AWSOME

Anaesthesia Written ShOrt answer & Multiple choice Examination Course

Continuous renal replacement therapy

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Overview

- Classification of AKI
- Indications
- Principles
- Types of CRRT
- Controversies

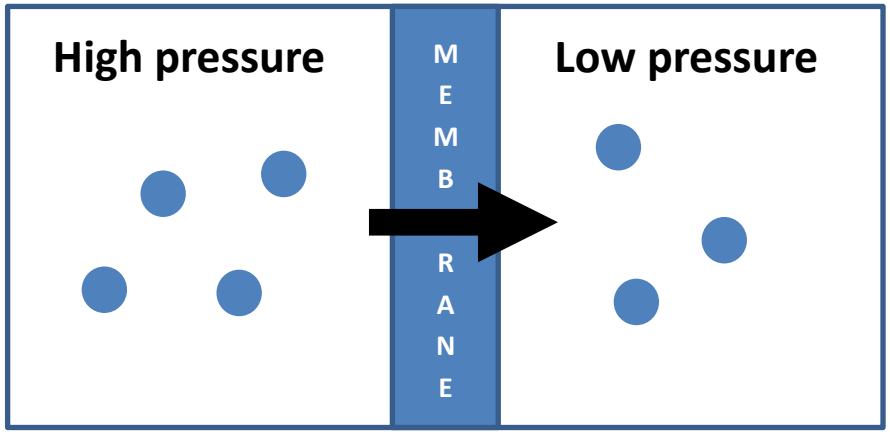
RIFLE criteria

Stage	GFR Criteria	Urine Output Criteria
Risk	Baseline creatinine × 1.5 *or* GFR decreased >25%	UO < 0.5 mL/kg/h for 6 hours
Injury	Baseline creatinine × 2 *or* GFR decreased >50%	UO < 0.5 mL/kg/h for 12 hours
Failure	Baseline creatinine × 3 *or* Baseline creatinine decreased >75% *or* New creatinine ≥350 µmol/L resulting from an acute rise ≥44 µmol/L	UO < 0.3 mL/kg/h for 24 hours *or* anuria for 12 hours
Loss	Complete loss of kidney function >4 weeks	
ESRF	Complete loss of kidney function >3 months	

Classic indications

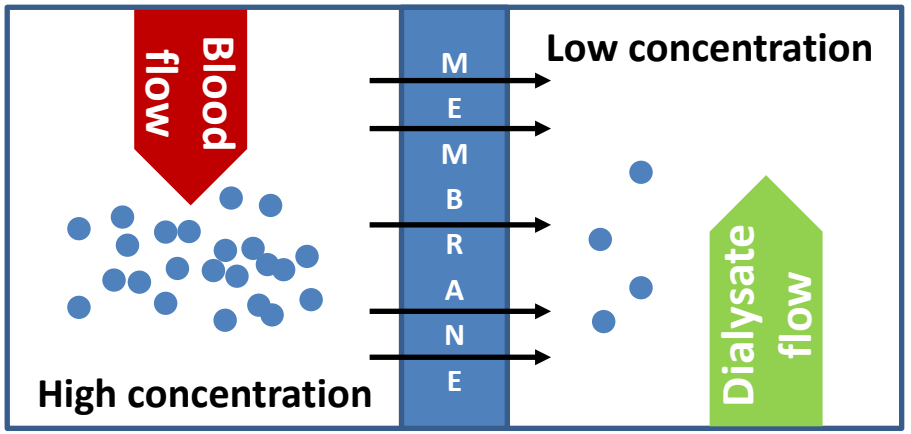
- Diuretic resistant pulmonary oedema
- Hyperkalaemia refractory to medical therapy
- Metabolic acidosis refractory to medical therapy
- Uraemic complications (pericarditis, encephalopathy, bleeding)
- Dialysable toxins (for example lithium, toxic alcohols & salicylates)

Filtration



- Solute dissolved in solvent
- A transmembrane pressure gradient carries the solute across a semi-permeable membrane (solvent drag)
- Filtration rate dependent on:
  - Membrane permeability
  - Hydrostatic pressure of the blood, which depends upon blood flow
- Effective at removing fluid & mid-sized molecules

Dialysis



- Solute diffusion occurs from an area of high to an area of low concentration across a semi-permeable membrane
- Gradient maintained by an electrolyte solution running countercurrently to blood flow
- Effective at removing small molecules (urea)
- Ineffective at removing larger molecules
- Solute removal is directly proportional to the dialysate flow rate

