Journal of Critical Care (2013) **28**, 379–388

ELSEVIER

Journal of Critical Care

Urine output is associated with prognosis in patients with acute kidney injury requiring continuous renal replacement therapy

Hyung Jung Oh MD, Dong Ho Shin MD, Mi Jung Lee MD, Kwang Il Ko MD, Chan Ho Kim MD, Hyang Mo Koo MD, Fa Mee Doh MD, Young Eun Kwon MD, Yung Ly Kim MD, Ki Heon Nam MD, Kyoung Sook Park MD, Seong Yeong An MD, Jung Tak Park MD, Seung Hyeok Han MD, PhD, Tae-Hyun Yoo MD, PhD, Shin-Wook Kang MD, PhD*

Department of Internal Medicine, College of Medicine, Brain Korea 21, Severance Biomedical Science Institute, Yonsei University, Seoul, Korea

Keywords:
Acute kidney injury;
Continuous renal replacement therapy;
28-Day mortality;
Urine output;
Blood urea nitrogen

Abstract

Purpose: Although some studies have found that early initiation of continuous renal replacement therapy (CRRT) is associated with better prognosis, no consensus exists on the best timing to start CRRT. We investigated whether the timing of CRRT initiation was relevant to overall mortality and explored which factors at the time of CRRT initiation were associated with better outcomes in critically ill patients with acute kidney injury (AKI).

Materials and Methods: A total of 361 patients who received CRRT for AKI between 2009 and 2011 were collected and divided into 2 groups based on the median blood urea nitrogen (BUN) levels or 6-hour urine output immediately before CRRT was started. The impact of the timing of CRRT initiation stratified by BUN concentration or urine output on 28-day all-cause mortality was compared between groups.

Results: When the timing of CRRT initiation was stratified by 6-hour urine output, 28-day all-cause mortality rates were significantly lower in the nonoliguric group compared with the oliguric group ($P = .02$). In contrast, clinical outcomes were not different between the low-BUN and the high-BUN groups ($P = .30$). Cox regression analysis revealed that 28-day all-cause mortality risk was significantly lower in the nonoliguric group stratified by 6-hour urine output, even after adjusting for age, sex, mean arterial pressure, Acute Physiology and Chronic Health Evaluation II and Sequential Organ Failure Assessment scores, and serum biomarkers (hazard ratio, 0.85; 95% confidence interval, 0.65-0.99; $P = .04$).

Conclusions: Urine output but not BUN concentration was significantly associated with a better prognosis in critically ill patients with AKI requiring CRRT.

* Corresponding author. Department of Internal Medicine, College of Medicine, Yonsei University, Seodaemoon-Gu, Seoul 120-752, Korea. Tel.: +82 2 2228 1959; fax: +82 2 393 6884.

E-mail address: kswkidney@yuhs.ac (S.-W. Kang).

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http://dx.doi.org/10.1016/j.jcrc.2012.11.019

1. Introduction

Severe acute kidney injury (AKI) is a well-recognized complication in critically ill patients and has a substantial impact on morbidity, mortality, and health resource use in these patients [1–6]. In the past, conservative treatment such as fluid and hemodynamic optimization was provided only for critically ill patients with severe AKI [7]. For more than a decade, however, continuous renal replacement therapy (CRRT) has been an integral part of critical care and is considered an established treatment modality for patients with AKI [8,9].

Despite remarkable improvements in critical care and dialysis technology, AKI is still associated with high mortality rates [2,10–13]. To date, numerous studies have demonstrated the influence of CRRT practice patterns on patient outcomes, including in critically ill patients with severe AKI. In particular, some observational studies have found that early initiation of CRRT is associated with a better prognosis in patients with AKI [14], possibly because of early control of uremia, acid-base and electrolyte imbalance, and volume status [15,16]. Despite a large number of studies on CRRT in critically ill patients with AKI, the impact of CRRT practice patterns on outcomes has not been explored in Korean critically ill patients with severe AKI.

