

## Original Article

## Continuous Renal Replacement Therapy for Acute Renal Failure in Critically Ill Patients and Early Predictive Factors

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### Abstract

**Background.** Acute renal failure (ARF) requiring renal replacement therapy (RRT) in critically ill patients is associated with high mortality and continuous renal replacement therapy (CRRT) is one of modalities to treat it. The aim of this study was to investigate the efficacy of CRRT, the outcome and early predictive factors of patients with Multiple Organ Dysfunction Syndrome (MODS) and ARF treated with CRRT.

**Methods.** This study was a prospective observational study conducted between October 05 and March 06. We collected data on all patients admitted in the cardiovascular ICU, Umberto I Hospital, “La Sapienza” University who developed ARF after cardiovascular interventions and were treated with CRRT. In addition to demographics, we collected: severity of illness (APACHE II), severity of illness (SOFA score), 24-48 hour from the start of CRRT treatment. Clinical outcomes assessed were, mortality, recovery of renal function, cardiovascular stability, complications of therapy, hemodynamic instability. We analysed the presence of Coma (GCS<8), vasopressor support, mechanical ventilation, oliguria, sepsis and jaundice as prognostic factors.

**Results.** During this period 30 (24 M, 6 F) patients underwent CRRT (CVVH, CVVHD, CVVHDF) for acute renal failure (ARF) after coronary artery bypass (46.6%), dissecting aortic aneurysm (30%), valvular surgery (6.7%), combined operations (6.7%), other (10%). The mean patient age was 64.6±11.8 years. 19 (63.3%) patients had oliguric ARF, vasopressor support occurred in 86.7% of patients and mechanical ventilation in 93.3%. At the time of start CRRT mean arterial pressure was 74.5±17.2 mmHg, BUN 93.6±40 mg/dl, serum creatinine concentration 5.5±2mg/dl, SOFA score 13.6±2.9, APACHE II score 31.7±6.6. Average length of treatment was 14.2±14.3 days (range 2-56). After 48 h of CRRT we had BUN decreased below 50 mg/dl, and a good control of fluid and electrolyte balance, and acid base homeostasis. There was no complication of therapy. 11 patients (36.7%) survived, 19 (63.3%) died. Recovery of renal function as possibility to interrupt RRT was in 53.3% of patients (100% survivors, 35.7% non surviving patients). There was no significant difference in mean age, BUN, serum creatinine concentration, APACHE II score at the start of CRRT between those who survived and those who died. It was a significant difference in mean SOFA score between the two

groups (12.1±2.5 vs 14.5±2.9; p=0.027). Univariate analysis (X<sup>2</sup> test) showed as important factors associated with mortality the presence of Coma (survival rate 13.3% vs 60%; p=0.008) and Oliguria at the time of initiation CRRT (survival rate 21% vs 63.6%; p<0.02).

**Conclusion.** We concluded that CRRT was found to improve hemodynamic and cardiovascular stability with a good fluid and electrolyte balance and control of biochemical status, increased nutritional intake. The presence of Coma and oliguric ARF, the higher SOFA score, were found to be the most important predictive factors.

**Keywords:** acute renal failure, APACHE II score, critically ill patients, continuous renal replacement therapy, early predictive factors, SOFA score.

### Introduction

Acute renal failure (ARF) requiring renal replacement therapy (RRT) in critically ill patients is associated with high mortality and continuous renal replacement therapy (CRRT) is one of modalities to treat it. When used in critically ill patients, intermittent hemodialysis may induce circulatory compromise. Even if tolerated hemodynamically, acute intermittent hemodialysis may not achieve adequate ultrafiltration or solute clearance [1]. CRRT are widely adopted in the treatment of severe ARF in an intensive care unit (ICU) setting [2]. In 1977 Peter Kramer applied continuous arteriovenous Hemofiltration (CAVH) for the management of refractory edema [3]. The types of techniques used vary according to vascular access (arteriovenous or venovenous) and the modalities (diffusion, conection or both) used [1]. Continuous venovenous hemofiltration (CVVHF), Continuous venovenous hemodialysis (CVVHD), Continuous venovenous hemodiafiltration (CVVHDF) are the favored techniques. Several studies suggested an improvement in outcome in critically ill patients treated with continuous forms of renal replacement [4,5], however, the only randomized, prospective trial failed to show a survival benefit [6]. Mortality in critically ill patients with ARF ranges from 28-90% [7,8]. Despite significant advances in supportive care, this lack of improvement in outcome may reflect the current trend for more aggressive surgical and medical intervention in the aging population, and an increase in ARF complicating Multiple Organ Dysfunction Syndrome (MODS) [9]. The presence of the following