Filter membranes

- Synthetic
  - High permeability to water (high-flux)
  - High sieving coefficients for solutes in a wide range of molecular weights
  - Allow transfer of solutes with a mass <20 kDa (urea/creatinine/urate/ammonia/heparin/drugs)
  - Cause less damage to platelets and white cells
  - Suitable for either haemofiltration or haemodiafiltration

- Cellulose-based
  - Low permeability to water (low-flux)
  - Activate inflammatory cascade
  - Suitable for dialysis

Dialysate fluid

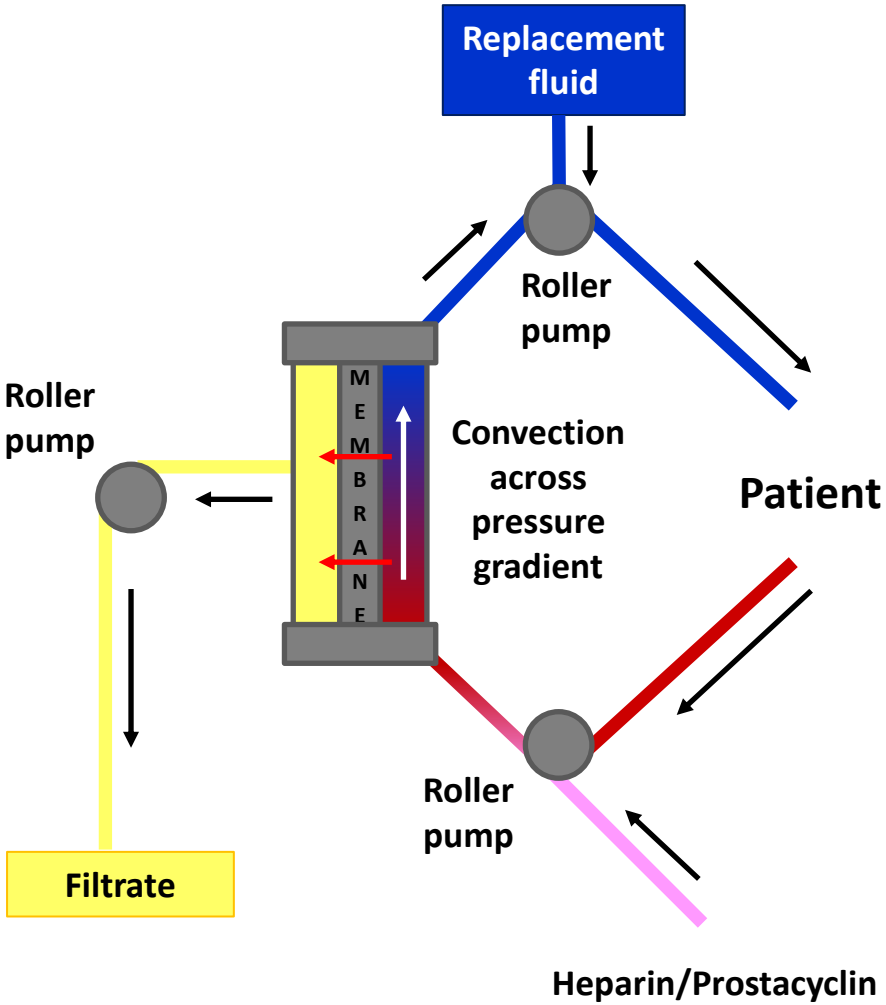
- Bicarbonate ions can cause:
  - The dialysate to have a short shelf life due to formation of carbonate which dissociates to carbon dioxide and evaporates from the solution
  - Formation of precipitants if mixed with calcium
- Lactate can be used as an alternative buffer
  - Only suitable if liver can convert lactate to carbon dioxide and water, generating bicarbonate ions via the TCA cycle
  - In liver failure, lactate free bags can be used and bicarbonate infused separately from the circuit
- Acetate can also be used as a buffer
- Standard solutions don't contain potassium or phosphate so supplementation may be required

Baxter Accusol 35

Ionic composition	Mmol/L
Ca^{2+}	1.75
Mg^{2+}	0.5
Na^{+}	140
Cl^{-}	109.5
$HCO3^{-}$	35

