ORIGINAL

Port J Nephrol Hypert 2009; 23(4): 331-336
Advance Access publication 06 September 2009

Renal replacement therapy in an Intensive Care Unit: the experience of a single centre

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Received for publication: 06/10/2008
Accepted in revised form: 17/08/2009

ABSTRACT

Introduction: acute kidney injury is frequent in intensive care and is associated to an increase in morbidity and mortality.

Aim: to describe and characterise the population of acute kidney injury inpatients in the Intensive Care Unit who have been treated with at least one renal replacement therapy.

Patients and methods: retrospective study of patients that required renal replacement therapy (n=63) admitted to the Unit between January 2004 and December 2007. Analysis of the variables of gender, age, diagnosis for admission, source, co-morbidity, severity scores upon admission (SAPS II, APACHE II), kidney functioning within the first 24 hours according to the RIFLE criteria, the type of renal replacement therapy and its impact on mortality. These results were compared with those of the population in the same Unit who did not undergo renal replacement therapy.

Results: the severity scores were APACHE II 20±6.7 and SAPS II 55±16. 7. The average hospital stay was 10 days, significantly higher than the average hospital stay of the non-renal replacement therapy group (10 days *vs*. 3 days, p<0.001).

In the first 24 hours, 71% of the patients presented acute kidney injury in the RIFLE failure category. The mortality in patients submitted to renal replacement therapy in ICU was 30%, significantly higher than the patients who did not require it (30.2 *vs*. 23%, p=0.04). Hospital mortality of this group was also superior (44% *vs*. 30.2%, p=0.036). There was a positive correlation between severity scores and mortality.

Conclusion: in our Unit acute kidney injury requiring renal replacement therapy has a similar incidence to that seen in the literature, and these patients have a worse prognosis, with longer hospital stay and higher mortality.

Key-Words:
Acute kidney injury; renal replacement therapy; intensive care.

INTRODUCTION

Acute kidney failure is frequent in Intensive Care Units (5-20% of the patients) and is associated to an increase in morbidity and mortality[1,2]. Although acute kidney failure is classically defined as a rapid decrease (hours and/or days) of the glomerular filtration rate, this concept is not unanimous. Thus, the RIFLE system was consensually proposed to classify patients into three different categories of severity (risk, injury and failure) and two of outcome (loss: renal replacement therapy >4 weeks and end-stage

renal disease). Further to this, the system suggests the term acute kidney injury instead of acute kidney failure[1]. Since then, data suggesting that smaller changes in serum creatinine than considered in the RIFLE criteria might be associated with adverse outcomes have emerged, with the AKI criteria proposed as the staging system[3].

In Intensive Care Units, approximately 70% of the patients with acute kidney injury need renal replacement therapy (RRT)[1,2]. Sepsis is its main cause and kidney dysfunction arises most of the times as part of multi-organ dysfunction syndrome[4]. Despite the advances in renal replacement therapy, the mortality associated to acute kidney injury in this population continues to be high, exceeding 50%[5,6].

The Pedro Hispano Hospital Intensive Care Department (ICD), created in 2004, is made up of a medical unit and a surgical unit, with a total of 14 beds. It works in collaboration with the Nephrology service and has nurses specialised in RRT.

At the ICU, the following renal replacement therapies are available and used regularly: continuous therapy – continuous venovenous haemofiltration (CVVHF), continuous venovenous haemodiafiltration (CVVHDF), SLED (sustained low-efficiency dialysis) and intermittent haemodialysis.

PATIENTS AND METHODS

We performed a retrospective study of the patients admitted to the Intensive Care Unit who required RRT, in the period January 2004 – December 2007 and the following variables were analysed: gender, age, diagnosis for admission, provenance, co-morbidities (diabetes mellitus, oncologic illness, chronic kidney disease, previous dependence on haemodialysis), severity scores on admission (SAPS II, APACHE II) and kidney function. The existence of acute kidney injury was determined in the first 24 hours according to the RIFLE criteria, using the urinary output and/or decrease of GFR in relation to the base value (using the worst of the two values). The type of RRT was also analysed (CVVHF, CVVHDF or HD/SLED), the length of hospital stay, mortality in the ICU and hospital and the dependence on kidney replacement therapy at 6 months.

The impact of these variables on mortality was determined. These results were also compared with the remaining population of the ICD.

We aimed to characterise the population with acute kidney injury that underwent at least one renal replacement therapy, evaluate the prognostic factors and the mortality, and compare these results with the remaining population of the ICD.

RESULTS

Between January 2004 and December 2007, 732 patients were admitted. Sixty three patients required RRT (8.6%). Of these, 26 (41%) belonged to the surgical unit and 37 (59%) to the medical unit. 37% were female and 63% male. The average age was 62±13.5 years. The majority of the patients were from the Intermediate Care Unit (29%) and the Emergency Room (24%). The main cause of admission was septic shock (52%) and the main source of infection was abdominal (47%) (Table I).

32% of the patients (n=20) had diabetes mellitus, 21% had neoplasic illness (n=13) and 29% had chronic kidney disease (n=18). Eight patients of the last group were enrolled in chronic haemodialysis (5%).