clinical conditions has been related to a worse outcome in ARF patients: mechanical ventilation [10], low perfusion status [10,11,12], sepsis [10,11,12], jaundice [10], coma [10], oliguria [10,11,12,8]. Several scoring systems for assessment of organ dysfunction and morbidity have been used on ARF patients in ICU. The ICU prognostic score APACHE II was developed in a population of 5030 ICU patients treated in the United States and published in 1985 [13]. The SOFA score is a simple, but effective method to describe organ dysfunction/failure in critically ill patients [14]. The aim of this study was to investigate the efficacy of CRRT, the outcome and early predictive factors of patients with MODS and ARF treated with CRRT.

**Patients and methods**

This study was a prospective observational study conducted between October 05 and March 06. We collected data on all patients admitted in the cardiovascular ICU, Umberto I Hospital, “La Sapienza” University, Roma, who developed ARF after cardiovascular interventions and were treated with CRRT. In addition to demographics, we collected: severity of illness (APACHE II), severity of illness (SOFA score), 24-48 hour from the start of CRRT treatment. Clinical outcomes assessed were, mortality, recovery of renal function, cardiovascular stability, complications of therapy, hemodynamic instability. We analysed the presence of Coma (GCS<8), vasopressor support, mechanical ventilation, oliguria, sepsis, and jaundice as prognostic factors.

CVVH, CVVHD or CVVHDF were performed using either the Prisma or Prismaflex System (Hospal SpA, Bologna, Italia). Vascular access was by cannulation of the internal jugular or the femoral vein with a double lumen catheter. Acrylonitrile sodium metallylsulfonate (AN69HF) hemofilters combined with the Prisma tubing set were used. Blood flow was kept between 100 and 150 mL/min. Commercially available bicarbonate-buffered solution (HCO<sub>3</sub> 30 mEq/L) was used as dialysate (CVVHD) and/or replacement fluid (post-dilution CVVHDF or CVVH). Dialysate flow rate and/or replacement fluid infusion rate were modified to maintain blood urea nitrogen (BUN) <50 mg/dL. The conventional systemic anticoagulation heparin protocol (2000 IU bolus + infusion 5-10 IU/kg/hr) applied only to patients with no bleeding problems.

Data are reported as mean ± standard deviation (m ± SD). Student’s t-test and chi-squared tests were used where appropriate.

**Results**

During this period 30 (24 M, 6 F) patients underwent CRRT for acute renal failure after coronary artery bypass (46.6%), dissecting aortic aneurysm (30%), valvular surgery (6.7%), combined operations (6.7%), other (10%). The characteristics of patients at the start of CRRT are given in table 1. Average length of treatment was 14.2±14.3 days (range 2-56). After 48 h of CRRT we had BUN decreased below 50 mg/dl, and a good control of fluid and electrolyte balance, and acid base homeostasis. There was no complication of therapy. 11 patients (36.7%) survived, 19 (63.3%) died. Recovery of renal function as possibility to interrupt RRT was in 53.3% of patients (100% survivors, 35.7% non surviving patients). There was no significant difference in mean age, BUN,

