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Which method of renal replacement therapy is best for patients with acute kidney injury in intensive care?

There are several methods of renal replacement therapy but none has a definitive survival benefit in patients with acute kidney injury. This article discusses the advantages and disadvantages of continuous and intermittent renal replacement for patients with acute kidney injury.

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Introduction

Acute kidney injury affects approximately 20% of acute hospital admissions (Kanagasundaram et al, 2019). In the most severe cases of acute kidney injury, renal replacement therapy may be indicated. Traditionally, renal replacement therapy is initiated to manage the complications of acute kidney injury, including refractory hyperkalaemia, uraemia, acidosis or fluid overload. There are two main modalities of renal replacement therapy used in patients with acute kidney injury: intermittent haemodialysis and continuous renal replacement therapy. In intensive care, continuous renal replacement therapy is most commonly used but randomised controlled trials are yet to show a difference in survival for patients with acute kidney injury receiving continuous renal replacement therapy vs those receiving intermittent haemodialysis (Wald et al, 2014; Kanagasundaram et al, 2019).

Advantages of continuous renal replacement therapy

Haemofiltration is a method of continuous renal replacement therapy that relies on convection. Hydrostatic pressure drives water and solute across a semi-permeable membrane to produce ultrafiltrate. A crystalloid buffer solution is then added post-filter, the volume of which can be adjusted to determine the overall fluid balance. Haemodiafiltration, a form of continuous renal replacement therapy, is a combination of haemodialysis and haemofiltration.

A major advantage of continuous renal replacement therapy in intensive care patients is that it provides more gradual solute clearance, with some filter sets lasting up to 72 hours, although sessions can last even longer than this. This slower removal of osmotically active substances results in smaller fluid shifts between the intracellular and extracellular fluid compartments. This is particularly beneficial in patients with traumatic brain injury where rapid changes in serum osmolality would worsen cerebral oedema and compromise the perfusion of the brain. These smaller fluid shifts, combined with improved control of net fluid balance over a longer period, also means that continuous renal replacement therapy is better tolerated by patients with cardiovascular compromise, including those on vasopressors. For these reasons the Renal Association supports the use of continuous renal replacement therapy in patients who are haemodynamically unstable or where cerebral perfusion is likely to be compromised by fluid shifts (Kanagasundaram et al, 2019).

Although there is yet to be any evidence of improved survival, meta-analysis of observational studies suggests that continuous renal replacement therapy may be associated with better renal recovery than intermittent haemodialysis, and a reduced need for long-term renal replacement therapy (Schneider et al, 2013). However, analysis of randomised controlled trials showed no difference in dialysis dependence between the two methods (Schneider et al, 2013). Further trials will be required to determine if there is a benefit of continuous renal replacement therapy in terms of renal outcomes.

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Advantages of intermittent haemodialysis

With intermittent haemodialysis, blood and dialysate flow in opposite directions, separated by a semi-permeable membrane. Solute diffuses from the blood to the dialysate, down its concentration gradient, and is therefore cleared. Fluid is then removed as it follows the cleared solute as a result of osmosis.

Intermittent haemodialysis removes solute more quickly than continuous renal replacement therapy and a session may last from 3–5 hours. While this may be detrimental in patients with cardiovascular compromise or cerebral oedema, the rapid solute clearance may be of benefit in cases of refractory hyperkalaemia (Kanagasundaram et al, 2019). Another advantage is that these shorter sessions allow better mobility of the patient. This facilitates increased physiotherapy and rehabilitation for the patient, as well as easier intra-hospital transfers (for example, when the patient is being transported for imaging).

Dialysis requires an ultra-pure water supply but once installed the need for consumables is relatively low. A large analysis of 53 centres worldwide found that the median cost of intermittent haemodialysis was nearly $300 less per day than continuous renal replacement therapy (Srisawat et al, 2010). The main component of this cost is the consumables. If lower flow rates are used the cost of continuous renal replacement therapy may be reduced by up to 20%, but it is still more expensive than intermittent haemodialysis (Srisawat et al, 2010). However, installing an ultra-pure water supply is a significant cost, so this is a major barrier to performing intermittent haemodialysis on the intensive care unit if it is not already in place.

Hybrid methods

Sustained low-efficiency dialysis has been developed to facilitate dialysis while maintaining haemodynamic stability. It can be conducted using standard haemodialysis equipment, but a session will take 8–12 hours rather than 3–5 hours, reducing the rate of fluid shifts. The use of conventional intermittent haemodialysis machines reduces the need for the expensive consumables required for continuous renal replacement therapy (Kitchlu et al, 2015). Several studies have shown that sustained low-efficiency dialysis and continuous renal replacement therapy have comparable outcomes in terms of haemodynamic stability and clinical outcome, but these studies are small and further work is required if sustained low-efficiency dialysis is going to be widely used (Kitchlu et al, 2015).

Conclusions

As there is no demonstrated mortality benefit between continuous renal replacement therapy and intermittent haemodialysis, and no definitive evidence that continuous renal replacement therapy reduces dialysis dependence, the choice of renal replacement therapy should be determined by patient and organisational factors. For patients with haemodynamic instability or cerebral oedema, continuous renal replacement therapy should be the first-line therapy, whereas patients who are stable could be offered intermittent haemodialysis if the infrastructure is available on the critical care unit. This may be of particular use during the rehabilitation phase of a patient's illness and may even be conducted on the dialysis unit if practicable. This could help reduce costs and protect the limited resources required for continuous renal replacement therapy.

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