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WHAT'S NEW IN INTENSIVE CARE

Renal replacement therapy

Stéphane Gaudry[1,2,3], Nattachai Srisawat[4] and Michael Joannidis[5*]

Over the past two decades, the approach to renal replacement therapy (RRT) in critically ill patients has shifted markedly—from early, largely empirical practices toward more individualized, evidence-based strategies. Large randomized-controlled trials (RCTs) have demonstrated the safety of applying a watch-and-wait strategy in the absence of urgent complications, while technical advances and refined dosing recommendations have improved safety and efficiency. This evolution supports a patient-centered model of care, integrating clinical judgment, therapeutic goals, and available resources to guide initiation, modality choice, and discontinuation of RRT. This article presents the key elements of the current standard of care for RRT in the intensive care setting. Figure 1 summarizes these elements (anticoagulation strategies and vascular access considerations are addressed in the figure but not discussed in the main text).

Initiation and timing

The optimal initiation of RRT during acute kidney injury (AKI) is guided primarily by clinical indications rather than a predefined timing. Four urgent indications necessitate immediate RRT to treat life-threatening complications: severe hyperkalemia unresponsive to standard medical treatment, severe metabolic acidosis not correctable by bicarbonate infusion (or by ventilatory compensation), refractory fluid overload unresponsive to diuretics leading to pulmonary edema, and specific uremic complications, such as encephalopathy or pericarditis. In the absence of these emergencies, a delayed RRT initiation strategy based on close clinical and biological monitoring should be preferred. Indeed, large RCTs (AKIKI [1], IDEAL-ICU [2], and STARRT-AKI [3]) have demonstrated that an early RRT initiation strategy (i.e., starting RRT before the occurrence of life-threatening complication) does not improve survival and may impair renal recovery. Notably, around 40% of patients managed with a delayed strategy never required RRT. However, excessive delays (more than 3 days of oligo-anuria or a serum urea concentration above 40 mmol/L) are associated with increased mortality, as highlighted in the AKIKI-2 study [4]. Therefore, the current standard of care supports a prudent, indication-driven initiation of RRT, balancing the need to avoid both unnecessary procedures and harmful delays. Personalized approaches are under investigation.

Modalities

Once the decision to initiate RRT is made, several modalities are available, including continuous RRT (CRRT), intermittent hemodialysis (IHD), hybrid techniques such as sustained low-efficiency dialysis (SLED) or prolonged intermittent RRT (PIRRT), or peritoneal dialysis in resource-limited settings. The optimal choice remains subject to ongoing debate. Current KDIGO guidelines recommend the use of CRRT in hemodynamically unstable patients due to its presumed better hemodynamic tolerance. Nonetheless, other expert groups emphasize that local expertise, staff training, and resource availability should primarily guide modality selection. While CRRT provides gradual solute and fluid removal, RCTs [5] and meta-analyses [6] have not shown a consistent survival benefit or improved renal recovery compared to IHD. A secondary analysis of the STARRT-AKI trial [7] suggested that CRRT may be associated with a reduced risk of death or dialysis dependence at 90 days (adjusted OR 0.81; 95% CI 0.66–0.99) which was more pronounced in patients with accelerated initiation of RRT. Similarly, a large claims-based cohort study involving over 34,000 patients found lower RRT dependency at hospital discharge among those treated with CRRT versus IHD (26.5% vs. 29.9%, $p < 0.0001$) [8]. In contrast, a secondary

*Correspondence: michael.joannidis@i-med.ac.at
[5] Division of Intensive Care and Emergency Medicine, Department of Internal Medicine, Medical University Innsbruck, Anichstrasse 35, 6020 Innsbruck, Austria
Full author information is available at the end of the article