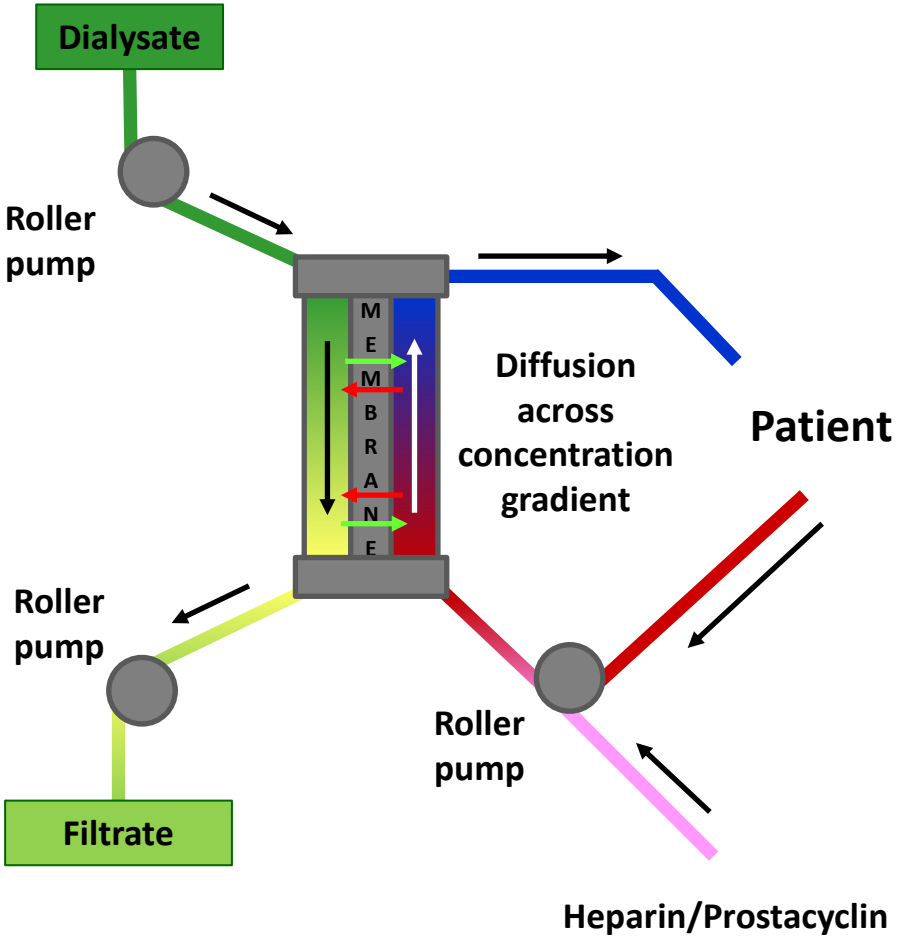
- Most commonly used UK dialysate fluid
- Bicarbonate contained in separate pouch
- Once mixed, must be used within 24 hours
- Precipitation has been noted in filter lines (MHRA 2008)

Continuous Veno-Venous Haemofiltration (CVVHF)



