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Original Article

Etiology and outcomes of anuria in acute kidney injury: a single center study

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Abstract

Background: It was previously known that anuric acute kidney injury (AKI) is uncommon and its occurrence suggests complete ureteral obstruction, shock, or a major vascular event. As the epidemiology of AKI has significantly changed over the past decade, it is possible that the incidence, etiology, or clinical characteristics of anuric AKI have also changed.

Methods: A prospective cohort study was conducted that included all patients undergoing renal replacement therapy (RRT) for AKI during a 2-year period in a tertiary hospital. Patients were classified as having anuric, oliguric, or nonoliguric AKI based on their volume of urine when RRT started using the modified Acute Kidney Injury Network criteria.

Results: Of the 203 patients included in the study, 21.2% met the criteria for anuric AKI. Septic and postoperative AKI were the main causes of anuric AKI, with 60.5% of incidences occurring in hospital. Anuric AKI was associated with a younger age, a lower prevalence of pre-morbid chronic kidney disease and diabetes, more frequent continuous RRT requirement, and multi-organ dysfunction. In addition, patients with anuric AKI had a higher rate of in-hospital mortality and long-term dependence on RRT than patients with nonanuric AKI.

Conclusion: Anuric AKI is common, with sepsis as the main etiological insult, and is associated with adverse outcomes among patients with AKI who require RRT.

Introduction

Acute kidney injury (AKI) may be described clinically as oliguric, nonoliguric, or anuric [1,2]. These categories may help to identify the cause and predict the prognosis of each episode of AKI, which may aid in guiding the appropriate diagnostic and therapeutic strategies. Classically, anuric AKI has been reported to be uncommon and is associated with complete ureteral obstruction, shock, or a major vascular event such as bilateral renal artery occlusion and cortical necrosis [1].

The incidence of AKI has been increasing recently and significant changes have occurred in the epidemiology of AKI during the past decade [3]. Several factors, such as older patients and a higher burden of illness, including significant comorbidities, might contribute to the increased incidence of AKI. In addition, patients are now more likely to undergo invasive diagnostic testing and complex surgery or interventions. There is a possibility that the

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incidence and etiology of anuric AKI have also changed; anuric AKI has recently been more commonly encountered in clinical practice even in patients without shock. Nevertheless, information is limited regarding the epidemiology of anuric AKI, although a number of anecdotal case reports have been published.

The aim of this study was to examine the causes, characteristics, and outcomes of patients with anuric AKI and to compare these findings with those for patients with nonanuric AKI. As virtually all patients who are anuric for ≥ 24 hours receive emergency renal replacement therapy (RRT), we selected those patients with the most severe form of AKI – that is, those who required RRT stage 3 based on the Acute Kidney Injury Network (AKIN) criteria [4]—to obtain similar clinical levels of AKI severity in the patients with anuric and nonanuric AKI. We determined the epidemiology of patients with AKI who required dialysis, considering, in particular, the volume of urine at the time of initiation of RRT and the association between urine volume and outcomes, including mortality and long-term dependence on RRT.

Methods

Study population and design

Between March 2010 and February 2012, all adult patients who received RRT for AKI were entered into a prospective registry at the Korea University Anam Hospital, Seoul, Korea. We included patients from both the intensive care unit (ICU; medical, surgical, and cardiac units) and general wards. Emergency RRT encompassed intermittent hemodialysis (IHD) and continuous RRT (CRRT), with the ICU offering both IHD and CRRT. The decision to start RRT was made by the nephrologists at the hospital based on the patients' clinical condition. The study was approved by the Institutional Review Board of the university and written informed consent was obtained from all patients.

We excluded patients with pre-existing advanced chronic kidney disease (CKD)—that is, any evidence of CKD stage 4 or clinically evident end-stage renal disease—for the following reasons: (1) when patients with advanced CKD receive unplanned dialysis, it is often unclear whether this is a result of AKI in addition to CKD, or a rapid progression of their CKD; and (2) the wide range of patients with CKD could have confounding effects on the results. Patients with terminal cancer or those who died within 48 hours of the start of RRT were also excluded because they are commonly in the final stages of multiple organ dysfunction syndrome (MODS), which is fatal.

The etiology was determined by the nephrologists based on the clinical diagnosis. When more than one etiology contributed to the AKI, the main factor was considered for the analysis.

Data collection and definitions

Oliguric AKI was defined as a urine output of < 7.2 mL/kg in 24 hours or anuria for 12 hours using the modified AKIN criteria at the time of initiation of RRT (within 1 day prior to or after the day of acute dialysis). However, oliguric patients with AKI with a urine volume of < 50 mL/d were classified as having anuric AKI. Anuria that started several days after the initiation of RRT was not defined as anuric AKI.

The CKD status was determined by evaluating the available data and history for each patient. CKD was defined according to the National Kidney Foundation classification, including known glomerulopathy or structural abnormality with normal estimated glomerular filtration rate (eGFR) [5], where CKD(3) included only patients with CKD stage 3. Patients without previous data, but who had an eGFR ≥ 60 mL/min/1.73 m^2 during the follow-up period were considered to have no prior CKD.

Hepatorenal syndrome was defined according to the 2007 revised hepatorenal syndrome criteria, which include infection as the cause [6]. Cardiorenal syndrome (CRS) was indicated as the main factor in patients with type 1 CRS as defined by the Acute Dialysis Quality Initiative consensus [7]. Hypovolemia was determined as the cause of AKI in patients with massive bleeding (e.g., from obstetric or gastrointestinal causes) or evident dehydration. Hospital-acquired AKI (HA-AKI) was defined as AKI occurring during admission to hospital, whereas community-acquired AKI (CA-AKI) was defined as AKI developing outside the hospital setting. MODS was defined as a patient with at least two of the following criteria: hepatic failure, heart failure, respiratory failure, or coagulopathy (disseminated intravascular coagulation).

The outcomes assessed included in-hospital mortality, 90-day survival, and long-term dialysis dependence (RRT for > 3 months, class E based on the Risk Injury Failure Loss End-Stage outcome criteria).

Statistical analysis

SPSS software, version 14.0 (SPSS Inc., Chicago, IL, USA) was used for the statistical analysis. Data are presented as mean $\pm$ standard deviation values or as absolute numbers with percentages. Comparisons between groups were performed using the Student t test, one-way analysis of variance, the χ^2 test, or Fisher's exact test, as appropriate.

We identified the prognostic factors for the 90-day survival in a Cox proportional hazards model by calculating the crude and adjusted hazard ratios. Variables with $P < 0.05$ in the univariate analyses were assessed as independent predictors using the multivariate model by the forward conditional method. We used Kaplan–Meier curves to demonstrate the relationship between the urine volume and survival. A log-rank test was used to compare the differences in survival.

Results

Study cohort

RRT was performed in 304 patients during the study period and 203 patients were included in the study (Fig. 1). Of the 101 patients excluded from the final study, 64 patients died within 48 hours of the initiation of RRT and 11 patients had pre-existing advanced CKD.

Of the 203 patients included in the study, 43 (21.2%) had anuria at the initiation of RRT despite supportive care, including hydration and diuretic drugs. Fifty-seven patients (28.1%) and 103 patients (50.7%) met the criteria for oliguric and nonoliguric AKI, respectively. A diuretic challenge with furosemide was administered in all patients with anuria and oliguria. We monitored and recorded the patients' urine output throughout the course of the treatment.

Etiology of anuric AKI

Table 1 gives the causes of AKI among patients with anuric, oliguric, and nonoliguric AKI. Sepsis was the most common