TITLE: **LABORATORY EVALUATION OF A HIGH EFFICIENCY I.V. FLUID WARMER**

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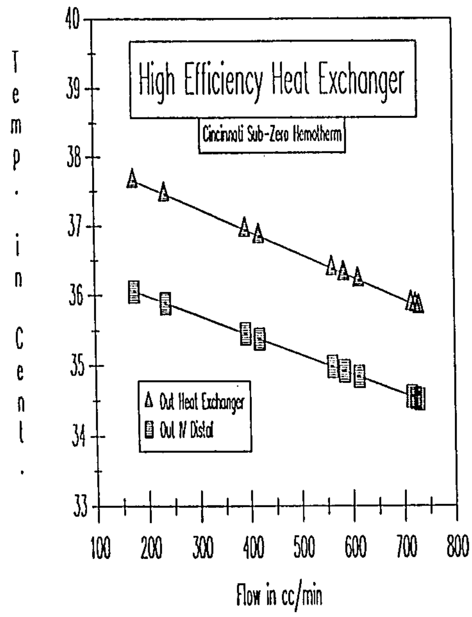
<u>INTRODUCTION</u>: Of the devices used to preserve patient's body temperature during surgery, perhaps the most frequently used is the blood warmer. While the currently available commercial models do add heat to fluids, the majority are unable to raise the temperature of blood from near zero to body temperature, unless flow through the warmer is quite slow[1],generally because most blood warmers restrict the temperature of the device. to 37° C to prevent any theoretical possibility of red cell damage. When flow is maximal, less than 200 ml/min, an outlet temperatures of 33°C is common[1]. In recognition of these limits, infusion devices are now available that maintain fluids at body temperature while flowing at 2000 ml/min, generally through 2 or more catheters, but at substantial initial & recurring costs. This paper reports an evaluation of a new inline fluid warming device, an Electromedics High Efficiency Heat Exchanger, that utilizes warming blanket heating units, thus allowing for a substantial reduction in cost. This device is fundamentally a cardioplegia heat exchanger, and was initially designed to operate at the upper limit of bath temperatures used for blood warming during CPB, which is 42°C.

<u>METHODS</u>: An Electromedics D720 High Efficiency Heat Exchanger with associated infusion tubing, filter, & float-equipped air trap,was initially primed with 150 ml. of normal saline. Inlet & outlet temperature were constantly measured at the installed temperature ports with Electromedics model 4700 reusable temp probes, while the fluid temperature at the distal IV site was measured with an Edwards Lab model 93-505 flow-through housing & a 9520A cardiac output computer. Saline, cooled to an inlet temperature of 8°C, was used as test fluid throughout. The performance of the exchanger was evaluated using one of two water bath controllers: Gaymar model 4700(maximum bath flow rate 1L/min) & Cincinnati Sub-Zero model 400M(maximum bath flow rate 14L/min), with the water bath reservoir temperature kept at 42 °C. I.V. flow rates were measured using timed collections at the distal site, utilizing gravity feed with the bag raised 5 feet above the distal site.

<u>RESULTS</u>: Figure 1 shows the outlet temperature vs. flowrate for the Cincinnati 14 L water bath. At the peak flow of 700 ml/min, an outlet temp of 35°C was maintained over time. The data for the Gaymar low flow system is not presented, as the warming capability was simply inadequate for any clinical purpose.

<u>DISCUSSION</u>: In the current era of cost reduction, it is essential that necessary performance be obtained at minimal outlay. For those centers with sufficient trauma volume, the most aggressive devices



may be in order, but even then, cost, set up time, and the requirement for an independent operator may be limitations. This heat exchanger makes use of of available equipment to accomplish the desired task. It is equipped with 0.25 in I.D. tubing,which makes it doubtful that substituting blood for saline will significantly retard flow through the exchanger. A potential problem of blood overheating seems unlikely, for even at less than 200 ml/min flow, the outlet temperature remains 36°C. Circumstances arise where greater flow is required, but maintaining a continuous fluid supply becomes the limiting factor, unless a system with a reservoir is available. At a cost of less than $100, requiring a priming volume of 150 ml, and using a tested design of a cardioplegia heat exchanger, this device may represent a useful alternative to more expensive equipment. Such an approach should make either the IV catheter[2], or the operator the only restriction to fluid administration.

1. Blood Warmers. Health Devices 13:191-216,1984.
2. Kestin, I.G. Flow through intravenous cannulae. Anaesthesia 42:67-70, 1987.