ER BASICS · ONE-PAGER

CRRT (Continuous Renal Replacement)

Modes, dose, circuit pressures, citrate and nursing care for critical care exams

20 sources + more detail
erbasics.com/sheets/crrt.html
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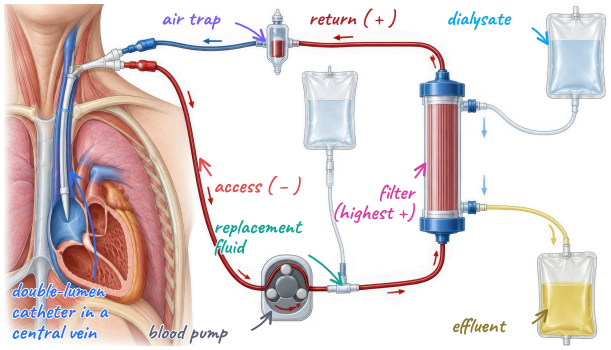
CIRCUIT Follow the blood



1 Indications: why continuous

CRRT removes fluid and solutes slowly, around the clock, so shifts are small. It suits unstable ICU patients with AKI.

- A: severe metabolic acidosis, refractory to treatment
- E: refractory hyperkalemia
- I: dialyzable toxins (lithium, methanol); intermittent HD preferred
- O: fluid overload or pulmonary edema despite diuretics
- U: uremic pericarditis, encephalopathy or bleeding

KDIGO suggests CRRT over intermittent HD for hemodynamic instability and for brain injury or high ICP. EASL advises CRRT in acute liver failure, including for persistent high ammonia.

2 Modalities and dose

All modes can also remove fluid (net ultrafiltration).

MODE	MECHANISM	FLUID USED	CLEARS
SCUF	Ultrafiltration	None	Fluid only
CVVH	Convection	Replacement	Small + middle molecules
CVVHD	Diffusion	Dialysate	Small solutes (K, urea)
CVVHDF	Both	Both	Small + middle molecules

EXAM TIP Diffusion down a dialysate gradient best clears small solutes (K, urea). Convection is solvent drag from high-volume ultrafiltration, driven by TMP; it also pulls middle molecules. Replacement fluid gives back the volume removed. SCUF removes water, almost no solute.

- Dose = effluent rate (dialysate + replacement + fluid removed)
- KDIGO: deliver 20–25 mL/kg/h
- Prescribe about 25–30 mL/kg/h to allow for downtime and pre-dilution
- Example: 80 kg × 25 = 2,000 mL/h
- 35–40 mL/kg/h (ATN, RENAL trials) added no survival benefit
- Bicarbonate-buffered fluids, not lactate, especially in shock or liver failure

Typical adult targets for exam study. Follow your institution's protocols.

3 Access and circuit pressures

- Nontunneled dialysis catheter, placed with ultrasound
- KDIGO site order: right IJ, femoral, left IJ, subclavian last
- Subclavian: central vein stenosis. Femoral: recirculation, immobility, infection risk in obesity
- Chest x-ray before first use of an IJ or subclavian line
- Dialysis catheter for RRT only, except in emergencies

PRESSURE	USUAL SIGN	ABNORMAL MEANS
Access (draw)	Negative	More negative: kink, clot, wall contact, low volume
Filter (pre-filter)	Positive, highest	Rising: clotting or return-side block
Return	Positive	High: kink or clot. Sudden drop: disconnection
TMP (across membrane)	Positive	Steady rise: clogging or clotting
Pressure drop (along filter)	Positive	Rising: clot in the fibers

SAFETY A sudden fall in return pressure can mean disconnection: rapid blood loss, and air entry through an open lumen. Keep connections visible and secured.

EXAM TIP Exams link rising TMP and pressure drop to a clotting filter, and very negative access pressure to a catheter problem. Check kinks, clamps and position first.

4 Anticoagulation

KDIGO suggests regional citrate over heparin when citrate is safe: longer filter life, less bleeding.

