Controversies in Clinical Nephrology: Optimizing renal replacement therapy deliverables through multidisciplinary work in the intensive care unit

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Introduction

Acute kidney injury (AKI) is a complex medical syndrome that carries high morbidity and mortality [1, 2, 3, 4] and has been associated with incident or progressive chronic kidney disease (CKD) [5, 6, 7], end-stage renal disease (ESRD) [8, 9], and nonrenal complications such as cardiovascular disease [10, 11, 12] and hypertension [13]. More than 5 million patients are admitted to hospital intensive care units (ICU) each year in the U.S., and ~ 2 – 10% of these patients suffer from AKI requiring renal replacement therapy (RRT) [3, 14]. Renal replacement therapy is frequently provided by nephrologists and/or intensivists to critically ill patients with AKI in the ICU. RRT is a supportive therapy that can potentially be life-saving when provided to the right patient at the right time; however, several questions related to RRT in AKI are still being studied. Among these questions, critical ones are related to the optimal timing of RRT initiation [15, 16]; the optimal strategy of RRT de-escalation; the examination of renal recovery [17]; and the value of high-volume hemofiltration [18, 19] and hemoadsorption [20, 21] to attenuate inflammation and alleviate immunosuppression in critical illness. Overall, there is a paucity of randomized interventional trials and standardized risk-stratification tools (integrating clinical, biomarker, imaging data) that can feasibly guide RRT management in critically ill patients. Furthermore, in the complex and challenging ICU environment, RRT is sometimes led by nephrologists as consultants and sometimes by intensivists who are also the primary team for ICU care.

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How to optimize RRT deliverables in the ICU?

Two essential elements to provide effective RRT to critically ill patients with AKI in the ICU are: 1) the multidisciplinary interplay among intensivists, nephrologists, pharmacists, nurses, nutritionists, and other key members of the acute-care team for personalized therapy (i.e., RRT candidacy, timing of RRT initiation, RRT goals for solute control, RRT goals for fluid removal/regulation, renal recovery evaluation, RRT de-escalation, etc.) and 2) the iterative assessment and adjustment of RRT goals according to the clinical status of the patient. Therefore, the vehicle for effective RRT in the ICU requires optimal channels of communication among all members of the acute-care team and the systematic monitoring of the clinical status of the patient and RRT-specific goals (prescribed and delivered). Several tools such as customized flowsheets in the electronic health record (EHR) and static and functional tests or point-of-care ultrasonography (POCUS) to assess hemodynamic status, heart function, and intravascular volume assessment can be employed for this purpose.

It is essential that the multidisciplinary team systematically navigates the process of RRT deliverables for standardization, problem identification, and improvement. During this journey, the development of quality metrics (i.e., dose, modality, anticoagulation, filter life, downtime, etc.) and effective quality management systems for assurance and control are critically important (Figure 1).

These are key RRT deliverables that could be potentially improved:

Timing of RRT initiation

In a setting of RRT-led by nephrologists, intensivists should consult with the nephrology team in a timely manner when evaluating patients with severe AKI (KDIGO stage

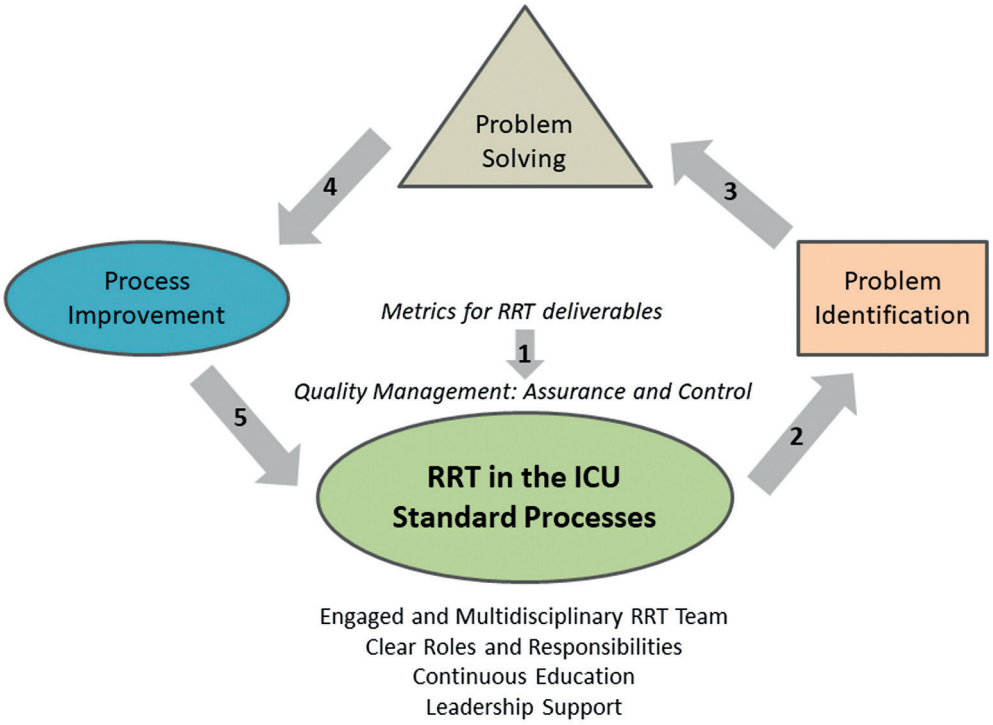

Figure 1. A multidisciplinary approach for the optimization of RRT deliverables in the ICU.

