ICU MANAGEMENT & PRACTICE

Oliguria And The Role Of Urine Monitoring In Renal Replacement Therapy (RRT) Management

ABSTRACT
Renal Replacement Therapy (RRT) is a complex treatment modality for a high-risk, critical care patient population with advanced AKI. While there are still no clear guidelines regarding the timing of initiation and termination of RRT, there is a growing body of evidence supporting the importance of urine monitoring and the clinical significance of oliguria for the execution of these treatment decisions.

RENAL REPLACEMENT THERAPY (RRT)

Over the past decade, renal replacement therapy (RRT) - including dialysis (hemodialysis or peritoneal), hemofiltration, and hemodiafiltration - has become an integral part of critical care and an established treatment modality for patients with severe AKI and multiple organ failures. It is also used for removing fluid in ICU patients with fluid overload [1].

To date, a number of studies have demonstrated that early initiation of CRRT is associated with a better prognosis in patients with AKI, possibly because of early control of uremia, acid-base and electrolyte imbalance, and volume status [2].

Nevertheless, whether or not to provide RRT, and when to start, are complex issues facing nephrologists and intensive-care practitioners in most cases of severe AKI. In recent publications, the timing of initiation of RRT was listed as one of the top priorities in research on AKI [3].

RRT: WHEN TO START, WHEN TO STOP

The timing of RRT initiation remains controversial due to the fact that there is a great deal of uncertainty regarding its risks vs. potential benefits. On the one hand, while early initiation of RRT may rapidly improve fluid and electrolyte status, correct acid–base homeostasis, and perhaps prevent subsequent complications of AKI, it may also unnecessarily expose patients to a myriad of potential complications and risks such as hemodynamic instability, infections, and reduced renal recovery. As a result, clinicians tend to delay RRT when they suspect that patients may recover on their own. On the other hand, delaying RRT when warranted can be associated with a high risk of fluid overload, uremic complications, and mortality [4, 5, 6]. As a result, there is considerable variation in practice among clinicians, and across institutions. Unfortunately, there are no clear practice guidelines.

There is also a lack of data regarding when to stop CRRT. Although it is accepted that RRT can be stopped when there is sufficient improvement in renal function, how this should be evaluated while the patient is still receiving RRT remains unclear [7].

An additional key factor to be considered when determining the optimal timing for RRT is cost. Correctly predicting when to initiate and discontinue RRT could result in significant cost savings to the ICU by preventing the multitude of complications the patient would otherwise likely sustain, as well as the treatment interventions s/he would require.

URINE OUTPUT AS A PROGNOSTIC TOOL FOR INITIATING RRT

There are several factors that might influence the decision when to start RRT. Early detection and accurate prediction of patients that ultimately will require RRT may facilitate earlier initiation in those who need it and prevent harm in those who do not [8]. In addition, understanding which clinical parameters predict poor outcomes could help guide decisions regarding which patients are not candidates for RRT.

A number of studies designed to identify clinical markers that can predict when to initiate and when not to initiate RRT have found urine output to have strong predictive value.

In a 2016 retrospective study of 939 septic shock patients with AKI who received CRRT in the intensive care unit (ICU), low urine output during the 24 h prior to CRRT initiation (<0.05 mL/kg/h), was a strong predictor of lower survival in KDIGO Stage 3 AKI [9].

In a 2015 retrospective observational study with 165 septic AKI patients on CRRT, decreased urine output (<30 mL/hour) during the first 24 hours was a strong predictor of mortality. Serum creatinine levels did not differ between the two groups, and did not predict survival [10].

In a 2013 study of 361 ICU patients with severe AKI, the investigators evaluated whether timing of CRRT initiation based on the last 6-hour urine output and BUN levels was associated with mortality. They found that, whereas no differences were seen in clinical outcomes between the low-BUN and the high-BUN groups, patient survival rates were significantly lower in patients with 6-hr urine output ≤107 mL immediately preceding initiation of RRT compared with non-oliguric patients. The authors concluded that continuous and careful monitoring of urine output might be more helpful than serial measurement of BUN levels to determine whether or not to commence CRRT in critically ill patients with severe AKI [11].

In a randomized controlled trial evaluating whether the early initiation of RRT improved mortality in patients with AKI, 28 patients who developed AKI after cardiac surgery were studied in two groups based on urine volume. The early-start group received RRT when urine volume was <30 mL/h for 3 h, and the conventional-start group waited to receive RRT until urine volume was <20 mL/h for 2 h. Early RRT significantly improved patient survival, leading the authors to conclude that the timing of RRT initiation in post-cardiac surgery patients with AKI should be determined by urine volume, not by SCr levels [12].

URINE OUTPUT AS A PROGNOSTIC TOOL FOR DISCONTINUING RRT

The KDIGO clinical practice guidelines for AKI recommend discontinuation of RRT when "it is no longer required, either because intrinsic kidney function has recovered to the point that it is adequate to meet patients' needs or because RRT is no longer consistent with the goals of care (no evidence level) [13]." The question remains, how to determine whether kidney function has recovered adequately.

Two major observational trials, both of which concluded that urinary output is the best predictive parameter for successful discontinuation of RRT, are widely cited in the literature.

The first, a retrospective, observational case control study in a 64-bed surgical ICU, was designed to identify the risk factors for successful discontinuation of intermittent RRT in 304 postoperative AKI patients. In this study, oliguria (urine output <100 mL/8 hours) was found to be a strong predictor ($p < .0001$) of successful discontinuation [14].

The second was a post hoc analysis of the BEST (Beginning and Ending Supportive Therapy for the Kidney) study, a multi-center, prospective observational study of 1,006 critically ill AKI patients treated with continuous RRT in 54 centers in 23 countries. The study analysis indicated that urine output was the most significant predictor of successful discontinuation among the 529 patients who survived, especially without the administration of diuretics. (Urine output in the 24 hrs before stopping CRRT: odds ratio, 1.078 per 100 mL/day, $p < .0001$; "urine output increased" as a reason to stop CRRT: odds ratio, 3.097, $p < 0.0001$). In terms of clinical practice, this means that if patients make 400 mL/day of urine without diuretics, they seem to have an 80% chance of successful discontinuation of CRRT. In this study, although creatinine concentration was also related to successful discontinuation of CRRT, its predictive value was low [15].

CONCLUSION

There is still a major gap in knowledge around the timing of RRT for the critically ill patient. Retrospective and prospective observational studies have demonstrated that urine output is among the strongest predictors of survival and an important parameter for determining the need to initiate and/or discontinue RRT. Further prospective studies are needed to confirm these findings and facilitate the development of RRT management guidelines.

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