Acute Renal Failure

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For normal function, kidneys require

• Normal renal blood flow
• Normal glomeruli and tubules
• Clear urinary outflow tract
Type of Renal Failure

• **Acute Renal Failure**
  – Sudden Loss of Kidney function

• **Chronic Renal Failure**
  – Long & Slow Progression of Loss of Kidney function

• **End Stage Renal Disease**
  – Complete Loss of Kidney function.
Acute Renal Failure

Definition

- Abrupt fall in GFR
- Over a period of minutes to days
- With rapid & sustained rise in nitrogenous waste products in blood.
  - Creatinine
  - Urea
  - Ammonia
  - Uric Acid
Cause of ARF

1. Pre renal
   • Hemodynamic cause

2. Renal:
   • Acute tubular necrosis
   • Acute glomerulonephritis
   • Vasculopathy
   • Acute interstitial nephritis

3. Post renal
   • Obstruction cause
PRE-RENAL (Hemodynamic) ARF

Hypovolemia
  Haemorrhage
  Volume depletion
    (vomiting, diarrhoea, Burns)

Hypotension
  Cardiogenic shock
  Distributive shock
    (sepsis, anaphylaxis)

Hypovolemic state
  Cardiac failure
  Hepatic cirrhosis
  Nephrotic syndrome

Oedema state
  Cardiac failure
  Hepatic cirrhosis
  Nephrotic syndrome

Generalized or localized reduction in RBF

Reduced GFR

Pre Renal ARF

Renal Hypoperfusion
  NSAIDs
  ACEI / ARBs
  Renal Artery Stenosis
  Hepato-Renal syndrome
Renal cause of ARF

1. **Acute Interstitial nephritis**
   - Drug – Antibiotic induced
     - NSAIDs, ACEI, Antibiotics (Streptomycin, Amikacin)
   - Radio-contrast dye
   - Post-infective, Pyelonephritis

2. **Vascular occlusion**
   - Renal vein thrombosis
   - Cholesterol plaque

3. **Acute Glomerular Nephritis**
   - Post-infectious
   - Systemic Lupus Erythematus

4. **Acute Tubular Necrosis**
   - Ischemia
   - Toxins
Intra-luminal
- Stone
- Papillary Necrosis

Intra-mural
- Urethral stricture
- BPH
- Carcinoma prostate
- Bladder tumour
- Radiation fibrosis

Extrinsic
- Pelvic malignancies
- Prolapse Uterus
- Retroperitoneum fibrosis

Intrinsic

Post Renal ARF

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**ARF Signs and Symptoms**

- Oliguria
- Edema
  - Facial edema
  - Pedal edema
  - Pulmonary edema
- Hypertension
- Flank pain
  - associated with renal artery or vein obstruction
- Encephalopathy
  - Headache, dizziness, confusion, seizure
- Fever
- Respiratory Distress
  - Tachypania
RIFLE Criteria

<table>
<thead>
<tr>
<th>Risk</th>
<th>GFR Criteria*</th>
<th>Urine Output Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Increased SCreat x 1.5 or GFR decrease &gt; 25%</td>
<td>UO &lt; .5ml/kg/h x 6 hr</td>
</tr>
<tr>
<td>Injury</td>
<td>Increased SCreat x 2 or GFR decrease &gt; 50%</td>
<td>UO &lt; .5ml/kg/h x 12 hr</td>
</tr>
<tr>
<td>Failure</td>
<td>Increase SCreat x 3 GFR decrease 75% OR SCreat ≥4mg/dl</td>
<td>UO &lt; .3ml/kg/h x 24 hr or Anuria x 12 hrs</td>
</tr>
<tr>
<td></td>
<td>Acute rise ≥0.5mg/dl</td>
<td></td>
</tr>
<tr>
<td>Loss</td>
<td>Persistent ARF** = complete loss of kidney function &gt; 4 weeks</td>
<td></td>
</tr>
<tr>
<td>ESKD</td>
<td>End Stage Kidney Disease (&gt; 3 months)</td>
<td></td>
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Calcium Homeostasis Changes In CRF

- Decrease GFR
- Hyperphosphatemia
  - Hypocalcemia
  - Increase PTH
    - Bone disease

Source: J Am Board Fam Med © 2009 American Board of Family Medicine
Calcium Homeostasis Changes In CRF

