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LETTER TO THE EDITOR

Ultra-small neonatal dialysis circuits do not maintain safe fluid balance

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Nishimi and colleagues have designed a renal replacement device for tiny babies in which the extracorporeal circuit volume (ECV) is "ultra-small" at only 3.2 ml, by just using one operating syringe [1]. They note that their current system does not maintain fluid balance "accurately", but that they "are working on" this "serious weakness". Unfortunately, they will not be able to regulate the ultrafiltration rate without adding extra components to the circuit. This is because water moves across a dialyser according to the transmembrane pressure (TMP), and this cannot be regulated while the filter is exposed to the pressures in the blood access or return lines.

In their earlier (manual) circuit design, the proximal operating syringe created a positive TMP by pushing blood through the dialysis filter, and generated a mean daily ultrafiltrate of 40 ml (abstracted from their Figure 5a). Their new (automated) circuit uses a distal syringe to draw blood through the filter, which generates a negative TMP that drew a mean of 112 ml/day of water into the blood (range 16 to 260; $P = 0.02$, one-sample t test; Figure 5b). Large, unpredictable fluid shifts like this could harmfully overload small infants, most of whom are fluid-replete when they commence renal replacement therapy.

Two ways of isolating the dialysis filter pressure from the rest of the blood circuit include using a valve and second syringe, as we have done in the Nidus [2], and generating a TMP by using a computer-controlled intermittent isolation valve distally. The latter requires a pressure transducer in the circuit, and a method of continuously measuring the ultrafiltration rate to provide feed-back to the computer algorithm. So far, devices that use this approach cannot produce precise fluid control; the Prismaflex is inaccurate by ±30 ml/h [3], and the CARPEDIEM by ±7.5 % of the dialysate fluid flow, despite weighing its ultrafiltrate to the nearest gram [4]. All methods of controlling fluid balance inevitably increase the ECV, which makes safe "ultra-small" renal replacement devices difficult to build.

Compliance with ethical standards

Conflicts of interest The author declares no conflicts of interest.

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