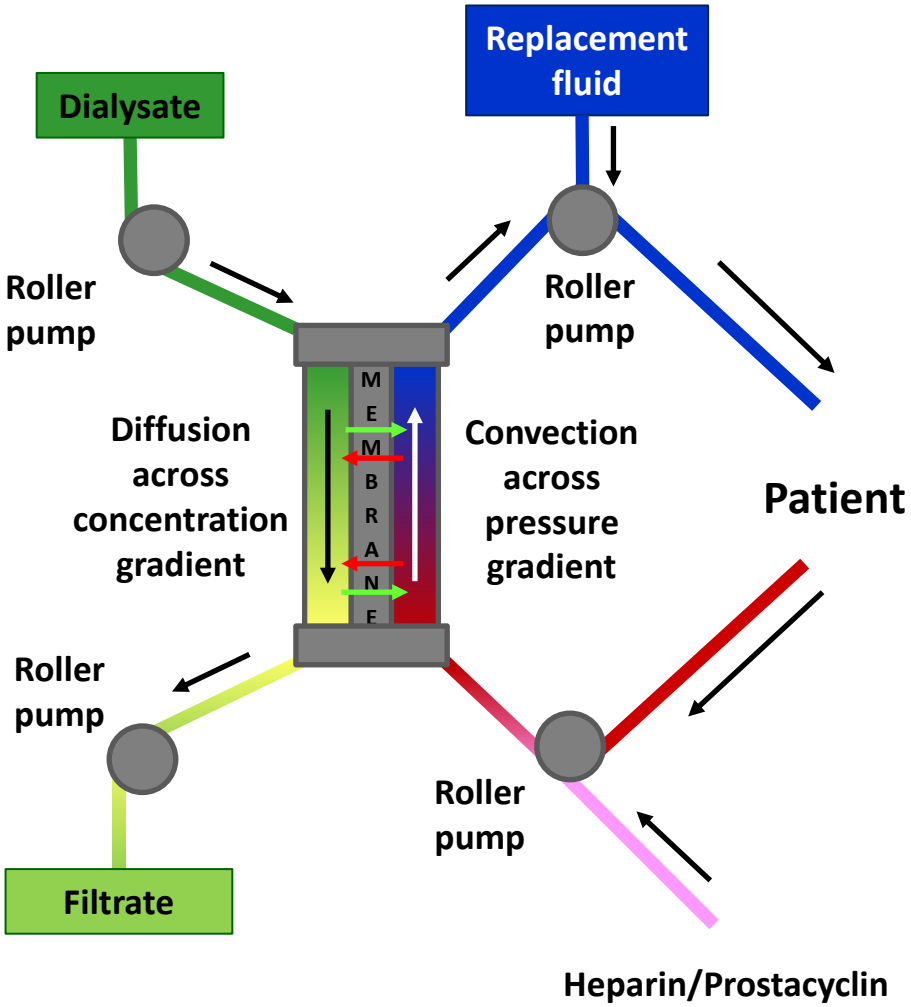
- Replacement fluid may be pre or post the filter membrane
- Pre-dilution improves the life of the filter by reducing haematocrit but also decreases its efficiency

Continuous Veno-Venous Haemodialysis (CVVHD)



Blood flow	100-200 ml/min
Dialysate flow	1-2 L/h

Continuous Veno-Venous Haemo-Diafiltration (CVVHDF)



Controversies

- Dose
  - Optimal dosing should aim for an effluent flow rate of 20-25ml/kg/hour
  - Based on 2 large multicentre RCTs (ATN & RENAL)
- CRRT versus IHD
  - BEST Kidney observational study showed that the majority of ICUs favour CRRT (80%) with the exceptions of North & South America who prefer IHD
  - Hypotension during IHD leads to increased risk of non-renal recovery
  - Consensus favours CRRT in haemodynamically unstable patients but without formal evidence
- Timing of CRRT
  - BEST Kidney observational study showed the median time to commencement is 5 days
  - Higher RIFLE score at commencement of RRT is associated with increased mortality
  - Late initiation of RRT is associated with increased mortality, longer duration of RRT & longer hospital stay
  - Optimal timing is an unresolved issue requiring further research
- CRRT modality (CVVHF versus CVVHDF)
  - Modalities may be equivocal
  - Unresolved at present

MCQ 1

1. Regarding intermittent haemodialysis (IHD):

- Dialysis occurs via diffusive and convective processes
- Dialysis is driven by a transmembrane pressure across a haemofilter
- IHD does not require replacement fluid
- Hypotension is common
- IHD is more efficient at removing solute than CRRT

MCQ 2

2. Regarding replacement solutions:

- They are added pre-filter
- Bicarbonate is stable in solution
- Bicarbonate-buffered haemofiltration must be used if blood lactate concentrations are initially high
- Patients with blood lactate concentrations persistently >5 mmol litre^{-1} require bicarbonate-buffered haemofiltration
- Metabolic alkalosis occurs because of over-buffering

MCQ 3

3. Dialysis dysequilibrium syndrome (DDS):

- Causes symptoms primarily because of cerebral oedema.
- Is primarily associated with IHD.
- Presents rapidly during the dialysis cycle.
- Is more common in patients with epilepsy.
- Causes symptoms that are self-limiting.

MCQ answers

- **FFTTF**
- **FFFTT**
- **TTFTT**

References

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- Gambro, The Prismaflex system brochure
- Hall N & Fox A, (2006) Renal replacement therapies in critical care, CEACCP, 6(5): 197-202.
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- Prowle J, Schneider A & Bellomo R, (2011) Clinical review: Optimal dose of continuous renal replacement therapy in acute kidney injury, *Critical Care*, 15(2): 207.
- Pannu N & Gibney N, (2005) Renal replacement therapy in the intensive care unit, *Therapeutics and Clinical Risk Management*, 1(2): 141-150.