The degrees of severity were APACHE II 20±6.7 and SAPS II 55±16.7. The number of organs in failure was, on average, three.

Table I

Diagnosis for hospitalisation

Diagnosis	n	%
Septic shock:	**33**	**52**
Abdominal infection	16	47
Respiratory infection	9	27
Urinary tract infection	3	10
Coetaneous infection	2	6
other infection	3	10
Respiratory failure	**9**	**15**
Cardiogenic shock	**5**	**8**
Cardiorespiratory arrest	**4**	**6**
Post Surgery	**3**	**5**
Hypovolaemic shock	**2**	**3**
Acute pancreatitis	**2**	**3**
Others	**5**	**8**
Total	**63**	**100**

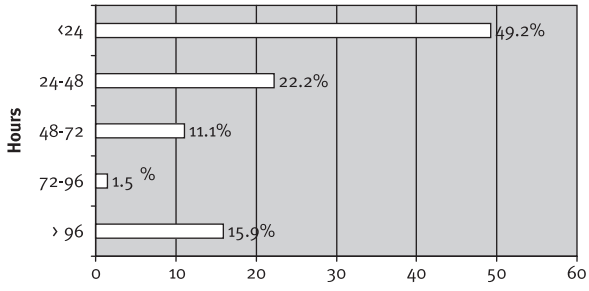

Figure 1

Time until initiation of renal replacement technique.

In the first 24h, 71% of the patients had acute kidney injury in the RIFLE category failure. 13% were in the risk category and 13% had criteria of injury. Only 3% did not have acute kidney injury according to the RIFLE criteria.

In 49% of the patients the renal replacement therapy was started in the first 24h of hospital stay in the ICU and in 22% of the cases between 24 and 48h (Fig.1). The creatinine and urea mean levels at the starting point of kidney replacement were 3.3±1.6 and 142±59.4 mg/dl, respectively.

HFVVC was performed in 54% of the patients, SLED/HD in 46% and HDFVVC in 30%. On average, the patients underwent renal replacement therapy for 4 days, required mechanical ventilation for 6 and needed vasopressor and inotropic support for 4 days.

The average length of hospital stay was 10 days and significantly higher than the average in the Unit of the group of patients without RRT (10 days *vs.* 3 days, p ‹0.001).

The mortality in patients who underwent RRT in the ICU was 30% (n=19).

The severity score SAPS II of the patients who required RRT was significantly higher than the patients that did not; 55 *vs.* 42 (p‹0.001).

Mortality in the surgical unit was 27% and mortality in the medical unit was 32% (p=0.63).

The main cause of mortality was septic shock (Fig. 2).

The severity score (APACHE II and SPAPS II) and serum creatinine at RRT initiation were statistically related with mortality of the patients who required RRT (Table II).

When analysing the timing of initiation of RRT, there was no statistically significant difference when considering starting according to an early (BUN ‹67.3 mg/dl) or late (BUN≥67.3 mg/dl) strategy, nor before or after 24 hours of admission (table IV). No other variables were found to have association with mortality.

In our study, we found that the patients with acute kidney injury requiring RRT had higher mortal-

Table II

Characterisation of patients according to outcomes

	Deceased patients (n=19)	Surviving patients (n=44)	*p*
Age (years)	61.4 ± 14	64 ± 12	0.5
Time of hospitalisation before ICU (days)	11.7 ± 48	17.5 ± 62	0.7
Time to initiation of RRT (days)	1.6 ± 2.5	1.8 ± 3.2	0.9
Serum Creatinine at RRT initiation (mg/dl)	5 ± 3	3.3 ± 1.6	0.03
APACHE II	22.7 ± 6	18.7 ± 7	0.03
SAPS	65.8 ± 16	50.7 ± 15	0.001
Days on RRT	8.4 ± 12	7.1 ± 10	0.7
Time on mechanical ventilation (days)	12 ± 14	15.4 ± 19	0.5
Time on vasopressor support (days)	6.4 ± 7	10 ± 10	0.1
ICU stay (days)	17.9 ± 2.8	16.2 ± 4.6	0.7
Hospital stay (days)	18 ± 19	16 ± 20	0.8

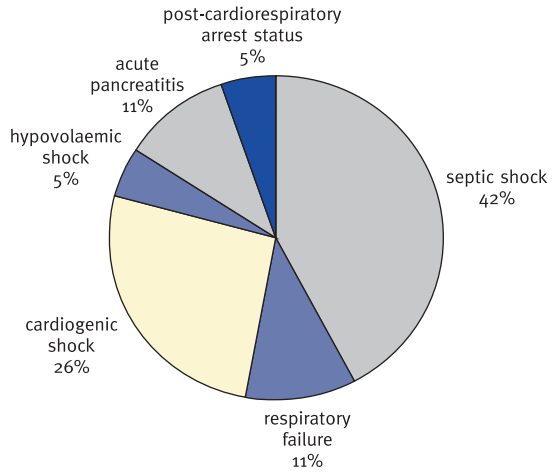

Figure 2

Causes of death.

