**In vitro evaluation of a new lithium dilution method of measuring cardiac output and shunt fraction in patients undergoing venovenous extracorporeal membrane oxygenation**

Linton R, Turtle M, Band D, O'Brien T, Jonas M. *Crit Care Med*. 1998 Jan;26(1):174-7. doi: 10.1097/00003246-199801000-00035.

Objective: To evaluate, in vitro, a method of measuring cardiac output and shunt fraction during venovenous extracorporeal membrane oxygenation (ECMO).

Design: Experimental study using an in vitro model.

Setting: A teaching hospital.

Model: An ECMO circuit was set up in parallel with a patient circuit consisting of tubing through which saline was circulated from a 50-L reservoir by a pump which was set at 3 L/min to represent cardiac output. A second pump in the ECMO circuit drew saline from the patient circuit and passed it through a membrane oxygenator. The flow from the membrane oxygenator either returned directly to the patient circuit or was diverted, via a third pump, back into the ECMO circuit, thereby producing a shunt.

Interventions: By adjusting the flow rates of the second (ECMO) and third (shunt) pumps, three shunt fractions of 12%, 25%, and 50% were produced at three different ECMO flow rates. Lithium chloride (0.15 mmol) was injected just downstream of the membrane oxygenator; the lithium ion concentration-time curves were recorded simultaneously in the flow returning to the saline reservoir and in the flow just upstream of the membrane oxygenator using lithium selective electrodes.

Measurements and main results: Nine pairs of curves were recorded, one pair for each combination of ECMO and shunt flow rates. Analysis of these curves allowed shunt flow and "cardiac output" to be calculated and compared with the flow rates delivered by the pumps. Mean "cardiac output" derived from the lithium dilution curves was 2.98 +/- 0.18 (SD) L/min, compared with a delivered pump flow of 3 L/min. Measured shunt flow = 0.008 + 1.09 x actual shunt flow (R = 0.997).

Conclusions: This method would allow cardiac output and shunt flow to be measured in patients undergoing venovenous ECMO. It could result in better patient management and improved cannula design.