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A comparison of preemptive versus standard renal replacement therapy for acute kidney injury after cardiac surgery



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ABSTRACT

Background: The optimal timing of renal replacement therapy (RRT) initiation in patients undergoing cardiac surgery remains controversial. This study aimed to determine whether preemptive RRT or standard RRT was associated with hospital mortality in cardiac surgical patients with acute kidney injury (AKI).

Methods: Data were retrospectively collected from patients who underwent cardiac surgery and experienced postoperative AKI requiring RRT at Zhongshan Hospital of Fudan University from September 1, 2006 to December 31, 2013. The patients were divided into two groups according to the RRT strategy applied.

Results: A total of 213 patients were enrolled in this study; 59 patients were categorized into the preemptive RRT group and 154 into the standard RRT group. The preemptive RRT group exhibited significantly lower mortality (33.90% versus 51.95%, $P = 0.018$) and time to recovery of renal function than the standard RRT group (15.34 ± 14.46 versus 22.88 ± 14.08 d, $P = 0.022$). Moreover, the preemptive RRT group showed significantly lower serum creatinine levels and higher proportions of recovery of renal function and weaning from RRT at death or discharge than the standard RRT group. There was no significant difference in the duration of mechanical ventilation, RRT, intensive care unit stay, or hospital stay between the two groups. **Conclusions:** In patients after cardiac surgery, preemptive RRT was associated with lower hospital mortality and faster and more frequent recovery of renal function than standard RRT. However, preemptive RRT did not affect other patient-centered outcomes including mechanical ventilation time, RRT time, or length of intensive care unit or hospital stay.

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Introduction

Acute kidney injury (AKI) is a common and serious complication with high morbidity and mortality in patients undergoing cardiac surgery. Approximately 18% of cardiac surgical patients experience AKI, and approximately 2%-6% require renal replacement therapy (RRT).¹ The effect of RRT timing in cardiac surgical patients has been reported in several studies, but, the optimal timing of RRT initiation remains controversial.²⁻⁴ A meta-analysis by Liu et al.⁵ revealed a beneficial effect of early initiation of RRT to critically ill patients with AKI after cardiac surgery; however, the paucity of randomized controlled trials included and the very high heterogeneity of RRT timing between studies in the meta-analysis precluded the establishment of definitive conclusions.

The definitions of “early” and “late” RRTs in previous studies of cardiac surgical patients were generally based on urine output, serum creatinine (SCr) levels, or blood urea nitrogen (BUN) levels.⁵ These conventional renal indicators could be easily affected by a patient’s hemodynamic state.^{6,7} However, studies examining the timing of RRT rarely carefully evaluated the hemodynamic status of patients experiencing AKI after cardiac surgery.^{2,8-11} Determining the optimal time of RRT initiation probably involves the assessment of not only renal indicators but also the systemic condition. For example, aggressive initiation of RRT in patients with hypovolemia was probably unnecessary given that these patients were likely to recover from this condition after fluid resuscitation.¹² Hence, the decision of whether to perform RRT according to urine output, SCr levels, or BUN levels alone could lead to excessive performance or delay of RRT.

In the present study, we aimed to determine whether preemptive RRT (in the absence of traditional indications of RRT) or standard RRT (in the presence of traditional indications of RRT) is associated with hospital mortality in cardiac surgical patients.

Materials and methods

Study population

This single-center, retrospective, observational study was performed in a cohort of adult patients who underwent cardiac surgery at Zhongshan Hospital of Fudan University from September 1, 2006 to December 31, 2013. This hospital, one of the largest centers for cardiovascular medicine in mainland China, performs more than 2000 cardiac surgery procedures per year. The mortality rates for cardiac surgery over the last decade maintained around 2%-2.5% in our center. In this retrospective cohort study, we reviewed the medical records of patients who received cardiac surgery during the aforementioned period. Adult patients who underwent cardiac surgery and experienced postoperative AKI requiring RRT in the intensive care unit (ICU) were enrolled in this study. AKI was diagnosed according to the Acute Kidney Injury Network (AKIN) classification.¹³ The exclusion criteria were as follows:

underwent heart transplantation, aged less than 18 y, underwent preoperative RRT, or died within 48 h after surgery.

Definitions

The estimated glomerular filtration rate (eGFR) was calculated using the Modification of Diet in Renal Disease study formula.¹⁴ Sepsis was defined as systemic inflammatory response syndrome in response to a confirmed infectious process.¹⁵ Neurologic dysfunction was defined as a Glasgow Coma Scale score < 9 points. Hypoxemia was defined as PaO₂/FiO₂ < 200 mm Hg. Postoperative hypotension was defined as systolic blood pressure < 90 mm Hg lasting more than 1 h or the use of at least two types of vasoactive drugs, such as noradrenaline, dopamine, vasopressin, and adrenaline. Weaning from RRT was defined as cessation of RRT for at least 30 d. Recovery of renal function was defined as freedom from dialysis and a SCr level <115 μmol/L. To quantify the cumulative fluid balance at the initiation of RRT, we used the following formula: (cumulative fluid intake [L] – total output [L])/body weight (kg) × 100%.^{16,17}

Indications for RRT and group selection

Before 2010, the decision to initiate RRT in patients after cardiac surgery in our ICU was principally based on the presence of one or more of the following traditional indications: refractory metabolic acidosis (pH < 7.2), urine output < 0.3 mL/kg/h for more than 24 h despite preload optimization, azotemia (SCr level >4 mg/dL), hyperkalemia > 6.0 mmol/L, and evidence of fluid overload (FO) with pulmonary edema. Because delaying RRT appeared to be associated with worse outcome, preemptive RRT was applied in our ICU beginning in 2010 to achieve a potential benefit from accelerated achievement of euvolemia, removal of inflammatory mediators, correction of electrolyte imbalance, and prevention of overt complications attributable to AKI. The preemptive indications for RRT were defined as follows: (1) AKI in absence of traditional indications for RRT; (2) persistence of hypotension (for more than 6 h) despite preload optimization; and (3) low probability of rapid renal recovery according to the judgment of the intensivists and nephrologists.

In this study, patients were retrospectively classified into two groups based on the RRT strategy applied.¹⁸ A flowchart of patient enrollment and group selection is shown in [Figure 1](#). Written informed consent was waived for this routine clinical practice in the ICU. This study was approved by the Ethics Committee of Zhongshan Hospital of Fudan University and was in compliance with the institutional requirements.

The modality of RRT

The type of RRT was prolonged intermittent RRT, which lasted approximately 8-16 h per session. The procedure was performed using a Baxter BM25 or Aquarius CRRT instrument. We used our hospital formula as a replacement fluid. Vascular access was attained by placing a dual-lumen hemodialysis catheter into the internal jugular or femoral vein using the

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