NEW APPLIANCES

Inexpensive Heat-exchanger System for the Rygg Bag Oxygenator

Mr. Donald Longmore, consultant physiologist, National Heart Hospital, Mr. Donald Ross, consultant surgeon, National Heart Hospital, and Mr. Derek Ray, research engineer, British Heart Foundation, write: Having successfully used the Rygg bag in over 140 human perfusions, we felt that we had not fully taken advantage of the low prime of this oxygenator, for we were employing a separate heat exchanger the large volume of which often made it necessary to use blood in the prime. The low prime of the Rygg bag with the coil described makes it possible to use a clear fluid prime.

The advantage of disposability is lost if difficult-to-clean multi-tube stainless-steel heat exchangers have to be used. Disposable stainless-steel heat exchangers were found to be satisfactory, but they had a considerable resistance to flow and were prohibitively expensive. Accordingly, we investigated other techniques for maintaining temperature while on perfusion. Since we have used hypothermia below 34.5° C. only once in the last hundred bypass cases, a high-thermal-capacity heat exchanger was not thought necessary.

Microwave heating of the blood was rejected because of its complexity. Radiant heat was also rejected because of the risk that it would dry the blood film left on the sides of the bag as the levels changed. Therefore the simple device for immersion in the blood in the bag was designed (Fig. 1). The two collecting-chambers on the arterial side of the bag are slit with a sterile knife on the connector side of the bag, and the autoclaved coils* are then threaded carefully through these slits, avoiding contamination against the outside of the bag. A thermometer is placed in the fluid entering the coils from the heat reservoirs, so that the critical upper limit of temperature of 42° C. is never exceeded. Slitting of the bag is not a disadvantage, for, although it increases the prime slightly, this increase is nullified by the immersed volume of the coils.

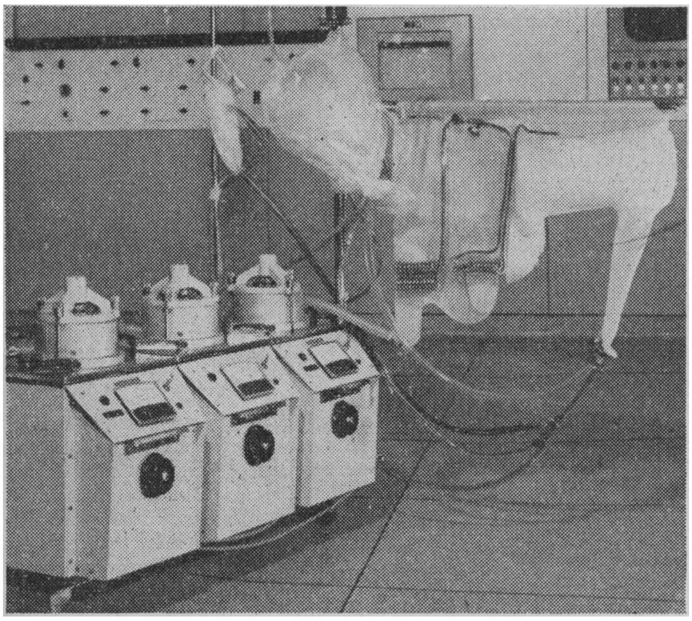

Fig. 1.—Cooling coils are shown against the Rygg bag in the position they would occupy. The pumps are National Heart Hospital pattern—Belmedical driven roller pumps, adjustable for occlusiveness with split heads for immediate tube-changing. The trolley is made from speed frame Dexion.

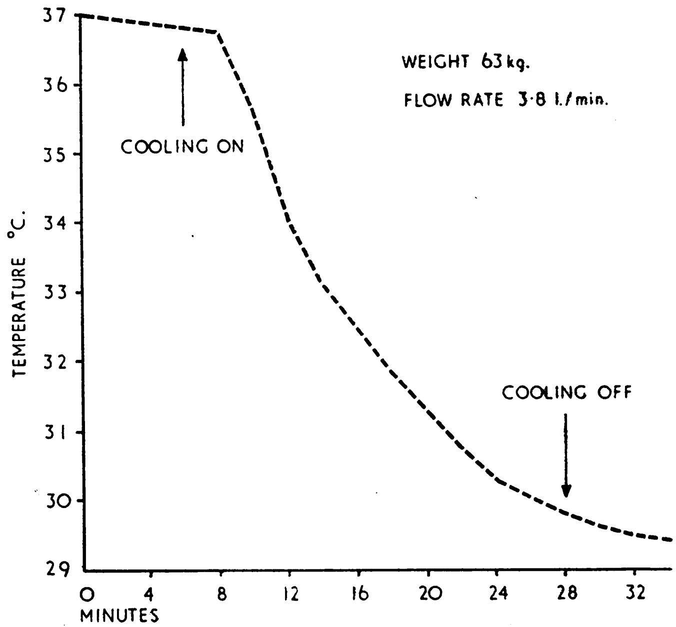

Fig. 2

Even if the coils are not used, we routinely pierce the bag for blood sampling and never proceed to perfusion without venting all three chambers of the bag. Venting of these chambers avoids the possible risk of embolism, which could result if both inlets to the defoaming chamber were blocked by drip nozzles.

* These coils are commercially available from Belmedical, Farnham Road, Slough, Bucks.

The prototype coil itself was made from standard ¼-in. (6-mm.) 16-gauge copper tube, hand-formed with loosely wound coils. These coils were chromed before they were compressed to their final form. Experimentally we have shown that with a blood flow of three litres, a gradient of 10° C., and a fluid flow of 0.75 litre the heat transfer is 6,000 calories/minute. The performance of these coils is shown in the cooling curve for a 63-kg. patient with a 3.8 l./minute flow (Fig. 2). This was the one patient in whom hypothermia was instituted ; the rate of cooling is shown with the coil perfused with ethylene glycol, starting at +2° C. and ending at +18° C. as the cold reservoir warmed. The room temperature was 22° C. If cooling is instituted by using the coil in this way it is necessary to have a brief circulatory arrest while a conventional heat exchanger is added to the circuit to assist rewarming.

This device is commercially available in stainless steel ; we think it will be a worthwhile adjunct to the use of this excellent oxygenator until such time as Polystan Ltd. can produce a four-layered bag with heat-exchange surfaces on both sides of the blood compartment.