Chronic Kidney Disease

- Reduced renal phosphorous clearance
  - Hyperphosphatemia
  - Increased FGF-23

- Vitamin D resistance
- Reduced 1,25 (OH)₂ vitamin D
- Calcidiol deficiency

- Hypocalcemia
- Secondary Hyperparathyroidism

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Life threatening consequences of ARF

- Volume overload
- Hyperkalaemia
- Metabolic acidosis
- Encephalopathy
- Uremia
- Platelet dysfunction
Factors that suggest chronicity

- Long Duration of symptoms
- Nocturia
- Absence of Acute illness
- Anemia
- Hyperphosphatemia
- Hypocalcaemia
- High Parathyroid hormone
Clinical markers of ARF

- Reduced GFR
- Raised Serum Creatinine
- Serum Creatinine is poor marker of renal function.
- Poor correlation between Serum Creatinine and level of GFR.
GFR vs Creatinine

Stages of chronic kidney disease

Serum creatinine (mg/dL)

Creatinine clearance

True glomerular filtration rate

Glomerular filtration rate (mL/min)
### Table 1. Stages of CKD

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
<th>GFR (mL/min/1.73 m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kidney damage with normal or GFR</td>
<td>≥ 90</td>
</tr>
<tr>
<td>2</td>
<td>Kidney damage with mild GFR</td>
<td>89-60</td>
</tr>
<tr>
<td>3A</td>
<td>Mild to moderate GFR</td>
<td>59-45</td>
</tr>
<tr>
<td>3B</td>
<td>Moderate GFR</td>
<td>45-30</td>
</tr>
<tr>
<td>4</td>
<td>Severe GFR</td>
<td>30-15</td>
</tr>
<tr>
<td>5</td>
<td>Kidney failure</td>
<td>&lt; 15 or dialysis</td>
</tr>
</tbody>
</table>

CKD, chronic kidney disease; GFR, glomerular filtration rate.

Biochemistry

✓ Blood urea
✓ Serum Creatinine
✓ Blood Electrolytes
  - Potassium = Hyperkalemia
  - Calcium = Hypocalcemia
  - Phosphate = Hyperphosphatemia
✓ Serum bicarbonate
✓ FBS, PP2BS
✓ Serum Total protein & Albumin
✓ Blood gas analysis –
  ✓ Metabolic acidosis
✓ Urinary examination
Haematology

✓ Complete blood count
  ▪ Eosinophilia
  ▪ Thrombocytopenia

✓ Coagulation study
  ▪ Disseminated intravascular coagulation

Immunology

✓ Antinuclear antibody (ANA)
✓ Anti-double stranded (ds) antibody
✓ C3 & C4 complement concentrations
✓ ASO and anti-DNAse titres
✓ AntiGBM (Glomerular Basement Membrane) Antibodies
Serology

✓ Hepatitis B and C, HIV serology

Radiology

✓ Renal ultrasonography
  ▪ For renal size
  ▪ Symmetry
  ▪ Evidence of obstruction
Management principles in ARF

• Identify & correct pre-renal and post-renal factors
• Optimise cardiac output and RBF
• Stop drugs ACEI, ARB, NSAID
• Monitor fluid balance and daily body weight
• Maintaining calories requirement
• Maintaining Protein intake
• Identify and treat acute complications
  – Hyperkalaemia
  – Metabolic Acidosis
  – Pulmonary oedema
Management

- **Maintain Volume homeostasis**
  - Hypovolumia = $1 - 1.5 \text{ ml/kg/hour IV normal saline}$
  - Hypervolumia = Diuretics = Furosemide

- **Correction of Biochemistry parameter**
  - Metabolic Acidosis
  - Hyperkalemia
  - Ureamia

- **Vasodilator = Dopamine = Improve Renal flow**

- **Dietary**
  - Salt & Fluid
  - Potassium and Phosphorus
  - Protein
Indication Of Dialysis

- Hyperkalemia
- Volume overload
- $K^+ > 6.5 \text{ mmol/l}$
- $\text{PH} < 7.0$
- Urine output < 200 ml in 12 hours
- Anuria < 50 ml in 12 hours
- Azotemia BUN > 70 mg%
- Toxic removal
- Drug Overdose
- Uremicencephalopathy
- Pericarditis
Prophylactic Strategies for Radio-contrast

- Use I.V. contrast only when necessary
- Hydration with normal saline (1-1.5 mL/Kg/h) 6-12 h before and after the procedure.
- Minimize contrast volume
- N-acetylcysteine
  - 600-1200 mg BID
  - For 1 day before and 1 day after procedure