CRRT VS IHD - AN OVERVIEW

Dr Adam Mugford BVetMed MVetMed DACVECC MRCVS
CVS Referrals – Lumby Park Veterinary Specialists
Emergency and Critical Care
Selbourne Road, Alton, Hampshire GU34 3HL
United Kingdom

Methods have been discussed in other sessions to promote restoration and support renal function with medical therapy. But when this fails to achieve satisfactory improvements or a case is severe enough from the outset there are more advanced treatment strategies available that aim to “mimic” renal function.

These are employed to improve the patient’s clinical status by preventing the sequelae that are associated with severe azotaemia (anorexia, vomiting, mucosal ulceration, coagulopathy) by removing uraemic molecules and provide a “bridge” to provide more time until renal function is, at least partially, restored. They can also be employed to reduce refractory life threatening hyperkalaemia and volume overload efficiently.

The two main options are peritoneal and haemodialysis with continuous renal replacement therapy (CRRT) being a subset of haemodialysis and the modality currently available most widely see http://queenofthenephron.net/list-of-units/ for reference.

Criteria for dialysis include:

- Volume overload with persistent oliguria or anuria despite medical therapy.
- Refractory hyperkalaemia following medical therapy (see other sessions).
- Severe clinical signs of uraemia.
- Reversibility of disease process
- Removal of renal toxins with haemodialysis

Illustrated below are the differences between techniques:

**Peritoneal dialysis (PD):** A feasible option in general veterinary practice, but warrants 24-hour care and is very labour intensive often for several days. It would be suggested that referral to an advanced specialist center would be recommended due to practical experience with this technique being necessary to achieve the optimal outcomes.

PD uses the same principle of haemodialysis (the removal of uraemic solutes by diffusion), but the semipermeable membrane is the peritoneum membrane, rather than an artificial membrane. So, dialysate is instilled into the abdominal cavity and, after equilibration, is then removed again.

Diminishing the uraemic substances within the patient. It is most commonly used to treat acute kidney injury if other renal replacement therapies are not available.

**Potential complications of peritoneal dialysis:** These can be significant and include Peritonitis, Respiratory compromise, Catheter blockage, Leaking of catheter site, Abdominal distention, Hypovolaemia, Hyperglycaemia, Hypothermia.

**Haemodialysis:** An intermittent renal replacement therapy that mainly is aimed at removing uraemic substances or toxins from within the bloodstream. Repeated sessions can be performed to gradually decrease uraemic substance levels, intermittent haemodialysis (IHD) removes small molecules faster than continuous renal replacement therapy (CRRT).
Complications of haemodialysis: Include Haemorrhage, hypotension, dialysis disequilibrium, anaemia, hypoproteinaemia, catheter sepsis, catheter or cartridge thrombosis and hypocalcaemia.

Continuous renal replacement therapy (CRRT): CRRT works to replace normal kidney function by exposing the patient's blood in an extracorporeal chamber to a semi-permeable membrane. Substances are removed from the blood by way of diffusion, convection, and/or adhesion, or a combination depending on the modality chosen. CRRT differs from traditional intermittent haemodialysis (IHD), as therapy is continuous with gradual removal of substances, and IHD uses diffusion exclusively as its modality.

The purpose of CRRT is to gradually and effectively eliminate uraemic and other blood-borne toxins, correct electrolyte and acid-base imbalances, and modulate fluid balance. The most common use is in the treatment of acute renal failure, however it is also of use with certain toxicities or drug overdoses, fluid overload such as that with congestive heart failure, and sepsis.

There are four different possible modes of operation in CRRT.

1. **Slow continuous ultrafiltration (SCUF)** technique uses convection for solute and fluid transport and works by driving blood through the filter and creating a positive pressure gradient, allowing fluid and solute passage through the pores, creating the ultrafiltrate. This fluid is not replaced before the blood is returned to the body. This technique is used in cases of fluid overload, as fluid is removed and blood volume drops.

2. **Continuous veno-venous haemofiltration (CVVH)** is similar to SCUF in that convection is used as blood is passed through the semipermeable filter and a positive pressure gradient is created, so ultrafiltrate is removed. However, in this mode, the ultrafiltrate is replaced with a replacement solution, so there is no net loss of blood volume for the patient. This mode is superior to intermittent haemodialysis in removal of larger sized particles (up to 50 kilodaltons) such as bilirubin, some toxins, and certain inflammatory mediators.

3. **Continuous veno-venous haemodialysis (CVVHD)** uses diffusion for solute transport. As blood is passed through the semipermeable filter, a dialysate solution is concurrently flowing outside the filter. Particles selectively move from areas of higher concentration to areas of lower concentration. Therefore, uraemic solutes such as creatinine and blood urea nitrogen pass out into the dialysate, which is then discarded as ultrafiltrate. There is no net gain or loss of fluid with this modality, as solute diffusion is the main process.

4. **Continuous veno-venous haemodiafiltration (CVVHDF)** uses a combination of diffusion and convection, as fluid is moved through the filter with a positive pressure gradient, and dialysate solution is simultaneously flowing in the opposite direction, outside the filter. Ultrafiltrate removed is again replaced by a replacement solution, preventing net gain or loss of fluid.

Advantages of CRRT over PD and IHD:

PD creates a risk of peritonitis, insufficient solute clearance, poor fluid removal, abdominal leaks, and respiratory dysfunction. All of these are avoided with CRRT. IHD is only able to remove smaller sized substances, as opposed to the larger substances removed by CRRT. Also, there is increased risk of haemodynamic instability and dialysis disequilibrium with IHD, where these are largely avoided with CRRT due to the slow, continuous removal of solutes. CRRT is technically less intensive than IHD and PD. CRRT the dialysate fluid is pre-packaged and mechanical support equipment required is reduced compared to IHD.

Disadvantages:
CRRT requires specialized equipment and training (a lot of mathematics!). It is labor intensive and requires constant monitoring 24-hours per day (similar to PD) by staff with the necessary training.

Summary of the difference between peritoneal (PD) and intermittent haemodialysis (IHD)
Dialysate preparation and composition:
IHD – Prepared by the dialysis machine from ultra-purified water with added electrolytes and bicarbonate to a prescribed quantity of sodium to mimic plasma concentrations; this often requires a large amount of additional space although more mobile units are now available. One advantage cited for CRRT is that the dialysate fluid is prepackaged.

PD – Prepared commercially, available in bags of peritoneal dialysate, with electrolyte concentrations similar to plasma, and 1 to 4% dextrose; it can however also be prepared using the correct components and strict aseptic technique.

**Differences regarding anticoagulation**

IHD/CRRT – Heparin dosing throughout treatment or citrate therapy before and calcium therapy after the cartridge.

PD – None needed (no extracorporeal circuit), some recommend adding heparin to dialysate to reduce fibrin formation.

**Differences regarding ultrafiltration**

IHD – Vacuum applied to dialysate circuit post-dialyzer – fluid follows area of lower hydrostatic pressure (vacuum applied)

PD – Peritoneal surface exposed to solution of higher dextrose concentration creating an osmotic gradient.

**Differences regarding blood pump mechanism**

IHD – Machine blood pump

PD – Heart

**Differences regarding the exchange surface**

IHD - Dialyzer of hollow tube semipermeable membranes, various compositions depending upon desired goal. Protein not filtered

PD – Peritoneal surface

Any questions come to CVS Stand 124 at the conference in the exhibit hall!

**REFERENCES**


(http://www.sciencedirect.com/science/article/pii/B9781437706543000366)
