Artificial Organs

Zero Diffusive Sodium Balance in Hemodialysis Provided by an Algorithm-Based Electrolyte Balancing Controller: A Proof of Principle Clinical Study

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Abstract: Restoring and controlling fluid volume homeostasis is still a challenge in contemporary end-stage kidney disease patients treated by intermittent hemodialysis (HD) or hemodiafiltration (HDF). This primary target is achieved by ultrafiltration (dry weight probing) and control of intradialytic sodium transfer (dialysate-plasma Na gradient). The latter task is mostly ignored in clinical practice by applying a dialysate sodium prescription uniform for all patients of the dialysis center but unaligned to individual plasma sodium levels. Depending on the patient's natremia, a positive gradient gives rise to intradialytic diffusive sodium load and postdialytic thirst. On the contrary, a negative gradient may cause unwanted diffusive sodium removal and intradialytic symptoms. To overcome these challenges, a new conductivity-based electrolyte balancing algorithm embedded in a hemodialysis machine with the aim to achieve "zero diffusive sodium balance" in HD and online HDF treatments was tested in the form of a prospective clinical trial. The study comprised two phases: a first phase with a conventional fixed-sodium dialysate (standard care phase), followed by a phase with the electrolyte balancing control (EBC) module activated (controlled care phase). The results show a reduction in the variability of the intradialytic plasma sodium concentration shift, but it is overlain by a small but statistically significant increase in the mean plasma sodium levels. However, no clinical manifestations were observed. This sodium load can be explained by the design of the algorithm based on dialysate conductivity instead of sodium concentration. Furthermore, the increase in plasma sodium can be corrected by taking into account the potassium shift during the treatment. This study showed that the EBC module incorporated in the HD machine is able to automatically individualize the dialysate sodium to the patient's plasma sodium without measuring or calculating predialytic plasma levels from previous laboratory tests. This tool has the potential to facilitate fluid management, to control diffusive sodium flux, and to improve intradialytic tolerance in daily clinical practice. **Key Words:** Conductivity—Sodium gradient—Diffusive sodium balance—Electrolyte balance—Hemodialysis—Online hemodiafiltration—Renal replacement therapy

Restoring and controlling fluid volume homeostasis is still a challenge and clearly an unmet medical need in contemporary end-stage kidney disease (ESKD) patients treated by intermittent hemodialysis as renal replacement therapy (RRT) (1). Fluid volume balance is currently achieved by combining fluid and sodium depletion by RRT: By a so-called "dry weight probing" approach referring to intra-dialytic weight loss (IDWL) (1,2), by adjusting the dialysate-to-plasma sodium gradient (3–5) and by enforcing daily dietary salt and fluid restrictions (6). The improper control of fluid volume and sodium mass balance in RRT patients leads to chronic fluid

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