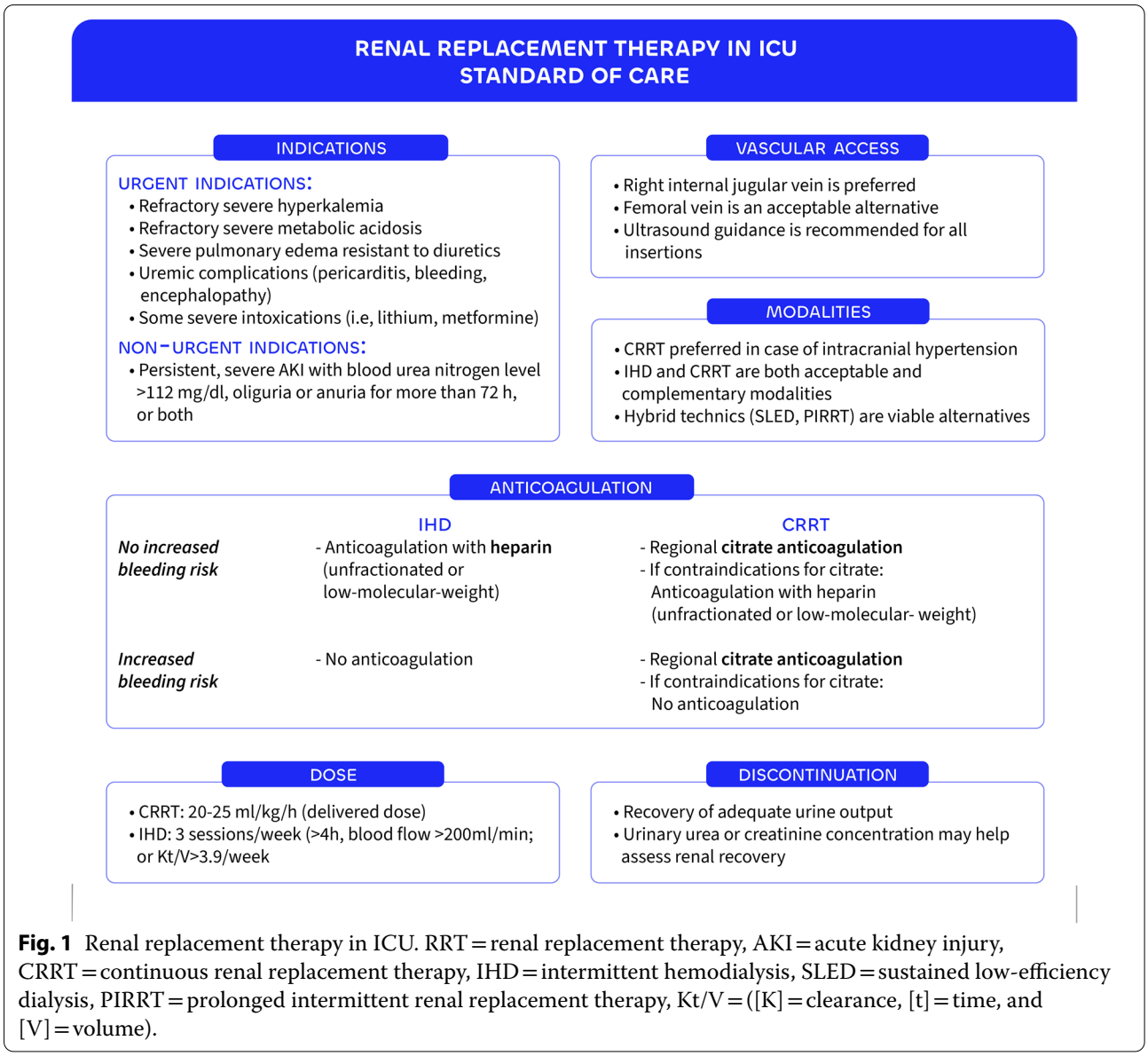

Fig. 1 Renal replacement therapy in ICU. RRT = renal replacement therapy, AKI = acute kidney injury, CRRT = continuous renal replacement therapy, IHD = intermittent hemodialysis, SLED = sustained low-efficiency dialysis, PIRRT = prolonged intermittent renal replacement therapy, Kt/V = ([K] = clearance, [t] = time, and [V] = volume).

analysis of AKIKI and IDEAL-ICU trials [9] suggested that CRRT might be associated with increased mortality. The contradictory nature of these results highlights the limitations of observational data and post hoc analyses, especially in the context of confounding by indication and treatment heterogeneity. This uncertainty has led to the design of the ongoing ICRAKI trial (NCT05586503), an RCT specifically intended to clarify the impact of RRT modality on clinically meaningful outcomes, including survival and renal recovery.

