

Specialty guides for patient management during the coronavirus pandemic

Clinical guide for renal replacement therapy options in critical care during the coronavirus pandemic

15 April 2020 Version 1.1

As doctors we all have general responsibilities in relation to coronavirus and for these we should seek and act on national and local guidelines. We also have a specific responsibility to ensure that essential care continues with the minimum burden on the NHS. We must engage with those planning our local response. We may also need to work outside our specific areas of training and expertise and the General Medical Council has already indicated its support for this in the exceptional circumstances we may face: www.gmc-uk.org/news/news-archive/how-we-will-continue-to-regulate-in-light-of-novel-coronavirus

The need to provide renal replacement therapy (RRT) to an increasing number of critically ill patients is likely to exceed machine capacity.

In all cases, maximal medical management should be considered before attempting RRT, including:

- **appropriate dose loop diuretics** (oral or intravenous) for fluid overload
- **potassium binders** as per [NICE guidance](#) and other measures to manage acute hyperkalaemia (see [Clinical guide for acute kidney injury \(AKI\) in hospitalised patients with COVID-19 outside of the ICU during the coronavirus pandemic](#))
- **sodium bicarbonate** (oral or intravenous).

The **conventional indications** to start RRT include:

- life-threatening hyperkalaemia
- refractory fluid overload
- severe metabolic acidosis.

The following options may be considered, based on local availability, equipment, supplies, staffing and local expertise.

	CRRT	Intermittent RRT	PD
Requirements	A machine Dual lumen venous access Anticoagulation Consumables Prepared fluids Trained staff	A machine Dual lumen venous access Anticoagulation Consumables Water via a RO (most HD equipment) Trained staff	A soft PD catheter An operator to place the PD tube Peritoneal dialysis fluid Optional – an automated PD machine with consumables Connection, shields Trained staff
Modes (see below)	CVVH CVVHD CVVHDF	IHD IHDF SLED PIRRT	CAPD (manual exchanges) APD
Access to circulation	Dual lumen Right then left internal jugular preferred	Dual lumen	Not required
Anticoagulation	Regional: citrate Regional/systemic: heparin Systemic: epoprostenol	Regional: citrate Regional/systemic: heparin/LMWH Systemic: epoprostenol	Not required

Modality options for RRT within critical care (CC)

- A facility should assess its available capacity and match this to patients according to need
- **A conservative approach** to using RRT may preserve consumable stocks.

The following RRT modalities are available in CC:

- **continuous veno-venous haemo(dia)filtration (CVVH(D)F)/continuous veno-venous haemodialysis (CVVHD)**
- **slow low efficiency dialysis (SLED)/prolonged intermittent dialysis (PIRRT)**
- **intermittent haemodialysis (IHD)**
- **peritoneal dialysis (PD).**

CVVH(D)F/CVVHD

Requirements

- **A machine** capable of delivering CVVH(D)F/CVVHD.
- **Dual lumen** venous access.

- **Anticoagulation** (regional or systemic).
- **Consumables.**
- **Prepared fluids.**
- **Trained staff.**

Modes

- **CVVH** – pure convection.
- **CVVH(D)F** – combination of diffusion and convection to increase solute management.
- **CVVHD** – predominantly diffusion.

CVVH and CVVH(D)F can be performed in pre-dilution mode (substitute fluid added pre-filter; may prolong filter life), post-dilution (post-filter; reduced substitution fluid usage) or dual mode.

Vascular access

- **Appropriate vascular access is paramount** in providing RRT and preventing premature filter clotting.
- **Site:**
 - first choice: right internal jugular
 - second choice if proning likely: left internal jugular vein
 - second choice if proning unlikely: femoral vein.
- **Choice of catheter:**
 - femoral vein: 24-cm catheter
 - right internal jugular vein: 15-cm catheter
 - left internal jugular vein: 20-cm catheter.

Anticoagulation

COVID-19 infection appears to induce a hypercoagulable state.

Options:

- **regional:** citrate
- **regional/systemic:** heparin
- **systemic:** epoprostenol.

In case of frequent clotting:

- **optimise vascular access**
- **consider alternative combinations/strategies:** citrate and heparin (systemic or via circuit):
 - heparin and epoprostenol

- argatroban
- **increase pre-/post-filter replacement ratio access** – in case of CVVH
- **exclude other pro-thrombotic disorders** (ie heparin-induced thrombocytopenia, antiphospholipid syndrome, etc).

