A SIMPLE HEAT EXCHANGER FOR USE DURING BLOOD TRANSFUSION

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CONSIDERABLE INTEREST has recently been paid to the external warming of bank blood during massive transfusion. Boyan and Howland claim that a rapid infusion of cold bank blood into an antecubital vein may produce an oesophageal temperature behind the heart as low as 27.5°C . The advent of this extremely cold blood into the right atrium has been held responsible for the incidence of cardiac arrhythmias, particularly ventricular fibrillation during the rapid replacement of blood intra-operatively. There is no doubt that during infusions of blood the human arm acts as an adequate heat exchanger. During high-flow blood replacement it would seem logical to supplement this heat exchange by warming the donor blood prior to, or during, transfusion. The practice of immersing an entire 500 ml unit of bank blood in a water bath at body temperature is impractical. Such a procedure requires a considerable amount of time and the patient's blood requirements must be anticipated. Boyan and Howland have described a simple heat exchanger utilizing a coil of plastic intravenous tubing located in a water bath. During transfusion blood circulates through this unit, which is placed in circuit between the blood container and the patient. There is now available at least one commercial blood warmer utilizing this principle. However, this is an expensive piece of equipment particularly when one considers that in massive blood replacement, two transfusions may be proceeding simultaneously, requiring the purchase of two units. It was decided to produce a suitable heat exchanger in the hospital workshop using readily available material and as economically as possible. Since it is important to maintain the temperature of the water bath close to the body temperature, it was also decided to incorporate a thermostatically controlled heating system into the unit.

CONSTRUCTION DETAILS

The apparatus consists of 24 feet of sterile plastic tubing (4.5 mm in diameter) which is wound around a circular stainless steel former. The plastic tubing is now readily available commercially and the stainless steel spool, which is 8 inches in diameter and 8 inches high, was easily constructed in the hospital workshops. The area of contact between the plastic tubing and the metal spool is kept at a minimum in order to allow adequate circulation of warm water around the coil. Various types of water bath in which to submerge the unit were tried but the most suitable was found to be a metal and glass aquarium tank, 5 U.S. gallons in capacity. This has proved easy to clean and allows the anaesthetist to monitor

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the water temperature by means of a mercury laboratory thermometer. In order to maintain the temperature of the water bath in the range 36 to 37.5° C a combined immersion heater and thermostat was partially immersed in the tank. Again the most suitable type was found to be one designed for use in a tropical fish aquarium. Since thermostats of this kind have a bimetallic strip mechanism and since they are not completely sealed from the atmosphere arcing occurring within the glass tube could constitute an explosion hazard. After further trial it was decided to abolish the thermostat and to replace the heater with a fully submersible sealed aquarium heater of sufficient wattage to maintain the water at the required temperature without danger of overheating. It was found that if a tank of this size was filled with warm water at body temperature (37° C) a 75 watt heater would closely maintain this temperature over a period of several hours in an ambient operating room temperature of 23° C.

There is an inherent increase in resistance to flow due to the length of tubing used. However this is overcome by the use of positive pressure applied to the blood to be transfused. In our case external pressure is applied to the plastic bag containing the blood.

This system has been used successfully to warm cold bank blood (5° C) to 35° C at transfusion rates as high as 125 ml per minute. The apparatus described is simple to operate, safe and inexpensive (Fig 1). All parts should be readily available from local suppliers.

FIGURE 1 Coil immersion heater and water bath

SUMMARY

The need for a simple heat exchanger to warm cold bank blood during massive transfusion has been discussed. A simple inexpensive easily constructed apparatus incorporating an electrical water heater has been described.

RÉSUMÉ

L'administration rapide de sang de banque froid serait responsable, dit-on, de l'apparition d'arythmies cardiaques, spécialement de fibrillation ventriculaire. Il n'est pas pratique de réchauffer tout un flacon de sang avant une transfusion, mais on a décrit antérieurement de simples réchauds qui s'appliquent à l'extérieur du tube à transfusion.

L'appareil décrit ci-dessus consiste en un serpentín de tube en plastique d'une longueur de 24 pieds, ce tube est placé dans un bain d'eau dont la T° est maintenue par un chauffe-eau aux environs de 36° à 37° C. Le sang passe dans ce serpentín intercallé entre la malade et le flacon de sang.

Le bain est un réservoir aquarium (5 gallons américains) et le chauffe-eau est de 75 watts.

On a réussi à réchauffer de façon continue de 5° C à 35° C du sang qui coulait à raison de 125 ml / minute.

REFERENCES

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