Dose

Regardless of the modality, the dose of RRT is recognized as a key determinant of its effectiveness. It primarily reflects small solute clearance and the correction of complications related to electrolyte and acid–base imbalances. Large multicenter RCTs and several systematic reviews have not demonstrated a beneficial effect of higher versus lower RRT doses [10, 11]. Higher doses may even delay renal recovery at day 28 [relative risk 1.15 (95% confidence interval 1.00–1.33); $P = 0.05$] [12]. Regarding very high-dose CRRT (high-volume hemofiltration)—mainly studies in sepsis/septic shock patients and typically defined as a total effluent flow rate ≥ 45 mL/kg/h—systematic reviews of RCTs have shown no clinical benefit over standard CRRT dosing [13]. Additionally, small retrospective studies from Japan have evaluated the effects of lower-than-standard CRRT dosing (total

effluent flow rate between 10 and 20 mL/kg/h) [14]. These studies suggest that lower doses may be tolerated and can achieve comparable control of electrolyte, acid–base, and metabolic parameters. However, their findings regarding major clinical outcomes remain unknown, and RCTs on low-dose RRT are ongoing. Current recommendations, such as those from the KDIGO guidelines, suggest targeting a CRRT dose of 20–25 mL/kg/h. For intermittent hemodialysis (IHD) or prolonged intermittent RRT, a weekly Kt/V of approximately 3.9 is recommended.

Discontinuation

Discontinuation of RRT is indicated if renal recovery is occurring. Since creatinine and other uremic toxins are removed by RRT, the recovery of endogenous glomerular filtration rate is difficult to obtain. Based on large cohort studies, a spontaneous urinary output of > 500 ml/h or 2.4 L when using diuretics is widely accepted criterion to try discontinuation [15]. Since prolonged or unnecessary RRT may even harm renal recovery, biomarkers are investigated on their ability to help in decision-making (upon those are NGAL, proenkephalin, and CCL14) for the optimal time-point for discontinuation. Beside urinary output at time of discontinuation, urinary output at beginning of RRT, duration RRT, and preexisting CKD are prognostic factors which can be taken into consideration. The use of diuretics however, does not appear to hasten deliberation from RRT [16].

In the coming years, RRT practices in the ICU are expected to evolve toward greater personalization, guided by patient-specific clinical and biological markers. Individualized timing of initiation, as proposed in the recent modeling studies, may optimize outcomes by targeting therapy more precisely. Ongoing trials aim to clarify the optimal modality choice, while other studies are exploring the benefits of lower RRT dosing strategies. Additionally, efforts to standardize and optimize RRT discontinuation will help refine decision-making in this critical phase. Together, these advances promise a more tailored and effective approach to RRT in critical care.

Author details
[1] Département de Réanimation Médico-Chirurgicale, APHP Hôpital Avicenne, Bobigny, France. [2] INSERM, UMR-S 1155, Common and Rare Kidney Diseases, Sorbonne Université, Paris, France. [3] Health Care Simulation Center, UFR SMBH, Université Sorbonne Paris Nord, Bobigny, France. [4] Division of Nephrology, and Center of Excellence in Critical Care Nephrology, Faculty of Medicine, Chulalongkorn University; Excellence Center for Critical Care Nephrology, King Chulalongkorn Memorial Hospital, Academy of Science, Royal Society of Thailand, Bangkok, Thailand. [5] Division of Intensive Care and Emergency Medicine, Department of Internal Medicine, Medical University Innsbruck, Anichstrasse 35, 6020 Innsbruck, Austria.

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