Intermittent RRT

Requirements

- **A machine** capable of delivering intermittent RRT (standard haemodialysis machine, CRRT machine).
- **Dual lumen** venous access.
- **Anticoagulation.**
- **Consumables.**
- **Trained staff.**
- **In case of intermittent haemodialysis:** a reverse osmosis (RO) unit to provide ultrapure water (exception – NxStage System one with either filtration fluid or Pureflow unit).
- **For offline haemodiafiltration:** substitution fluid.

Modes

- **IHD** – conventional intermittent haemodialysis:
 - traditionally delivered during a 4-hour session
 - as a diffusive therapy with high dialysate rates solute clearance can be more efficient, but ultrafiltration can be problematic in haemodynamic instability.
- **IHDF** – intermittent haemodiafiltration:
 - convection with replacement fluid (online or offline); may be better for removing fluid
 - note online generation of fluid requires ultrapure water.
- **SLED** – slow low efficiency dialysis
 - slower dialysis so trade-off is session time prolonged to 6–8 hours.
- **PIRRT** – prolonged intermittent renal replacement therapy.
- **All forms of intermittent RRT can be provided** with conventional haemodialysis machines and usual CRRT machines.
- **These machines may be used for two to three patients in a 24-hour period.**
- **However, a new set of consumables is needed each time.**

Examples:

- Alternate days, to provide 24 hours alternate days to two patients.

- 16 hours over 48 hours, treating three patients.
- 8 hours treating six patients in 48 hours.

These examples do not take into consideration set-up, take-down and cleaning times.

The dialysis dose delivered may not be sufficient to meet catabolic demands, in particular during the hyperinflammation phase.

Anticoagulation

COVID-19 infection appears to induce a hypercoagulable state:

- **regional:** citrate
- **regional/systemic:** heparin
- **systemic:** epoprostenol.

In case of frequent clotting:

- **optimise vascular access**
- **consider alternative combinations/strategies:** citrate and heparin (systemic or via circuit)
 - heparin and epoprostenol
 - argatroban
- **exclude other pro-thrombotic disorders.**

Peritoneal dialysis

Requirements

- **A soft PD catheter, single or double cuffed**, inserted and tunnelled through the anterior abdominal wall:
 - the distal end should be within the pelvic basin and the catheter remains in situ.
- **An operator to place the PD tube at the bedside** (can be surgical using mini-laparotomy or medical using blind Seldinger technique).
- **Peritoneal dialysis fluid.**
- Optional – an automated PD machine with consumables,
- **Connection, shields.**
- **Trained staff.**

Modes

- **Manual PD:**
 - fluid is drained from the abdominal cavity and fresh fluid then drained in (note this relies purely on gravity)

- the cycling, volume and type of fluid can be altered to achieve both solute and fluid control.
- **Automated PD (APD):** a programmable machine delivers therapy in an automated way.

Anticoagulation

- No anticoagulation is required.

Indications

The most basic form of PD is low tech but also very low efficiency. APD is automated to save staff time.

- PD can only be delivered when the patient is on their back.
- **Some head-up positioning** may help as the fluid is more effective when the natural basin of the pelvis is used.
- **There may be leakage from the incision** but this can be managed by keeping exchange volumes low.
- **Hypertonic solutions (glucose 3.86%)** should be part of the prescription to enable adequate ultrafiltration.
- **There is limited experience** with using:
 - icodextrin
 - PD in patients requiring prone positioning.
- Two strategies may be considered in prone patients:
 - turn more frequently and deliver fluid, leaving in situ when turned back
 - use the 8-hour window between turns to deliver rapid exchanges.

PD effluent and any plastic waste should be handled as a potential infection risk.

Risks

- **Bowel injury** during insertion.
- **Leak** (especially in the early phase, in prone position).
- **Peritonitis.**

Continuous arterio-venous haemofiltration (CAVH)

- **CAVH was the precursor to CVVH**, employing arterial pressure as the circuit pump.
- **Requires cannulation of a large artery and adequate BP** to drive the circuit.
- **Relatively low efficiency**, so a longer duration of treatment may be required under catabolic conditions.

Other considerations

- **Review daily** the indications and type of RRT.
- **Fluid use should be minimised** – there will likely be a shortage of consumables.
- **There is no evidence that higher doses of RRT** improve outcome in AKI.
Recommended starting dose:
 - CRRT: 25mL/kg/h, then adjusted daily
 - SLED/PIRRT: 50–60mL/kg/h for ~6 hours.
- **Adjust dose daily** – aim for urea 20–25mmol/L and serum creatinine 200–300µmol/L.
- **Consider a ‘filter holiday’** if spontaneous urine output >400mL/24h, urea <40mmol/L and fluid status controlled.
- **Close collaboration with renal team** and identification of patients who are suitable for step down to renal ward.