2 or 3), fluid overload (cumulative fluid balance expressed as a percent of body weight increment from baseline, cutoff of > 10% has been associated with increased mortality) [22, 23, 24], and/or patients who may be on the verge of needing RRT for solute control.

Adjustment of the RRT prescription and goals of therapy in the context of critical illness, fluid overload, and multiorgan failure

In a setting of RRT-led by nephrologists, nephrologists should effectively communicate with intensivists to discuss the clinical status of the patients, incorporating data on functional tests of hemodynamic status, heart function, and intravascular volume assessment. This effective communication and interaction may promote timely RRT prescription adjustments and dynamic modification of goals of therapy for solute and fluid control.

Assessment of renal recovery and effective RRT de-escalation

In a setting of RRT-led by intensivists, nephrologists should be consulted in a timely manner to assist in the systematic examination of renal recovery and guide the transition from continuous RRT to prolonged intermittent RRT or hemodialysis when necessary.

Risk stratification of recurrent AKI and incident or progressive CKD or de novo ESRD

Tools incorporating clinical data, kidney function/injury/recovery biomarkers, functional imaging studies, real-time glomerular filtration rate (GFR) estimation, and machine learning algorithms should be developed and validated for the clinical care of critically ill patients with AKI on RRT. Pragmatic and implementation research in this area is sorely needed.

Post-AKI outpatient care

Over the last few years, dedicated AKI Survivor Clinics have been implemented in some centers for both children and adults [25]. These AKI Clinics target follow-up of survivors who suffered from KDIGO stage 2 or 3 AKI, some of them requiring RRT and tailor individualized interventions for post-AKI complications such as preventing recurrent AKI or attenuating incident or progressive CKD. The value of this model of post-AKI care needs to be further investigated with emphasis not only on hard outcomes (i.e., CKD, ESRD, or death) but also on qualitative studies and patient-centered outcomes. Importantly, since January 2017, a change in legislation allows placement of AKI survivors requiring RRT in outpatient hemodialysis units, which constitutes a timely and needed change in practice. In this context, the AKI Clinics could potentially expand operations towards de-escalation of RRT and frequent examination of RRT need in those patients exhibiting early signs of renal recovery in the outpatient setting. Nephrologists should guide and orchestrate post-AKI outpatient care in survivors at high risk of renal and nonrenal complications [17, 27].

The future (or present) of RRT in the ICU

Over the last years, there has been substantial development in RRT to support critically ill patients. RRT devices have been improved to provide more sustainable and effective treatment, and the software for monitoring treatment has been constantly upgraded. In addition, integration of machine and patient data is now possible through different EHRs. Here we outline a few items that will be crucial for the future of RRT in the ICU.

Integration of machine and patient data in the EHR

Machine data are comprehensive and can provide critical information related to delivered therapy, duration of therapy, downtime, filter life, pressure alarms, malfunctioning alarms, fluid removal, etc. The integration of these data with patient data (i.e., patient characteristics at RRT initiation, fluid balance, access, organ failure status, etc.) is essential to monitor the clinical practice of RRT and feed the quality management system. The challenge is transforming data to information and knowledge that can effectively and sustainably guide therapy [28]. In this context, there are ongoing studies, such as *CRRTnet*, a prospective, multicenter observational study of critically ill patients with AKI undergoing CRRT [26], that aim to integrate patient, prescription, machine-generated, and outcome data and thereby identify variations in CRRT deliverables and validate quality metrics that can potentially impact patient-centered outcomes.

Development of a quality management system

Institutions that provide RRT to critically ill patients should have the ability to create a standardized protocol and surveillance metrics to monitor RRT deliverables. Importantly, engaged stakeholders with clear roles and responsibilities and adequate institutional support can promote innovative care and constant improvement in the clinical practice of RRT according to evolving technology and evidence-based developments.

POCUS for dynamic fluid management

Intensivists and nephrologists recognize the additive value of POCUS to extend the limited traditional physical exam in critically ill patients. POCUS can be an effective tool to examine hemodynamic status, heart function, and intravascular volume status (i.e., subaortic velocity time index, inferior vena cava collapsibility, lung ultrasound, etc.). However, there are remaining questions related to the standardization of bedside ultrasonography: Who should perform the test? How to effectively document the results? How can we incorporate these data into effective fluid management in patients receiving RRT?

In this section of *Controversies in Clinical Nephrology*, we invited a group of nephrologists and intensivists who are leaders in the field to provide their perspectives about the advantages and challenges of performing RRT in the ICU either as the consultant team (nephrologists) or the primary-care team (intensivists). All readers are invited to participate in these discussions by submitting a *Letter to the Editor* through the journal web page.

Conflict of interest

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