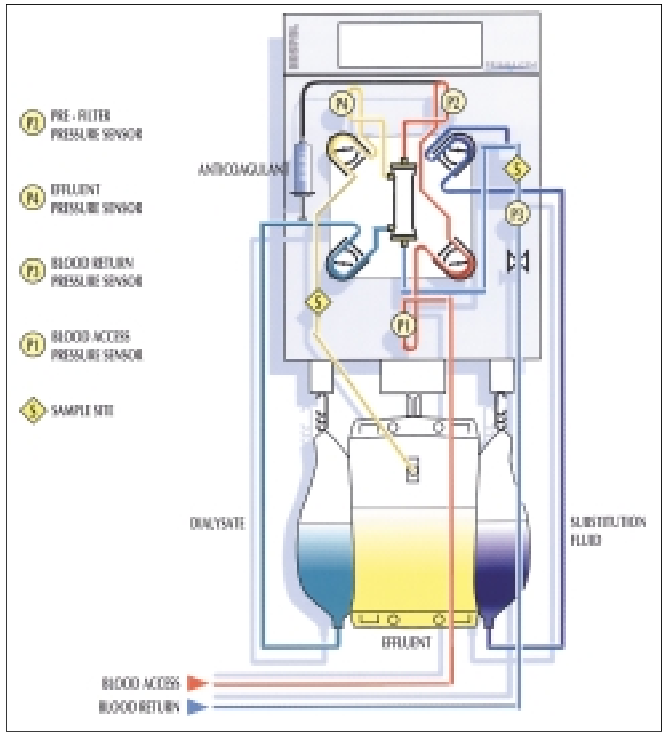
Continuous venovenous hemodiafiltration for renal failure and sepsis

Demetrios J. Kutsogiannis

Technology: Continuous venovenous hemodiafiltration (CVVHD)

Use: CVVHD is a form of continuous renal replacement therapy that is used for critically ill patients with multisystem organ failure in whom acute renal failure develops. This form of dialysis differs from intermittent hemodialysis in that it is a slower, continuous mode of dialysis that permits the clearance of blood solutes both by diffusion across a semipermeable membrane (dialysis) and by convection of solutes across a membrane as they are separated from whole blood in response to hydrostatic pressure.[1] Hydrostatic pressure is generated by simultaneously circulating fluid in conjunction with blood through a dialysis circuit before it enters the dialysis hemofilter.

History: Continuous renal replacement therapy was first described by Scribner and associates[2] in 1960. It was initially performed through an arteriovenous circuit that incorporated a dialysis hemofilter and relied on the patient's arterial blood pressure to circulate blood through the hemofilter. This technology was inspired by the limitation in the use of intermittent hemodialysis in hemodynamically unstable patients and has been demonstrated to improve hemodynamic and cerebrovascular stability compared with intermittent hemodialysis in patients with acute renal failure who also have liver failure or cerebral edema.[3,4] Continuous renal replacement therapy has evolved rapidly. With CVVHD, sophisticated pump-driven devices with venovenous access are used to circulate blood through a dialysis hemofilter (Fig. 1), and thus the risks inherent with arterial access are avoided. CVVHD is used to treat acute renal failure complicated by refractory fluid overload or hemodynamic instability, and to treat life-threatening electrolyte and acid–base disorders.[5] In Canada, its use has been limited to critically ill patients in tertiary care facilities with renal failure, fluid overload and major electrolyte abnormalities.



Hospal Gambro Inc.

Fig. 1: Multi-mode continuous renal replacement machine.

Promise: Sepsis due to bacterial infection and systemic inflammatory response syndrome (SIRS) due to noninfectious causes such as trauma, burns and pancreatitis develop from the release of a multitude of biologically active inflammatory mediators. It has been hypothesized that the removal of these noxious molecules by hemofiltration may blunt the exaggerated inflammatory response and improve clinical outcome. Although the removal of several cytokines such as interleukin-1, interleukin-6, tumour necrosis factor-alpha and myocardial depressant substance has been demonstrated in animal and human studies, the lack of large randomized clinical trials in this area has made the role of continuous renal replacement therapy for sepsis and SIRS controversial.[6,7] Specific limitations with the use of continuous renal replacement therapy for sepsis and SIRS include the middle-molecular weight of most cytokines (< 30 000 daltons), which require clearance through convection (not diffusion), and the need for more than 100 L of replacement fluid daily to achieve clinically meaningful clearances of some inflammatory mediators.

Problems: Anticoagulation remains a major problem with the use of continuous renal replacement therapy. Systemic heparin has been the predominant mode of anticoagulation; however, a high risk of bleeding has been encountered in subgroups of critically ill patients. Alternative modes such as intravenous prostacycline and trisodium citrate have been used successfully.[8] Other drawbacks include the need for expensive dialysis machines and hemofiltration fluid for solute exchange.

Prospects: CVVHD has gained acceptance as an effective mode of renal replacement therapy in critically ill patients with renal failure, as evidenced by the publication of large series of patients given this treatment.[9] However, with the emergence of this technology, physicians caring for critically ill patients will have to face the ethical decisions regarding the futility of sustaining certain patients on yet another form of life support.

[Visit www.crrt.com for current references and conference information relating to continuous renal replacement therapy.]

Competing interests: Dr. Kutsogiannis is currently conducting research comparing modes of anticoagulation in CVVHD that has received funding from several sources, including Hospal Gambro Inc., manufacturer of continuous renal replacement therapy equipment.

References

1. Bellomo R. Choosing a therapeutic modality: hemofiltration vs. hemodialysis vs. hemodiafiltration. *Semin Dial* 1996;9:88-92.
2. Scribner BH, Caner JEZ, Buri R, Quinton W. The technique of continuous dialysis. *Trans Am Soc Artif Intern Organs* 1960;6:88-103.
3. Davenport A, Will EJ, Davidson AM. Improved cardiovascular stability during continuous modes of renal replacement therapy in critically ill patients with acute hepatic and renal failure. *Crit Care Med* 1993;21:328-38.
4. Davenport A. The management of renal failure in patients at risk of cerebral edema/hypoxia. *New Horiz* 1995;3:717-24.
5. Kirschbaum B, Galishoff M, Reines HD. Lactic acidosis treated with continuous hemodiafiltration and regional citrate anticoagulation. *Crit Care Med* 1992; 20:349-53.
6. Kellum JA, Johnson JP, Kramer D, Paleusky P, Brady JJ, Pinsky MR. Diffusive vs convective therapy. Effects on mediators of inflammation in patients with severe systemic inflammatory response syndrome. *Crit Care Med* 1998;26:1995-2000.
7. Schetz M. Evidence-based analysis of the role of hemofiltration in sepsis and multiorgan dysfunction syndrome. *Curr Opin Crit Care* 1997;3:434-41.
8. Favre H, Martin PY, Stoermann C. Anticoagulation in continuous extracorporeal renal replacement therapy. *Semin Dial* 1996;9:112-8.
9. Jones CH, Richardson D, Goutcher E, Newstead CG, Will EJ, Cohen AT, et al. Continuous venovenous high-flux dialysis in multiorgan failure: a 5-year single-center experience. *Am J Kidney Dis* 1998;31:227-33.

Dr. Kutsogiannis is with the Department of Public Health Sciences and the Division of Critical Care Medicine, University of Alberta, Edmonton, Alta.; fax 780 477-4032; dkutsogi @telusplanet.net