Continuous Venous-Venous-Hemodialysis versus Intermittent-Hemodialysis in Critically Ill Patients

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The column in this issue is supplied by Juan Jose Olivero, M.D., a nephrologist at Houston Methodist Hospital and a member of the hospital's Nephrology Training Program. Dr. Olivero obtained his medical degree from the University of San Carlos School of Medicine in Guatemala, Central America, and completed his residency and nephrology fellowship at Baylor College of Medicine in Houston, Texas.

Acute kidney injury (AKI) is a frequent complication in critically ill patients, adversely affecting outcomes. Renal replacement therapies, mostly continuous venous-venous-hemodialysis (CVVHD) and intermittent hemodialysis (IHD), have been used as bridges to allow recovery of kidney function and improve survival. Not only have these therapeutic modalities been used in the treatment of AKI, but they also have been used to treat other types of life-threatening emergencies–independent of kidney function–such as intoxication, accidental hypothermia, and profound metabolic disarray. Although there are specific advantages and disadvantages to both CVVHD and IHD, several meta-analyses have failed to show a clear advantage of one modality over the other in improving survival. Individual patient selection based on clinical status should determine the physician's choice of treatment modality.[1,2,3]

ADVANTAGES OF CVVHD

Hemodynamic Stability

- Provides greater hemodynamic stability, leading to fewer hypotensive episodes. Recurrent hypotensive episodes interfere with the potential recovery of kidney function by causing repeated focal ischemic injury, which is aggravated by loss of circulatory intrarenal autoregulatory mechanisms due to AKI. The hemodynamic stability provided by CVVHD could be partially attributed to hypothermia due to extracorporeal circulation, resulting in improved venous return and arterial vasoconstriction as the body attempts to maintain its core temperature.[4]
- Hemodynamic stability makes CVVHD better than IHD in patients with combined acute renal and hepatic failure.
- Despite these observations, meta-analyses have failed to demonstrate superiority of CVVHD over IHD for preservation of kidney function.[5]
- Better around-the-clock fluid removal, particularly when simultaneous exogenous fluids–such as parenteral nutrition, intravenous antibiotics, or blood products–must be infused into the oliguric patient.
- Renal replacement therapy during surgery. As in the case of liver transplantation with simultaneous impaired kidney function and hemodynamic instability, CVVHD can effectively control metabolic acidosis and electrolyte imbalance (particularly hyperkalemia) during the reperfusion period and massive transfusions.[6]

Removal of Cytokines

- Removal of cytokines in a population with acute inflammatory response would be a desired effect. TNF-alpha and several interleukins can be found in the ultrafiltrate due to either absorption by the membrane or transmembrane elimination. However, other studies have shown that removal of inflammatory markers is overwhelmed by the new generation of the same markers once the surface of the membranes is saturated. Thus, the indication for CVVHD as part of the treatment for severe sepsis has not been validated.[7]

Select Patient Populations

- Better than IHD in patients with acute brain injury, particularly those with cerebral edema or intracranial hypertension that results in decreased or absent autoregulation of cerebral circulation and cerebral blood flow.[8]
- Better in patients with ongoing lactic acidosis and persistent acidemia. In comparison, IHD could only transiently correct those abnormalities, at times resulting in interdialytic rebound.[9]
- Better in severe hyponatremia, fluid overload, and oliguric AKI. If hyponatremia is corrected rapidly (> 10-12 mEq/L the first 24 hours or > 18 mEq/L during the first 48 hours), it could result in central pontine myelinolysis with permanent neurologic sequelae. Azotemia may protect the brain from the development of osmotic demyelination in

these patients by preventing intracellular cerebral edema. CVVHD would be safer and would provide more control in serum sodium changes; using frequent determinations (every 3 hours) allows adjustments of therapy to take place safely.
- Rarely, lung transplant recipients can develop severe hyperammonemia. At times the only way to correct the problem is administering two simultaneous CVVHD units, which often lasts several days.[10]
- End-stage renal disease patients needing CVVHD should have a central venous catheter to conduct CVVHD. The primary arteriovenous fistula or graft should not be accessed for this purpose because of potential needle dislodgment, pain at the needle site, the need for recannulation when dialysis is interrupted (e.g., each time the patient is transported outside of the ICU), and an increased incidence of access thrombosis.

DISADVANTAGES OF CVVHD

- More expensive than IHD.
- Frequent interruptions due to equipment malfunction (clotted lines/hollow fibers) or patients traveling to diagnostic or therapeutic procedures.
- Prolonged immobilization (although most patients may need complete bed rest anyway).

ADVANTAGES OF IHD

Accidental Hypothermia

- Hemodialysis is a better choice than CVVHD to correct severe hypothermia, setting dialysate flow and temperature to a maximum. Usually hypothermia is associated with coagulopathy, for which there is no need to use anticoagulants.[11]

Removal of Toxic Substances

- Toxic levels of lithium, methanol, ethylene glycol, iodine (in burned patients), valproic acid, isoniazid, and metformin are effectively removed by IHD. Salicylate intoxication, particularly when complicated by pulmonary or cerebral edema, can also be corrected by IHD much more efficiently than by CVVHD.[12]

Select Patient Populations

- Tumor lysis syndrome, resulting in profound metabolic imbalance such as severe hyperuricemia and cases of severe malignancy-related hypercalcemia, is more efficiently corrected by IHD than by CVVHD.
- Rhabdomyolysis with hyperkalemia. However, if the degree of muscle injury is severe (creatine phosphokinase > 250K) and intracellular potassium release is constant, rebound hyperkalemia in the interdialytic period could become a problem, requiring longer dialysis sessions, often against a potassium-free dialysate.

DISADVANTAGES OF IHD

- Unsuitable for use in the hemodynamically unstable patient.

The studies comparing survival outcomes between CVVHD and IHD in critically ill patients may be affected by the biases in patient selection since sicker patients are usually chosen to go on CVVHD, therefore skewing the results. These modalities are not mutually exclusive; CVVHD is frequently used during the early phase of the acute event then transitioned to IHD once the patient is more stable.

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