Medicina Universitaria. 2017;xxx(xx):xxx—xxx

MEDICINA UNIVERSITARIA
www.elsevier.es/rmuanl

ORIGINAL ARTICLE

# Early initiation of renal replacement therapy in acute renal injury

**O. Torres Aguilar[a,*], R.J. Maya Quintá[b], G. Rodríguez Prieto[c], M. Leal[d], J.F. Castilleja Leal[e]**

[a] *Critical Care Medicine and Critical Care Nephrology at Tec Health, Mexico*
[b] *Nephrology at Tec Health, Mexico*
[c] *Autonomous University of Nuevo Leon, Mexico*
[d] *Medical School at TEC of Monterrey, Monterrey Campus, Mexico*
[e] *Director of Internal Medicine at Tec Health, Mexico*

Received 9 March 2017; accepted 25 July 2017

**KEYWORDS**
Acute kidney injury;
Renal replacement therapy;
Early initiation;
Sepsis

**Abstract** Acute kidney injury (AKI) is a widely-seen pathology in the hospital environment. Today, prevention is the best available treatment. Nowadays, one of the most common causes is sepsis-induced AKI, which is seen in critical care patients. Sepsis-induced AKI includes in its pathophysiology injury associated with low kidney perfusion and toxicity caused by inflammatory biomarkers but has a more complex treatment.

There is not yet a consensus of when to initiate renal replacement therapy, but it seems that early initiation confers a better prognosis, as well as that continuous renal therapy, could have an impact on life expectancy and early renal recovery. We analyze epidemiology, pathophysiology, and treatment in the following article, particularly the early initiation of renal replacement therapy in sepsis-induced AKI.


Definition, epidemiology, and prognosis of acute kidney injury.

Acute kidney injury (AKI) is defined as a sudden and sustained loss of renal function, causing the accumulation of products and toxins, both nitrogenated and non-nitrogenated, accompanied by disorders in the equilibrium of liquids, electrolytes, and acid-base.[1]

AKI incidence has increased, while mortality rates linked to its diagnosis have not had significant changes.[2] Estimations suggest that between 1 and 30% of hospitalized patients will present AKI. This percentage is even higher (70%)[3] in the intensive care unit (ICU).[4] Also, 20% of patients with this diagnosis will require renal replacement therapy (RRT).[5]

Additionally, AKI diagnosis and treatment have an impact on hospital costs by increasing hospital stay and the use of

* Corresponding author at: Instituto de Medicina Interna, Hospital Zambrano Hellion, Batallón de San Patricio 112, Piso 6, Mexico. Tel.: +52 8888 0653.
*E-mail address:* oscartorresmd@gmail.com (O. Torres Aguilar).

https://doi.org/10.1016/j.rmu.2017.10.004
1665-5796/

resources.[6] AKI is linked to 2.8 more days of hospitalization, in addition to an increase of 7082 dollars in hospitalization costs, combined with a more significant morbidity and mortality rate.[7,8] It also has long-term consequences, since 8% of patients which suffered from AKI with an RRT requirement, will present chronic RRT dependency, versus 0.1% of patients who did not have AKI.[7] A mortality rate of 28% up to 80% has been reported.[8,9] The highest percentage is linked to when there is involvement of multiple organ failure and/or requirement of renal replacement therapy.

Since 2012, the ''Kidney Disease Improvement Global Outcome'' workgroup (KDIGO),[10] published the criteria for the diagnosis of acute kidney injury. Today, this classification is the most widely utilized. This classification includes 3 degrees, depending on the severity (Table 1). The most outstanding aspect of these criteria is the increase in serum creatinine of just 0.3 mg/dl within 48 h of the injury, or a decrease of diuresis at 0.5 ml/kg/h for 6 h.[10]

For many years there has been controversy about when to begin RRT. Nowadays, current criteria to begin RRT are the following: having a third-degree KDIGO, or one of the following criteria: acute hyperkalemia (greater than 6 meq/L), acute metabolic acidosis (pH less than 7.15). Also hydric overload (weight gain greater than 10%, or acute pulmonary edema) or ureic nitrogen over 100 mg/dL (Table 2).[11] Likewise, there is still controversy over whether beginning RRT with these criteria is too late, and whether or not the use of creatinine as the only marker is enough.[12]

