

# Asanguineous Hypothermic Perfusion

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In recent years several new methods for the treatment of patients in advanced hepatic coma have been attempted. Some of these methods include extracorporeal heterologous or homologous liver perfusion;<sup>1</sup> exchange transfusion;<sup>2</sup> plasmaphoresis;<sup>3</sup> cross circulation with a human partner;<sup>4</sup> and cross circulation with baboon partners having human blood.<sup>5</sup>

More recently another procedure has been employed and labeled Asanguineous Hypothermic Total Body Perfusion. The experimental and clinical trails with this procedure have been reported by Klebanoff, et al.<sup>6</sup> with encouraging results. The purpose of this communication is to report our initial clinical experience and to present a totally disposable extracorporeal system which was devised as a result of that experience.

We feel this system offers the precision and accuracy necessary for this procedure and maximum safety for the handling of contaminated blood. We would also like to offer our observations and suggestions to those perfusionists who may become involved with this procedure.

In order to carry out a successful and expedient exchange, a pump oxygenator is utilized with hypothermia. The perfusate or "flush" solution consists of pre-cooled Lactated Ringers, Albumin, Sodium BiCarbonate and Heparin. As this solution is being infused the patient's blood is allowed to drain into a waste receptacle. The "flush" solution is then drained out of the patient as pre-cooled plasma is infused.

The plasma is recirculated through the pump oxygenator and most of it is allowed to drain out as fresh donor blood is infused into the patient. The drain line is then clamped and the patient's new blood volume is recirculated through the pump oxygenator for the remainder of the rewarming phase.

## CASE REPORT

On June 14, 1972, a 24 year-old male in terminal hepatic coma was brought to the Operating Room to undergo Asanguineous Hypothermic Total Body Perfusion. Under local anesthesia catheters were placed in the left radial artery and left basilic vein for pressure monitoring. An endotracheal tube was placed as well as an esophageal and rectal temperature probes. EKG and EEG electrodes were attached. Cut downs were then done to expose the right internal jugular vein and the right femoral artery and vein. These vessels were cannulated and connected to the extracorporeal circuit. (See Diagram)

Each liter of flush solution consisted of 870 ml of Lactated Ringers, 80 ml of 5% Albumin, 50 ml of Sodium BiCarbonate and 1000 units of Heparin cooled to 4°C. Twenty liters of this solution was infused via the femoral artery at a rate of 2.5 to 3 liters/min. This was followed by six liters of plasma as the flush solution was drained. By clamping the drain line some of the plasma was retained in the patient and allowed to recirculate through the pump oxygenator.

Ten minutes after beginning the exchange, 8 units of whole blood and 4 units of packed cells were infused into the patient and recirculated through the pump oxygenator. Rewarming was begun and the patient was defibrillated. As the rectal temperature reached 35°C, the patient was taken off bypass. The duration of the hypothermic washout was ten minutes and the total pump time was 41 minutes.

The patient survived the procedure and showed signs of improvement with changing of his comatose state. However, by the third post-operative day his condition worsened again and it was decided to repeat the procedure.

On June 17, 1972, another Asanguineous Hypothermic Total Body Perfusion was performed. This procedure was identical to the first except that the rewarming phase was shorter and no defibrillation was necessary. The total pump time was 33 minutes.

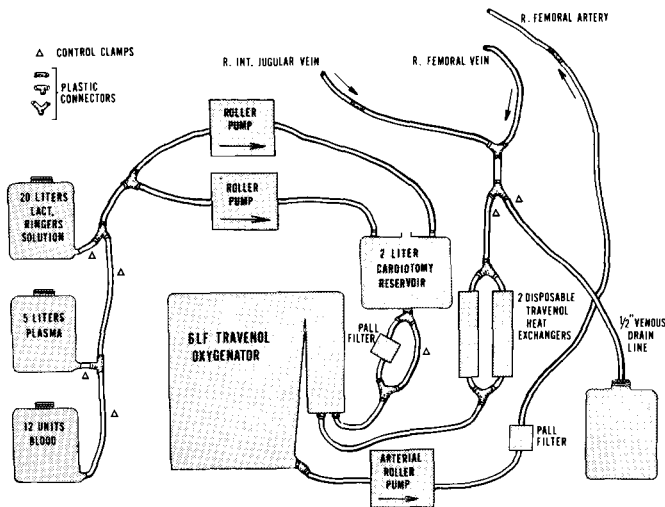
The patient survived the procedure, was no longer comatose and shortly thereafter was alert and responsive. Unfortunately he had no return of any liver function and died 14 days after the second procedure.

