External Hemoconcentration, a Fourth Variant of Autologous Blood Transfusion

Jeffrey Luckenbach, B.S., C.P.; Norig Ellison, M.D.; Thomas J. Conahan III, M.D.; Horace MacVaugh III, M.D.
Departments of Anesthesia and Surgery
University of Pennsylvania School of Medicine
Philadelphia, PA 19104

I. Introduction

Autologous blood transfusion is used to conserve homologous blood and to avoid its potential hazards. There are three common forms of autologous blood transfusion: (1) preoperative collection and storage, (2) acute perioperative collections, and (3) intraoperative scavenging. (1) A form of autologous blood transfusion unique to patients undergoing open heart surgery is the reinfusion of the contents of the oxygenator at the termination of bypass. However, on occasion the volume remaining may be so large that it cannot all be reinfused into the patient intraoperatively and the blood is then bottled for subsequent reinfusion. This bottled blood may also be centrifuged to obtain packed cells, a form of external hemoconcentration.

Proponents of external hemoconcentration argue that it (1) provides a more rapid rise in the low hematocrit after hemodilution commonly employed during bypass, (2) decreases the fluid load and incidence of "wet lungs", and (3) decreases the amount of bleeding by reducing the volume of heparinized plasma which is infused. We designed a study to determine the effect of external hemoconcentration on hemocrit, volume requirements, room air PaO_2, and bleeding.

II. Methods

Thirty-nine patients were divided into control and treatment groups. The groups were comparable in age, weight, procedure, bypass time, and sex (see TABLE I). In the control group, the contents of the oxygenator were bottled at the end of cardiopulmonary bypass and reinfused over the next 1–2 hours. In the treatment group the contents were first centrifuged so that only the packed red blood cells were reinfused. The following comparisons were made: Serial hematocrits, volume requirements, and urine output over the next 24 hours, time required for closure following bypass (which has been suggested as a rough measure of the degree of post bypass bleeding) (2), and the PaO_2 breathing room air the following morning.

III. Results

Nineteen patients in the control group received an average of 1129 ± 73 cc of bottled blood. Twenty

TABLE I
Comparison of control and treatment group characteristics

	Control Group N = 19 patients	Treatment Group N = 20 patients
Age (Years)	56.8 ± 2.2	53.5 ± 2.3
Weight (Kg)	71.5 ± 2.7	67.4 ± 5.3
Procedure	12 CABG 6 valves 1 ASD	12 CABG 7 valves 1 ASD
Bypass Time (mins)	79.6 ± 7.9	77 ± 8
Sex	12 M, 7 F	14 M, 6 F

TABLE II

Volume requirements and urine output for first twenty-four hours.

INTRAOPERATIVE BYPASS	Control Group	Treatment Group
Clear Fluids	350 ± 60	398 ± 68
Autologous Blood	737 ± 70	823 ± 71
Homologous Blood	79 ± 47	Zero
Pump Blood	1129 ± 73	525 ± 54
Discard Volume	None	1044 ± 144
OVERNIGHT TO 8:00 AM NEXT DAY		
Clear Fluids	982 ± 50	1102 ± 50
Colloid	297 ± 78	381 ± 64
Homologous Blood	140 ± 92	161 ± 137
Urine Output (Ml) Intraoperative	681 ± 90*	494 ± 64*
To 8:00 AM Next Day	1790 ± 138	1744 ± 207
Post Bypass Time (Min)	112 ± 14	109 ± 17
Room Air P_AO_2 (Torr) —Next Morning	69.1 ± 2.7 17 patients	65.0 ± 3.- 13 patients

* Results significantly different. P <0.05

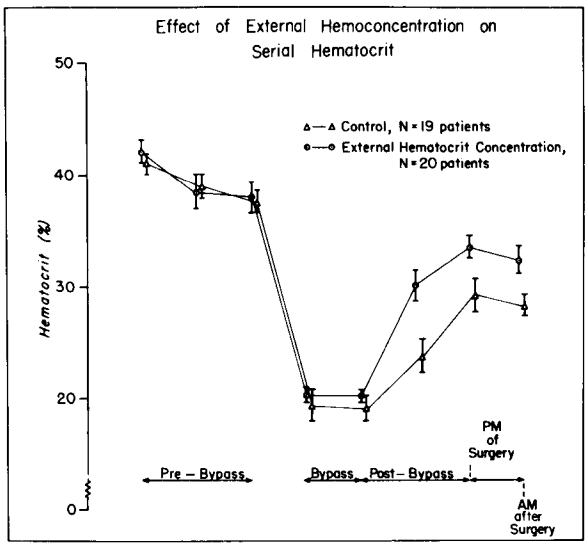

FIGURE 1. Effect of external hemoconcentration on serial hematocrit. The marked reduction in hematocrit is commonly seen when a clear prime is used as demonstrated. The slight, significant rise in hematocrit seen when packed cells are reinfused is also illustrated and demonstrated to persist for twenty-four hours.

patients in the treatment group received an average of 525 ± 54 cc of packed cells with hematocrits ranging from 49 to 81% PRBC, which were obtained using a portable compact centrifuge specifically designed for use in the operating room.* For both groups the volume requirements intraoperatively and for the next 24 hours were similar as was the postoperative urine output. During the intraoperative post bypass period the control group urine output (681 ± 90 cc) and the treatment group (494 ± 64 cc) were significantly different (P <0.05) (TABLE II).

Figure 1 illustrates the effects of external hemoconcentration on hematocrit. While statistically significant differences were noted for the hematocrits for twenty-four hours following the administration of packed cells to the treatment groups, the differences were not great and were of doubtful clinical importance. There were no important differences in chest bottle drainage, time required for completion of operation following the termination of bypass, or in the room air PaO_2 the next morning.

IV. Case Report

A forty-eight year old white male came to the operating room for emergency mitral valve replacement for mitral insufficiency (secondary to ruptured papillary muscle post myocardial infarction). The patient was in acute pulmonary edema at the time that anesthesia was induced. During the sixty-five minutes of cardiopulmonary bypass, fluid was removed from the oxygenator and centrifuged to obtain packed cells as indicated in table three. This patient ended up having 3600 ml of plasma discarded during the pump run (TABLE III).

V. Conclusions

External hemoconcentration is capable of raising the hematocrit more rapidly following the routine intra-bypass hemodilution. Volume requirements are not changed greatly with external hemoconcentration nor is the room air PaO_2 the following morning altered. The amount of bleeding as measured by post bypass

TABLE III

CASE REPORT: Fluid Balance Intra-bypass

Pump Prime – Clear	= 1500 ML
Pump Prime – Colloid	= 1000 ML
Pump Prime – Blood	= 500 ML
	TOTAL = 3000 ML

During Bypass 5500 cc Blood removed. 1900 PRBC (Hct 41% to 68 &) reinfused. 3600 Plasma Discard. Fluid remaining in Pump = 700 cc

* Cell Saver, Haemonetics Corporation, Braintree, MA 02184.

operative time or overnight chest bottle drainage was not altered.

While the routine use of external hemoconcentration does not seem necessary, patients in severe congestive heart failure who cannot tolerate the additional fluid load may benefit from this technique. In addition, with the increase in use of cardioplegia, larger volumes of crystalloid solution are being added to the volume infused. This practice may make the use of external hemoconcentration even more valuable.

References

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2. Guffin AT, Dunbar RW, Kaplan JA et al: Successful use of a reduced dose of protamine after cardiopulmonary bypass. *Anesth & Analg* 55: 110-113, 1976.