Table III

Variables' impact on outcomes

	ICU mortality (%)	P*
Gender: female *vs.* male	22 *vs.* 35	0.37
SCIM *vs.* SCIC (n=37 *vs.* n=26)	32 *vs.* 27	0.78
Chronic renal failure (Yes n=18 *vs.* No n=45)	21 *vs.* 32	0.46
Diabetes Mellitus (Yes n=20 *vs.* No n=43)	30 *vs.* 31	0.6
Neoplasic illness (Yes n=13 *vs.* No n=50)	31 *vs.* 30	0.6
Sepsis (Yes n=48 *vs.* No n=15)	29 *vs.* 33	0.5
Respiratory failure (Yes n= 9 *vs.* No n=54)	30 *vs.* 33	0.5
Cardiogenic shock (Yes n=5 *vs.* No n=58)	50 *vs.* 30	0.52
BUN at initiation of dialysis (median 67,3±mg/dl) ‹67.3 *vs.* ≥67.3	28 *vs.*. 32	0.46
Initiation of RRT after admission ‹24 *vs.* ≥24 hours	23 *vs.* 33	0.18

ity in the ICU when compared with the other patients of department (30% *vs.* 23%, p=0.04). Hospital mortality of these group was also superior (44% *vs.* 30.2%, p=0.036).

The percentage of patients who 6 months after being discharged were dependent on RRT was approximately 18% (n=8). Importantly, seven patients were dependent on haemodialysis prior to ICU admission. The other patient had previous normal renal function.

DISCUSSION

In our ICU, 8.6% of the hospitalised patients had acute kidney injury requiring RRT during the period studied. This incidence is higher than that described in some studies (3.4 to 6%)[5,8,9].

As described in the literature, septic shock was the main cause. The patients had multi-organ failure (on average, 3 organs).

In almost half of the cases RRT was started in the first 24 hours, data that agree with other observational studies showing that this therapy was consistently initiated within a median of one day after ICU admission[10].

Acute kidney injury is accepted as an independent prognostic factor in the critically ill patient[12,13]. In our study, we found that the patients with acute kidney injury requiring RRT were hospitalised for a longer period of time and had higher mortality in the ICU than the rest of the patients.

Patients submitted to RRT had higher hospital mortality as expected and shown in the literature where critical patients with acute kidney injury requiring RRT presented hospital mortality of 50 to 70%[1,9,11].

Our ICU provides CVVH, CVVHDF, SLED and intermittent haemodialysis. Heparin or low molecular weight heparin was predominantly used. Only after in 2008 was the technique of continuous haemodialysis for extra-corporal anticoagulation with citrate[17] implemented, the reason we do not have sufficient data yet to evaluate this technique.

Some authors defend that continuous RRT techniques are superior to intermittent haemodialysis in patients who are haemodynamically unstable. However, prospective and randomised studies did not prove this[3,5,14]. Two meta-analysis

were recently published which compared the two types and no difference was found in survival[15,16]. The Hemodiafe study did not show any differences in mortality between patients treated with CVVHDF or intermittent haemodialysis[18]. The ATN study, recently published, demonstrated that intensive renal support in critically ill patients with acute kidney injury did not decrease mortality or improve recovery of renal function when compared with less-intensive therapy involving intermittent haemodialysis three times per week and continuous RRT at lower dose (20 ml/kg/hour)[19]. One of the disadvantages of continuous techniques and SLED is the coagulation of the extra-corporal circuit, compromising the clearance of the solutes, maintenance of the hydroelectrolitic balance, acid-base and volume control[2].

At the ICU the technique most frequently used was HFVVC (54% of the patients) followed by HD or SLED (46%) and less often HDFVVC (30.1%). In the initial phase when the hospitalised patients frequently have haemodynamic instability, requiring a large volume of fluids and vasopressor support, the continuous techniques, particularly HFVVC but also HDFVVC and continuous haemodialysis, are initially used. In a subsequent phase, we turn to SLED, given that the ICU has a water treatment system, regular support from Nephrology and nurses with training in dialytic techniques. This technique has the advantage of being more economical and allowing the patient more freedom to follow procedures outside the Unit.

Published studies refer to an important percentage of these patients recovering kidney function, although approximately 5 to 10% need regular haemodialysis after hospital discharge[9].

In our population, all but one patient dependent on regular haemodialysis at 6 months after discharge were previously dependent on haemodialysis.

Our study has some limitations: the reduced sample sizes, the heterogeneous population (surgical and medical patients), the fact that it is an observational study, and the fact that it involves a long period of time (4 years), during which some classifications and techniques were modified.

CONCLUSIONS

In our Intensive Care Unit, acute kidney injury requiring RRT is common and is associated to a worse prognosis, with longer hospital stay and mortality. Septic shock and multi-organ dysfunction are the main cause.

Diverse RRT techniques are used in the ICU (continuous techniques, SLED and intermittent haemodialysis). In the group studied, early initiation of RRT seemingly did not contribute to a better prognosis than late initiation.

Conflict of interest statement. None declared.

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