## DISCUSSION

Several problems were encountered during both procedures. One of these was the preparation and delivery of the "flush" solution. During the first procedure 21 liter bags of Lactated Ringers were prepared and refrigerated. Just prior to the start of the exchange, these bags were emptied into three sterile basins. The 6 liters of plasma and the 12 units of blood was poured into two additional basins.

This meant that the pump suction lines had to be hand held in each successive basin. The manipulation of the sterile basins and their stands proved to be quite cumbersome. These basins also provided a large surface area for airborne particulate matter to settle on prior to its use.

## Extracorporeal Circuit For Asanguineous Hypothermic Total Body Perfusion



For the second procedure the 20 liters of "flush" solution was prepared and placed into a large glass container much like the water cooler type. Although this improved the delivery system the suction lines still had to be held in the container through a top opening. Also a glass container lends itself to a potential breakage hazard.

As in the diagram, we would suggest using autoclavable plastic containers, with a top opening and a bottom port to which the suction lines may be attached. These containers are relatively inexpensive and are available through most labware catalogs. A single container of this type should also be used as the waste receptacle. This will minimize the actual handling of the contaminated blood since direct blood contact can be a means of contracting hepatitis.<sup>7</sup> Such a container will also facilitate whatever decontamination process is used.

### SUMMARY

Based on our experience with a relatively new procedure the following observations were noted:

1. A totally disposable system is necessary to accomplish a total exchange with accuracy and safety.
2. The method for preparation and handling of the solutions should provide for an efficient delivery of those solutions.
3. A method for handling the contaminated blood should be considered with regard to personnel safety.
4. Appropriate equipment should be utilized to provide accurate monitoring and control of the perfusion.

A diagram of an extracorporeal system is included to illustrate the system which we propose for this procedure.

### REFERENCES

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### PERFUSION I

Time (min)	pH	PCO <sub>2</sub> (mmHg)	PO <sub>2</sub> (mmHg)	O <sub>2</sub> Sat (%)	Hct (%)	Rectal Temp (°C)	Pharyngeal Temp (°C)
0	7.48	31	237	100%	48 %	37.5°C	36.3°C
5	7.56				0 %	33.2°C	30.4°C
10	6.90	56	593	100%	4 %	31° C	27.7° C
15	7.05	63	400	100%	27.5%	30° C	27° C
20	7.17	48	460	100%	25 %	30.4°C	28° C
25	7.13	51	472	100%	34 %	31.2°C	30° C
30	7.20	41	460	100%	35 %	32.5°C	31.7°C

### PERFUSION II

Time (min)	pH	PCO <sub>2</sub> (mmHg)	PO <sub>2</sub> (mmHg)	O <sub>2</sub> Sat (%)	Hct (%)	Rectal Temp (°C)	Pharyngeal Temp (°C)
0	7.52	39	102	97%	36 %	37° C	36.2°C
5	7.65	57	555	100%	0 %	33° C	31.5°C
10	7.29	66	537	100%	0 %	31.5°C	29.5°C
15	7.16	61	325	100%	36 %	30.5°C	<27° C
20	7.24	53	418	100%	35.5%	29.5°C	27° C
25	7.25	50	387	100%	36 %	32.2°C	29.2°C
30						34.5°C	31° C

Although the washout is thought to be complete, during the recirculation of the plasma the extracorporeal system could potentially be contaminated. Therefore, all parts of the system should be disposable.

This would include tubing connectors, blood filters and heat exchangers. Two disposable heat exchangers in parallel are suggested (see Diagram) to prove efficient rewarming. In place of the Gross Arterial Blood Filter, a disposable Pall Blood Filter is suggested for use in the system. Temperature monitoring equipment should have a wide enough range to accommodate this procedure. The telethermometers used during our experience did not permit temperature monitoring below 27°C.

During both perfusions blood samples were taken at zero and then five minute intervals for pH, blood gases and hematocrit (See Charts I & II). On both occasions a moderate acidosis occurred and perhaps should be treated while patient is still on bypass.