**Table 1** Classification of LRA KDIGO 2012.[10]

| State | Creatinine | Urinary volume |
|---|---|---|
| 1 | >0.3 mg/dl.<br>1.5–1.9 times basal creatinine | <0.5 ml/kg/h for 6–12 h |
| 2 | 2.0–2.9 times basal creatinine | <0–5 ml/kg/h for >12 h. |
| 3 | 3.0 times basal creatinine<br>Creatinine greater than 4.0 mg/dl<br>Start TRR.<br>Less than 18 years old TFG <35 ml/min/1.73 $m^2$ | <0.3 ml/kg/h for >24 h.<br>Anuria for >12 h. |

KDIGO Clinical Practice Guideline for Acute Kidney Injury. *Kidney Int*. 2012;2(1):1–138.

**Table 2** [11]RRT indications.

| Renal indications | Non-renal indications |
|---|---|
| Uremic signs and symptoms | Thermoregulation (hyperthermia) |
| Progressive azoemia | Drug intoxication or overdose |
| Volume overload/oliguria | Sepsis |
| Electrolyte disorders | Crush syndrome/rhabdomyolysis |
| Metabolic acidosis | |

Gaudry S, Hajage D, Schortgen F, et al. Initiation strategies for renal-replacement therapy in the intensive care unit. *N Engl J Med*. 2016;375(2):122–133.

Thus, non-conventional RRT indicators have been explored, including non-renal ones (Table 2).

## A look at RRT types in AKI

Different types of RRT may be used in patients with AKI, including peritoneal dialysis (PD) and extracorporeal therapies like hemodialysis (HD) and continuous renal replacement therapy (CRRT).[13] Peritoneal dialysis was the first replacement therapy used in AKI in 1970.[14] It offers some advantages over extracorporeal therapies, some of the most significant ones are the fact that it does not require the use of anticoagulation, and thus there is less risk of hypotension during treatment and a lower cost. Some of the disadvantages are the requirement of an abdomen without recent surgeries, a higher risk of infection and the difficult control over ultrafiltration.[15] Despite the fact that results are similar to those of hemodialysis, the use of PD has decreased over the last few years.[16]

The currently utilized therapy is intermittent hemodialysis (IHD). This therapy utilizes a venous catheter and, through diffusion and osmosis mechanisms, conducts an exchange of small molecular weight particles. Among the advantages of IHD are the fact that this therapy is the most efficient of all, accomplishing a faster electrolyte and acid/base control compared to the other two, a lower cost compared to CRRT and a lower anticoagulation dose. Some of the disadvantages are the risks of bleeding caused by the use of heparin, hypertension during treatment, and the need for a new venous access.

Advantages and disadvantages of the different RRTs are summarized in Table 3.

## Continuous renal replacement therapy (CRRT)

### CRRT background

Continuous renal replacement therapy (CRRT) is defined as an extracorporeal method of purifying blood over an extended period, looking to replace renal function. First used by Kramer in 1977[17] for patients with acute kidney injuries in a critical state using continuous arteriovenous hemofiltration (CAVH).[18] CAVH uses blood pressure to create a flow and a transmembrane pressure gradient, thus accomplishing spontaneous ultrafiltration. However, this pressure gradient depends on the patient's mean blood pressure. Today, the same venous lumen is utilized with extracorporeal pumps to achieve transmembrane pressure gradient regardless of the patient's mean blood pressure, thus preventing many of the complications that an arterial catheter causes (i.e., ischemia, atheroemboli, bleeding, pseudoaneurysm).[19] Compared with intermittent renal replacement therapies, CRRT has not shown to be superior regarding survival rate; however, it has shown to be superior in the management of liquid volumes, as well as in renal recovery rate.[20,21]

There are different physical and chemical principles involved in the different modalities of CRRT, which are responsible for the depuration of toxins and water usually eliminated by the kidney. The main principles are ultrafiltration, diffusion, convection, and adsorption. Ultrafiltration

Please cite this article in press as: Torres Aguilar O, et al. Early initiation of renal replacement therapy in acute renal injury. Medicina Universitaria. 2017. https://doi.org/10.1016/j.rmu.2017.10.004