In this study, therefore, we evaluated whether the timing of CRRT initiation was relevant to mortality in patients who were treated in the intensive care unit (ICU) with CRRT for severe AKI. In addition, the associations between different physiological, metabolic, and comorbid factors at the time of CRRT initiation and subsequent outcomes were determined.

2. Subjects and methods

2.1. Patients

A total of 563 ICU patients who received CRRT for severe AKI between September 2009 and February 2011 were initially analyzed. We excluded 202 patients because they died within the first 24 hours of CRRT, were younger than 18 years, were on chronic dialysis, or were diagnosed as having terminal malignancy, which was considered having less than 3-month life expectancy. The data of 361 patients were analyzed (Fig. 1).

2.2. Data collection

Patient data were retrieved from the CRRT Database of Yonsei University Health System, Seoul, Korea. Demographic, clinical, and biochemical data at the time of admission to the ICU and CRRT initiation were recorded. For the assessment of disease severity, Sequential Organ Failure Assessment (SOFA) score, Acute Physiology and Chronic Health Evaluation (APACHE) II score, and

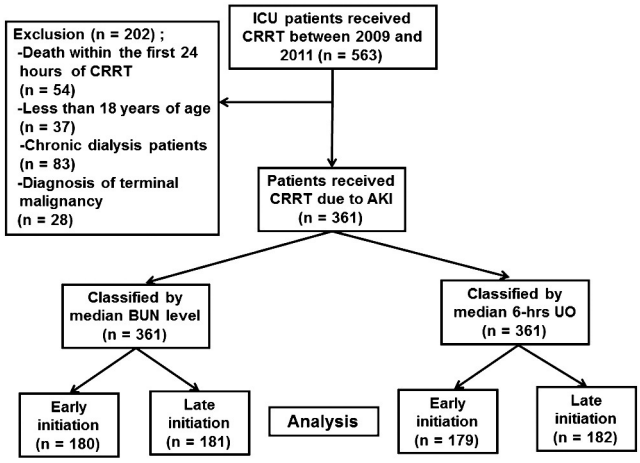

Fig. 1 Study selection diagram. From September 2009 to February 2011, 563 ICU patients who received CRRT were initially enrolled. In the final analysis, 361 patients were divided into 2 groups (early vs late CRRT initiation) based on the median BUN or 6-hour urine output and were compared between 2 groups. UO indicates urine output.

Charlson Comorbidity Index (CCI) were determined at the start of CRRT. Estimated glomerular filtration rate (eGFR) was calculated using the simplified Modification of Diet in Renal Disease equation.

The timing of CRRT initiation was assessed in 2 different ways. First, patients on CRRT were categorized into "low" and "high" groups based on serum biomarker values. Specifically, patients were divided according to the median level of blood urea nitrogen (BUN) at the time of CRRT initiation [14,17]. Second, we arbitrarily assessed 6-hour urine output before the start of CRRT and stratified patients based by median urine output.

All available intake and output data for 3 days immediately before CRRT initiation were retrieved from the medical records, and fluid balance was calculated. To quantify cumulative fluid balance in relation to body weight, the following formula was used: $\sum$daily {[fluid intake (L) − total output (L)]/body weight (kg)} × 100. *Baseline body weight* was defined as the body weight at the time of ICU admission. In addition, we used the term of *percentage of fluid accumulation* to define the percentage of cumulative fluid balance adjusted for body weight. *Fluid overload* was defined as a percentage of fluid accumulation greater than 10% [18,19]. Although the percentage of fluid accumulation was corrected for patient's body weight, the net fluid accumulation and urine output were not corrected for body weight.

2.3. Intensive care unit setting

The investigation site was a self-contained, 99-bed medical and surgical ICU in a 2076-bed teaching hospital in Seoul, Korea, equipped with 15 CRRT machines. The decision to start CRRT was made by the nephrologist in charge of the patient, and trained and educated nurses