Renal Replacement Therapy

Dr Ross Freebairn
Hawke’s Bay N.Z.
Oliguria

- urine output < 0.5 ml/kg/hr
Matter of perspective

- **Heart stops**
  - Cardiac arrest
- **Breathing stops**
  - Respiratory arrest
- **Kidneys stop**
  - Oliguria
  - Renal arrest
Acute renal failure

- failure of solute and (usually) water clearance
- common
- associated with increased mortality
Oliguria

• warning sign of impaired tissue perfusion
• leads to acute renal failure if not corrected
• 2 hours’ oliguria MUST be treated urgently
Pathophysiology

- outer renal medulla prone to ischaemia
Pathophysiology

- reduced renal blood flow worsens medullary ischaemia
- ischaemia causes structural changes and ultimately acute tubular necrosis
Management

• **treatable factors**
  - hypovolaemia and shock – resuscitate
  - infection – source control and antibiotics
  - nephrotoxic drugs – discontinue where possible
  - abdominal compartment syndrome – decompress
  - rhabdomyolysis – alkalinise, mannitol
  - hypercalcaemia
  - obstruction
Resuscitation

• correct hypovolaemia
  • volume repletion
  • CVP guidance using serial fluid challenges

• restore cardiac output
  • vasopressors/inotropes if other evidence of tissue hypoperfusion

• restore perfusion pressure
  • may need MAP > 80 mm Hg if previously hypertensive
  • volume repletion and vasopressors
Frusemide is NOT a resuscitation fluid
Dopamine

- inconsistent diuretic effect
  - but this may cause dehydration
- does not
  - increase creatinine clearance
  - prevent acute renal failure
- does cause serious toxicity problems
  - tachyarrhythmias
  - exacerbates renal and mesenteric ischaemia
  - impaired immune function
- fundamentally not useful
Frusemide

• does
  • reduce juxtamedullary oxygen consumption

• has not been shown to
  • improve creatinine clearance
  • affect survival either way

• disadvantages
  • of diuresis

• may be used but ONLY after adequate volume resuscitation
Established acute renal failure
Management of renal failure

• avoid volume overload
  – input = previous hour’s output + 20 ml
  – BUT do not withhold nutrition

• treat complications

• adjust drug doses

• renal replacement therapy
Temporizing measures

- **hyperkalaemia**
  - insulin/dextrose, NaHCO$_3$, $\beta_2$ agonists

- **severe acidosis**
  - NaHCO$_3$ infusion

- **volume overload**
  - GTN infusion if BP permits
  - frusemide if still passing urine
Indications for CRRT

- **Urgent**
  - Severe ↑ K
  - Severe metabolic acidosis
  - Severe pulmonary oedema due to fluid overload
  - Uraemic pericarditis

- **Less urgent/definite**
  - Non-obstructive oliguria >12 h
  - Creatinine 2 x baseline
  - Uraemic encephalopathy, neuropathy or myopathy
  - Progressive dysnatraemia
  - Hyperthermia
  - Significant oedema
  - Requirement for large volume transfusion in patients with/at risk of pulmonary oedema/ARDS
Mortality Probability Within 90 Days After Study Enrollment for Patients Receiving Early and Delayed Initiation of Renal Replacement Therapy (RRT)

KDIGO indicates Kidney Disease: Improving Global Outcomes. In the delayed group, 18 patients received RRT without reaching KDIGO stage 3 (these patients had an absolute indication). The median (quartile 1 [Q1], quartile 3 [Q3]) duration of follow-up was 90 days (Q1, Q3: 90, 90) in the early group and 90 days (Q1, Q3: 90, 90) in the delayed group. The vertical ticks indicate censored cases.
## Factors affecting RRT

<table>
<thead>
<tr>
<th>Patient focused</th>
<th>System Imposed</th>
<th>Clinician Influenced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comorbidity</td>
<td>Health structure</td>
<td>Indications (timing)</td>
</tr>
<tr>
<td>Kidney reserve</td>
<td>ICU organization</td>
<td>Prescription</td>
</tr>
<tr>
<td>Metabolic rate</td>
<td>Resource/Costs</td>
<td>Local Practice</td>
</tr>
<tr>
<td>Primary diagnosis</td>
<td>Resource/equipment</td>
<td>Goals of therapy</td>
</tr>
</tbody>
</table>
Continuous venovenous haemodiafiltration--an audit demonstrating control of electrolytes with haemodynamic stability in the critically ill.

Blood

Replacement fluid

Ultrafiltrate

Solute

Plasma protein

Haemofilter membrane
• Determines plasma electrolyte concentration
• Bicarbonate lost, needs to be replaced
Replacement fluid

- **Bicarbonate replacement**
  - Bicarbonate
  - Lactate
    - Metabolized to bicarbonate by liver (or not!)
    - Risk of metabolic acidosis
Dialysis fluid

- Solutes will reach equilibrium
- Plasma electrolyte & bicarbonate concentration will tend towards dialysis fluid concentration
Anticoagulation

- None
- Heparin
  - Unfractionated
  - Low molecular weight
- Citrate
- Prostacyclin
- Systemic anticoagulation
Anticoagulation

• **Avoid:**
  - Active, recent bleeding evident
  - Baseline INR >2, APTT >60s, platelets <60

• **Relative contra–indications**
  - Less severe coagulopathy/thrombocytopenia
  - Surgery within 24 h
Summary

- Haemofiltration – convection
- Haemodialysis – diffusion
- Adjust dose (effluent rate) according to patient’s needs, interruptions to treatment
  - Starting point 25 ml/kg/h
- Consider need for anticoagulation
- Caution when starting CRRT in haemodynamically unstable patients
Outcome with IRRT vs CRRT (3)

Choice of RRT

- 1218 patients CRRT or IRRT for ARF
- 54 ICUs in 23 countries.
- Multivariable logistic regression
  - choice of CRRT
    - Not independent predictor of
      - hospital survival
      - dialysis-free hospital survival.
    - But is predictor of dialysis independence at hospital discharge among survivors (OR: 3.333, 95% CI: 1.845 – 6.024, p<0.0001).

How much replacement and dialysate do you use?
Effects of different doses in CVVH on outcome of ARF – Ronco & Bellomo study. Lancet. July 00
Conclusions:

• An increased treatment dose from 20 ml/h/kg to 35 ml/h/kg significantly improved survival.

• A delivery of 45ml/kg/hr did not result in further benefit in terms of survival, but in the septic patient an improvement was observed.

Effects of different doses in CVVH on outcome of ARF – Ronco & Bellomo study. Lancet. July 00
• Blood Purification: It must work!!!
• maybe,
• possibly,
• Unlikely,
• No
Never let evidence get in the way of a good opinion

- The fact that an opinion has been widely held is no evidence whatever that it is not utterly absurd; indeed in view of the silliness of the majority of mankind, a widespread belief is more likely to be foolish than sensible.

Bertrand Russell, *Marriage and Morals* (1929)
Recommendation

- **When**
  - Acute renal Failure
  - Exogenous toxin removal (lithium)
  - Early may be better—Probably is !!!!

- **Dose**:
  - 35+ ml/kg/hr (averaged)
  - No evidence for high dose

- **Mode**:
  - Whatever works for you

- Frusemide is not a resuscitation fluid