RENAL FAILURE

DEFINITION
Failure of the kidneys to maintain metabolic stability in relation to fluid balance, electrolyte balance and excretion of nitrogenous waste

MAIN CAUSES

Congenital
- Usually affects term infants
- Often diagnosed antenatally with renal abnormality/hydrops
- Most commonly an obstructive uropathy
- Posterior urethral valves
- Bilateral pelvi-ureteric junction (PUJ) obstruction
- Non-obstructive cause
- Renal agenesis
- Polycystic kidneys (autosomal recessive)
- Secondary to congenital heart disease
- Hypoperfusion
- Severe acidosis

Asphyxia
- Occurs in severe hypoxic ischaemic encephalopathy
- Direct hypoxic effect or secondary to hypoperfusion
- Usually transient
- Poor prognosis for intact survival when severe

Prematurity
- Normally caused by poor renal perfusion secondary to:
  - hypovolaemia
  - hypotension
  - hypoxaemia
  - sepsis
- Inappropriate ADH in ventilated babies causes transient oliguria
  - will correct spontaneously as lung compliance improves

Other
- Renal vein thrombosis
- Renal artery thrombosis

DIAGNOSIS
- Renal abnormalities (prenatal)
- Risk factors (i.e. severe asphyxia/sepsis/hypotension/congenital heart disease CHD)
- Oliguria (<1 mL/kg/hr)
- Hypovolaemia
- Electrolyte disturbance (particularly raised potassium)
- Rising creatinine after 48 hr

PREVENTION
- This is the most important approach in the preterm infant
- Ensure adequate fluid intake particularly in very preterm infants with excessive transepidermal water loss (see fluid balance below)
Renal failure 2009-11

- Extra care required when using radiant heaters in contrast to high humidification in incubator (see Hypothermia guideline)
- Maintain a safe blood pressure (See Hypotension guideline)

INVESTIGATIONS

**Monitor**
- Weigh 12 hrly
- BP 12 hrly
- Cardiac monitor to detect arrhythmias

**Urine**
- Dipstick (proteinuria; sediment, such as blood, casts, tubular debris, indicate intrinsic problem; WBC and nitrites suggest infection)
- Microscopy and culture
- Electrolytes, urea, creatinine, osmolality

**Blood**
- U&E, creatinine 8 hrly
- Blood gas, pH 4-8 hrly
- Blood cultures, CRP
- Glucose 4 hrly
- Calcium, phosphate, magnesium, albumin
- Blood count (film and platelets)

<table>
<thead>
<tr>
<th>Typical biochemical changes in ARF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased urea, creatinine, K⁺, PO₄⁻</td>
</tr>
<tr>
<td>Reduced Na⁺, Ca²⁺, HCO₃⁻, pH</td>
</tr>
</tbody>
</table>

**Imaging**
- Abdominal X-ray if UAC in place to check position
- confirm UAC tip does not sit at L1
- Renal ultrasound scan
- to detect congenital causes, post-renal causes, pyelonephritis and renal vein thrombosis

**TREATMENT**

**Correct underlying cause**
- Surgical approach to uropathy unless prognosis hopeless (e.g. Potter’s syndrome)
- Correct hypovolaemia
  - sodium chloride 0.9% 20 mL/kg IV
  - if blood loss known or suspected, give 20 mL/kg packed red cells over 30-60 min
- If hypotensive in absence of fluid depletion:
  - start inotrope infusion: if central access give dopamine 5 microgram/kg/min or
  - if no central access (e.g. UVC), dobutamine 10 microgram/kg/min (See Hypotension guideline)
- Open duct in duct-dependent circulation in CHD (see cardiovascular guidelines)
- Antibiotics for sepsis
- Stop all nephrotoxic drugs (e.g. aminoglycosides) if possible
- In the majority of cases the kidneys will recover in 24-48 hr

**Supportive**

**Fluid balance**
- Assess fluid balance when problem recognised
Renal failure 2009-11

**Signs of depletion**
- Cold peripheries
- Delayed capillary refill
- Tachycardic
- Oliguric (<1 mL/kg/hr) or anuric

**Signs of overload**
- Tachypnoeic
- Oedema
- Excessive weight gain
- Raised blood pressure
- Gallop rhythm
- Hepatomegaly
- If baby hypovolaemic/hypotensive, it is important to correct this before instituting fluid restriction (see above)
- Strictly monitor all intake and output
- Restrict fluid intake to minimal maintenance fluids
- Calculate maintenance fluid:
  - maintenance fluid = insensible losses + urine output + GIT losses
  - insensible losses: <1500 g (at birth) = 50-80 mL/kg/day; >1500 g (at birth) = 15-35 mL/kg/day
  - for babies in well-humidified incubator or receiving humidified respiratory support, use lower figure
- Replace maintenance fluid as glucose 10-20% (electrolyte-free)
- Electrolytes will be required if electrolyte losses (e.g. diarrhoea, fistula) ongoing
- Weigh twice daily
  - best guide to change in hydration is change in body weight
  - stable weight indicates overhydration and need to reduce fluid intake further
  - aim to achieve 1% loss of body weight daily

**Hyperkalaemia**
- See Hyperkalaemia guideline

**Acidosis**
- Monitor pH 8-hrly
  - if pH <7.2, give sodium bicarbonate 1 mmol/kg IV over at least 2 min

**Hyponatraemia**
- Low sodium is more likely to indicate fluid overload than a deficit in body sodium
- Unless evidence of dehydration, treatment should be fluid restriction with maintenance sodium intake of 2-3 mmol/kg/day
- If severe (Na <120 mmol/L) and associated with neurological symptoms, such as seizures:
  - use hypertonic saline (sodium chloride 3%) 4 mL/kg over a minimum of 15 min. Dose can be repeated if baby still fitting after assessing serum sodium concentration
  - check serum sodium immediately after completion of infusion
- During recovery phase, infants rarely become polyuric, and sodium chloride 0.45% is typically required, although this will depend on a measurement of urinary sodium concentration

**Dialysis**
Hardly ever used in this population because of technical difficulty and poor prognosis. Only applicable to term infants with a treatable renal problem

**MONITORING**
- Most useful variable is urine output
Renal failure 2009-11

- In newborn renal failure, anuria/oliguria is the normal situation and increasing urine output indicates recovery
- Creatinine estimation is often misleading in first few days:
  - in utero, creatinine is cleared by the placenta
  - after delivery, creatinine production by muscles is not stable and can be influenced heavily by muscle damage resulting from delivery/hypoxia/sepsis
  - after 48-72 hr, it can be used, but the trend is much more valuable than the absolute concentration
- Urea estimation is misleading
  - it is influenced by tissue breakdown (e.g. bruises/ swallowed blood)
  - conversely, little is produced when protein intake is compromised

**CONCLUSION**

In the newborn infant, the vast majority of cases of renal failure will recover if underlying cause is addressed and supportive management provided to maintain fluid and electrolyte balance until recovery takes place, normally over 24-48 hr