FEATURE	CITRATE (REGIONAL)	HEPARIN (SYSTEMIC)
Action	Binds Ca in circuit; Ca replaced; liver makes HCO3	Boosts antithrombin
Monitor	Post-filter iCa 0.25–0.35; patient iCa 1.1–1.3 mmol/L	aPTT or anti-Xa, platelets
Risks	Low Ca, alkalosis, accumulation	Bleeding, HIT
Avoid / caution	Severe liver failure, shock with rising lactate (accumulation)	Active bleeding; never in HIT

Low iCa signs: tingling lips or fingertips, cramps, tetany, long QT, seizures.

SAFETY Citrate accumulation: patient iCa falls despite more calcium, total Ca rises, the total-to-ionized ratio is 2.5 or more (same units), and an anion gap acidosis appears. Report it; protocols cut or stop citrate.

Metabolic alkalosis usually means citrate overload (citrate becomes bicarbonate). In HIT, stop all heparin, including catheter locks, flushes and priming; use a non-heparin anticoagulant such as argatroban (liver-cleared, aPTT-monitored) per protocol.

5 Filter clotting

- Signs: rising TMP and pressure drop, dark streaks in the filter, falling clearance
- Causes: catheter flow problems (most common), weak anticoagulation, post-dilution filtration fraction above about 20–25%
- Filters clotting early again and again: suspect HIT
- Prevention: pre-dilution, CVVHD or CVVHDF over CVVH, good catheter position
- When pressures show clotting, return the blood promptly per protocol; a clotted circuit's blood is lost

6 Nursing care: fluid, labs, drugs

- Starting: blood fills the circuit and BP can fall; have fluid or a pressor plan ready per protocol
- Hourly balance: machine removal plus all patient intake and output, against a daily goal
- Net removal above about 1.75 mL/kg/h was linked to higher mortality (observational)
- BMP, Mg, phosphate every 6–12 h at start, then 12–24 h; on citrate, iCa more often per protocol
- Low K, Mg and phosphate are common; low phosphate can delay vent weaning
- Hypothermia: the circuit loses heat; use the warmer; it can mask fever
- Drugs: water-soluble, low-protein-bound drugs (vancomycin, beta-lactams) are removed; underdosing is the risk
- Drug levels and pharmacist review; reassess doses when CRRT stops or changes

MORE Clearance physics and hemodynamics

Diffusion moves solute down a concentration gradient into countercurrent dialysate. At CRRT flows (dialysate 1–2 L/h against blood 9–15 L/h) the dialysate leaves nearly saturated, so clearance of urea (60 Da), creatinine and potassium roughly equals the dialysate rate, while middle molecules (β2-microglobulin, myoglobin, cytokines) barely diffuse. Convection drags solute across with plasma water pushed by TMP; replacement fluid returns the volume. Adsorption is a small third route (AN69ST, oXiris).

Sieving coefficient = concentration in ultrafiltrate ÷ concentration in plasma water: about 1.0 for urea, electrolytes, glucose and citrate, 0 for albumin (66 kDa) on a 30–40 kDa membrane, roughly the unbound fraction for a drug. Post-dilution convective clearance = ultrafiltration rate × sieving coefficient. Pre-dilution lowers it by about Qb ÷ (Qb + Qpre), typically 15–25%, which is why effluent rate overstates delivered dose (KDIGO 2012).

Filtration fraction = total ultrafiltration (all replacement + net removal) ÷ plasma flow into the filter, with plasma flow = blood flow × (1 − Hct) plus any pre-dilution fluid. Example: Qb 200 mL/min = 12 L/h; Hct 0.30 gives 8.4 L/h plasma; 2 L/h post-dilution plus 0.1 L/h removal = 2.1 L/h; FF = 25%. The same 2 L/h pre-filter gives 2.1 ÷ 10.4 = 20%. Above 20–25% the hemoconcentrated blood leaving the fibers clots (Joannidis 2007).

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