1-conservative treatment
  2-Dialysis
- Treat the hypovolemia adequately.
- Emergency fluid management.

Usually patients void within 2 hours, failure to do so points towards intrinsic or post renal ARF. If no urine output do diuretic challenge (single iv frusemide)
Treatment---ARF

- Normal intravascular volume: give fluids (urine output plus insensible loss)
- Hyper volemic patients: treated by fluid restriction.
Treatment--ARF

- Monitor urine output and other outputs and daily weight.
- Careful restoration of caloric, fluid and electrolyte losses.
- Administer frusemide.
- Potassium restriction
Figure 29  Hyperkalemia may cause cardiac arrest.
Hyperkalemia

- K more than 6 mEq/l requires treatment by:
  - Albuterol
  - insulin and glucose.
  - kayexalate cation exchange resin.
  - Restrict potassium
Hyperkalemia & ECG

- Tall, peaked T’s
- Wide QRS
- Prolong PR
- Diminished P
- Prolonged QT
Hyperkalemia

- More severe elevation in serum potassium >7 mEq/l requires \textit{emergency} treatment:
  - IV Calcium gluconate 10%
  - Sodium bicarbonate
  - Insulin with glucose
- If no improvement dialysis.
Treatment --- ARF

- Treat metabolic acidosis
- Treat other electrolyte disturbance
- Treat hypertension
- Peritoneal dialysis
Indications for dialysis in ARF

<table>
<thead>
<tr>
<th>Clinical indicators</th>
<th>Biochemical indicators</th>
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<tbody>
<tr>
<td>❑ Volume overload (HF, pulmonary edema)</td>
<td>❑ Persistent hyperkalemia</td>
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<tr>
<td>❑ Severe metabolic acidosis</td>
<td>❑ Urea &gt; 150 mg/dl or rapidly rising</td>
</tr>
<tr>
<td>❑ Neurologic symptoms (convulsion, encephalopathy)</td>
<td>❑ Creatinine &gt; 10 mg/dl</td>
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<tr>
<td>❑ Pericarditis</td>
<td>❑ Calcium/phosphorus imbalance with hypocalcaemia tetany.</td>
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<tr>
<td>❑ Anuria</td>
<td>❑ K more than 6.5 mEq/l with ECG changes</td>
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Chronic Kidney Disease (CKD)

Defined as renal injury (proteinuria) and/or a glomerular filtration rate <60 mL/min/1.73 m² for >3 mo

The normal GFR in children is 90 - 130 ml/min/1.73m²
CKD is divided into 5 stages according to GFR:

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
<th>GFR mL/min/1.73 m²</th>
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<tbody>
<tr>
<td>1</td>
<td>Slight kidney damage with normal or increased filtration</td>
<td>More than 90</td>
</tr>
<tr>
<td>2</td>
<td>Mild decrease in kidney function</td>
<td>60-89</td>
</tr>
<tr>
<td>3</td>
<td>Moderate decrease in kidney function</td>
<td>30-59</td>
</tr>
<tr>
<td>4</td>
<td>Severe decrease in kidney function</td>
<td>15-29</td>
</tr>
<tr>
<td>5</td>
<td>Kidney failure; requiring dialysis or transplantation</td>
<td>Less than 15</td>
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Etiology— CKD--CRF

- Congenital
- Acquired
- Inherited
- Metabolic

The age of presentation of CKD correlates closely with the underlying cause:

- < 5 years → congenital
- > 5 years → acquired glomerular diseases.
- CKD related to metabolic disorders and certain inherited disorders (may present throughout the childhood years.
Pathogenesis

- progressive injury with ongoing structural or metabolic genetic diseases.
- Hyper filtration injury
- Proteinuria
- Hypertension
- Hyperphosphatemia
- Hyperlipidemia
CLINICAL MANIFESTATIONS

- Depends on the underlying renal disease.
- Anemia
- Acidosis
- Fluid overload
- Hypertension
- Renal osteodystrophy
- Stunted Growth
- Bleeding
- Edema
- Neurological manifestations
- Immunodeficiency
Signs and Symptoms--CRF

#Anorexia
#vomiting
#bone pain
#headache
#malaise
#Poluuria&polydipsia
#recurrent urinary tract infections

#paler
#Acidotic breathing
#Edema
#irritability
#poor muscle tone
#change in mental alertness
#stunted growth
Other systemic disorders--CRF

- Impaired immunologic defense mechanisms.
- Neurological complication & uremic encephalopathy.
- Duodenal ulcers.
- Pericardial effusion & pericarditis.
- Pulmonary edema.
- Pruritis.
Investigations

♥ Blood urea nitrogen ↑↑
♥ Serum creatinine ↑↑
♥ S. K⁺ ↑↑
♥ S. Na⁺ ↓↓ (if volume overloaded)
♥ Arterial pH ↓ (acidosis)
♥ S. Ca²⁺ ↓↓
♥ S. Phosphorus ↑↑
♥ S. uric acid ↑↑
♥ Patients with heavy proteinuria can have hypoalbuminemia
♥ CBC: normochromic, normocytic anemia
♥ Serum cholesterol and triglyceride levels may be elevated
♥ Bone x ray (signs of Rickets, renal osteodystrophy)
♥ Urinalysis:
  ☺ GN → hematuria and proteinuria
The treatment of CKD aimed at:

1-replacing absent/diminished renal function
2-slowing the progression of renal dysfunction
Slowing the progression of kidney dysfunction

1) Optimum Control of Hypertension
2) Control of proteinuria
3) Maintain Serum Phosphorus within normal range
4) Prompt treatment of infectious complications and dehydration
5) Correction of anemia
6) Control of hyperlipidemia
7) Dietary Protein restriction
Multidisciplinary service

- Medical
  - Nursing
  - Social service
  - Nutritional
  - Psychological
ﬂuid & electrolyte management

Acidosis

– Sodium bicarbonate is used to maintain the serum bicarbonate level above 22 mEq/L.

Anemia—what are the causes?

– Erythropoietin

– erythropoietin therapy plus iron supplementation.
**Renal osteodystrophy**

*It is spectrum of bone disorders seen in patients with CKD. (Bone pain, fractures, muscle weakness, bone deformities)*

- The goals of treatment are to prevent bone deformity and normalize growth velocity
  - low phosphorus diet
  - Phosphate binders are used to enhance fecal phosphate excretion.

  Ca carbonate and Ca acetate are the most commonly used phosphate binder.

- The cornerstone of therapy for renal osteodystrophy is vitamin D administration.
◆ **Growth problems**

– Growth problems (especially short stature) are very common in CKD children why?

– CKD children have an apparent growth hormone resistant state with elevated GH levels but decreased insulin-like growth factor-I (IGF-I).

– Treatment may be initiated with recombinant human GH- rHuGH
**Nutrition**

– Sufficient energy should be provided in the diet

– Proteins of **high biological value** or ‘good quality’ are preferred.

– Dietary phosphorus, potassium, and sodium should be restricted according to the individual patient's laboratory studies and fluid balance.

**Treat hypertension**
Figure 1. Chronic renal failure leading to major consequences in calcium and phosphate metabolism and the development of renal osteodystrophy.
ESRD represents the state in which homeostasis & survival can no longer be sustained without dialysis & the ultimate goal is renal transplantation.

Plans for renal replacement when a child reaches stage 4.
Thanks