we agree with these authors that this important component should not be neglected. However, performing cardiac output measurements at different PEEP steps would have added a great deal of complexity to the protocol. Of note, performing cardiac ultrasound could influence the reliability of the EIT monitoring (primarily, EIT signal disturbances related to positioning of the probe on the thorax), and such measurements should ideally be performed consecutively. Measurement of regional ventilation/perfusion by contrast-enhanced EIT (saline bolus)—a feature that has recently been developed—and/or performing volumetric capnography would also be an interesting approach to studying the effects of increasing levels of PEEP on macro- and microcirculation. We are lacking now a precise guidance on how these two complex approaches could be directly used.

Jimenez and Hyzy mentioned that the EIT-based PEEP level did not differ from the highest compliance approach in nonrecruitable patients. To clarify, in the high-recruitability patients, this difference was nonsignificant, as indicated in Figure 5 of our article (1). Overall, the EIT crossing point yielded a slightly higher PEEP level than with the compliance approach, but large individual variability was found. We agree that differences in recruitability likely explain the differences in optimal PEEP level by means of any PEEP setting approach (conventional or EIT based) in earlier ARDS studies, and that assessing lung recruitability should be part of a personalized mechanical ventilation strategy. EIT application is a feasible and promising technique for assessing lung recruitability at the bedside. One could imagine starting with the recruitment-to-inflation ratio (2) and then using EIT if the lung is found to be recruitable. Individualization of PEEP setting using EIT to improve outcomes is a topic of ongoing research (including a randomized clinical trial: ClinicalTrials.gov identifier NCT 05307913), and we look forward to further investigating the role of EIT to optimize personalized mechanical ventilation. ■

Author disclosures are available with the text of this letter at www.atsjournals.org.

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*L.B. is Deputy Editor of AJRCCM. His participation complies with American Thoracic Society requirements for recusal from review and decisions for authored work.

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Renal Replacement Therapy in a World of Constraints: Lessons from the COVID-19 Pandemic

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To the Editor:

We read with interest the insightful article by Mekontso Dessap and coworkers titled "Technical Innovation in Critical Care in a World of Constraints: Lessons from the COVID-19 Pandemic" (1).

Critical care services worldwide have had to cope with constrained conditions during the coronavirus disease (COVID-19) pandemic, particularly because of the limited availability of life-sustaining devices. Mekontso Dessap and colleagues (1) dealt only with the obvious major problems of respiratory failure and mechanical ventilation. However, COVID-19 also causes an excess number of other organ failures, particularly acute kidney injury (AKI), requiring renal replacement therapy (RRT).

Among critically ill patients with COVID-19, 56–76% developed AKI (2), and 14–36% of these patients required RRT (2). This led some teams to face RRT shortages, leading to significant challenges in RRT delivery during the first wave (3). Acute peritoneal dialysis, a modality seldom used in high-income countries, regained interest in this context (4), resulting in outcomes that were similar to those among patients who received extracorporeal RRT (5).

Besides recourse to peritoneal dialysis, a more rational use of extracorporeal RRT can help in coping with such constrained situations. Recent evidence demonstrates that RRT initiation can be safely deferred in many patients with AKI, allowing a major reduction in the number who actually need this treatment (6). In addition to a better selection of patients who need RRT initiation, wiser use of available techniques may allow a substantial increase in the number of patients who can be treated on the same day. Indeed, intermittent hemodialysis may allow the daily treatment of three to four patients with only one machine, in contrast to continuous RRT techniques. This is not the place to compare the relative merits of each technique in normal situations, even if current evidence does not provide any definite clue as to the superiority of one over the other technique for any patient-centered outcome (6). Catastrophic conditions, such as those recently encountered, do not allow subtle discussions on the possible minor advantages of any technique.

A frugal approach to critical care should not be limited to mechanical ventilation. The rationalization of RRT delivery is another

Originally Published in Press as DOI: 10.1164/rccm.202305-0926LE on July 12, 2023

means of aligning with the principles of sustainability mandated by climate and sanitary crises. This approach may be useful not only in low-income countries but also in rich ones, where economic and environmental challenges should encourage frugality. ■

Author disclosures are available with the text of this letter at www.atsjournals.org.

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Reply to: Gaudry *et al.*

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From the Authors:

We fully agree that frugal innovation should not be restricted to mechanical ventilation but is intended to cover all aspects of organ support (e.g., hemodynamic support, renal replacement therapy [RRT], etc.) and patient management (e.g., monitoring, drugs, etc.) in ICUs (1). We focused on mechanical ventilation in our article (2) for the sake of clarity and because it was difficult to cover all aspects of patient's care.

There is no doubt that intermittent RRT (IRRT) is better suited, in terms of logistics, to deal with a potential surge of patients suffering from acute kidney injury (AKI) than continuous RRT (CRRT), as emphasized by Gaudry *et al.* In addition, IRRT allows a significant reduction in healthcare costs in terms of material and nursing time without impeding the quality-adjusted life years, compared with CRRT. This may be important not only in the setting of disaster nephrology (3) but also in the current context of sustained increased costs of critical care. From a frugal perspective, it is also essential to prevent and delay the need for RRT in patients with AKI. Regarding the former, the use of sodium bicarbonate for the management of severe metabolic acidemia seems encouraging and should be further validated (clinicaltrials.gov: NCT04010630); regarding the latter, it is important to recall that patients with a delayed-RRT strategy in the STARRT-AKI (Standard versus Accelerated Initiation of Renal-Replacement Therapy in Acute Kidney Injury) trial were also less dependent on RRT at Day 90 than their counterparts, supporting the concept of artificial kidney–induced kidney injury.

Last, a major constraint for IRRT is the lack of facilities in and outside ICUs (4). For example, reverse-osmosis water systems enabling the production of pure hemodialysate are not the standard in the majority of hospitals worldwide and are often of suboptimal microbiological quality (5). In this context, there is a need for frugal innovation to optimize new solutions like home dialysis generators (which allow for the recycling of water for genesis of pure dialysate with a reduced footprint and cost) (3) or accelerated or intermittent hemo(dia)filtration protocols with CRRT monitors (combining some advantages of IRRT [limited duration] and CRRT [no need for an osmosis water system]) (6).

Obviously, the entire management of critically ill patients should be questioned in terms of frugality, given the economic, environmental, and societal challenges that humanity is currently facing. ■

Author disclosures are available with the text of this letter at www.atsjournals.org.

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Originally Published in Press as DOI: 10.1164/rccm.202306-1015LE on July 12, 2023