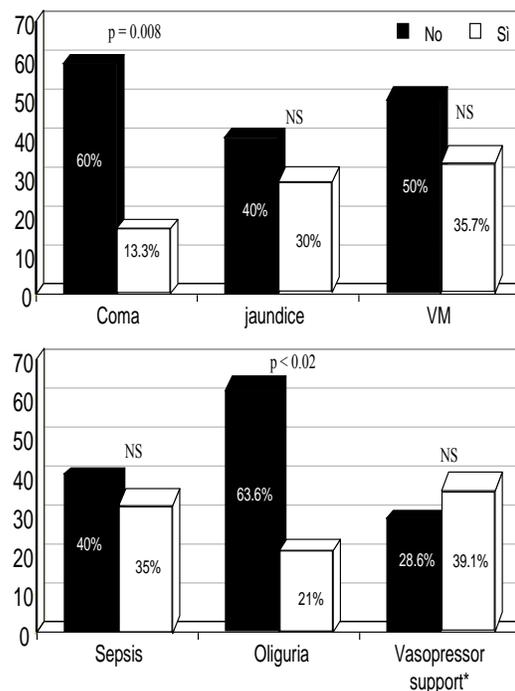
serum creatinine concentration, APACHE II score at the start of CRRT between those who survived and those who died. It was a significant difference in mean SOFA score between the two groups (12.1±2.5 vs 14.5±2.9; p=0.027) (Table 2). Univariate analysis (X<sup>2</sup> test) showed as important factors associated with mortality the presence of Coma (survival rate 13.3% vs 60%; p=0.008) and Oliguria (survival rate 21% vs 63.6%; p<0.02) at the time of initiation CRRT (Figure 1).

**Table 1.** The characteristics of patients at the start of CRRT

Age (m±SD)	64.6 ± 11.8 (range 35-78)
Oliguric ARF	19 (63.3%)
BUN (m±SD)	93.6 ± 40 mg/dl
Serum Creatinine (m±SD)	5.5 ± 2 mg/dl
MAP (m±SD)	74.5 ± 17.2 mmHg
Mechanical Ventilation	93.3%
Vasopressor Support	86.7%
TPN	100%
SOFA score (m±SD)	13.6 ± 2.9 (range 8-19)
APACHE II score (m±SD)	31.7 ± 6.6 (range 19-40)

**Table 2.** Statistical analysis of some parameters at the start of CRRT

	Survivors	Non Surviving	
Age	68.1 ± 11.5	62.6 ± 11.1	p = ns
BUN (mg/dl)	90.4 ± 32.4	99.3 ± 44.3	p = ns
Serum Creatinine (mg/dl)	5.3 ± 2.1	5.6 ± 2	p = ns
APACHE II score	29.6 ± 5.6	32.8 ± 6.9	p = ns
SOFA score	12.1 ± 2.5	14.5 ± 2.9	p = 0.027



butamin ≥ 3 µg/Kg/min

**Fig. 1.** CRRT in patients with ARF and MODS. Predictive factors and survival rate

## Conclusions

Many critically ill patients with ARF severe enough to require RRT are hypercatabolic and hemodynamically unstable. They frequently have large obligate fluid requirements owing to intravenous medication administration and parenteral alimentation. CRRT is shown to reduce significantly the incidence of complications commonly observed with intermittent HD in critically ill ARF patients [2]. This study showed once again the important advantages that CRRT provided when used in this patients: Hemodynamic stability, slow and steady urea removal, good control of electrolyte balance and acid base homeostasis, gradual fluid removal and unrestricted infusion of parenteral nutrition and drugs. The survival benefit of continuous therapy was not aim of this study. For that purpose a control group will be provided maybe in other studies. Acute renal failure requiring renal replacement therapy in critically ill patients is associated with high mortality till 90% [7]. The presence of one of the following clinical conditions in ARF patients: mechanical ventilation, low perfusion status, sepsis, jaundice, coma, is associated with a mortality of about 70% to 80%. A wide agreement has been established; the higher the number of organs in failure, the higher the mortality. This high mortality rate found in our study (63.3%) is comparable to other studies [12,5,8]. In our study the presence of Coma (survival rate 13.3%) and Oliguria (survival rate 21%) (Figure 1), were found to be the most important predictive factors. Coma [10] and oliguria [10,11,12] as risk factors associated with high mortality have been reported in other studies. Among the general ICU scores, APACHE II is the one that is used worldwide in the ARF setting [15]. Although the information referring to the use of SOFA score in ARF is scarce some studies using SOFA seem hopeful [16,11]. Our study demonstrated that SOFA score is a better prognostic estimator for ARF than APACHE II score.

Accurate scoring systems are needed to stratify patients enrolled in clinical trials and also to allow physicians to make informed treatment decisions.

*Conflict of interest statement.* None declared.

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