

Drastic Coagulation Improvements After Cardiac Surgery Without the Use of Blood Products

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Introduction

Optimal coagulation continues to be a challenge in the immediate postoperative period for the cardiac surgical patient. Exposure to red blood cell transfusions, fresh frozen plasma, platelet transfusions and cryoprecipitate has been associated with postoperative sequelae and increased morbidity and mortality. The impact of highly concentrated autologous whole blood on coagulation is less well understood.

There are increasing international stresses within healthcare regarding the allogeneic blood supply, its use and associated costs and morbidity (1,31,32). The concern is arguably one of greatest in the cardiac surgery arena today (2, 29). Improved blood administration practices have been encouraged by multiple professional societies whose members provide cardiac surgical care. (3,4,8).

There are vast differences in transfusion practices between cardiac surgical facilities throughout the world (5,18). As well, there are numerous blood conservation maneuvers that are employed during cardiac surgery that have not been widely adopted as standard of care (6,7,8).

Patient data from an ultrafiltration technique (the Hemobag®) to process residual extracorporeal circuit blood is presented as an example of a means to reduce allogeneic blood related use, risks and costs (9,20,21). This technology allows for the re-infusion of shed / residual blood without creating disturbances in hemodynamic or biochemical parameters, and avoidance of clinical complications or any increase in morbidity (9-10, 16-17). Further studies indicate that in over 50% of patients, FFP transfusion does not reliably reduce the PT or INR and exposes patients to unnecessary risk (18-19, 32-33).

Method

Twelve (12) patients undergoing coronary artery bypass graft, or redo coronary artery bypass graft surgery were evaluated for the effective change in the coagulation parameters of prothrombin time (PT), activated partial thromboplastin time (PTT), International normalized ratio (INR), fibrinogen concentration (FIB) as well as hematocrit, (HCT) and platelet (PLT) count.

After cardiopulmonary bypass (CPB) termination and neutralization of sodium heparin with protamine sulfate, these coagulation tests were collected before and after the infusion of "multipass" hemoconcentrated autologous whole blood via the Hemobag® (Global Blood Resources LLC, Somers, CT) technology using ultrafiltration/hemoconcentration (HBV).

Cell washer (Cell Saver® 5 Haemonetics Corporation, Braintree MA) was also employed for all 12 patients to conserve blood. Residual heparin in the HB contents was neutralized with an additional 50mg of protamine sulfate after HBV infusion.

Process indicators and central hospital laboratory results were statistically compared by independent group t-test before and after the protamine administration and the reinfusion of ATS, ANH and HBV blood. Statistical analysis was performed using JMP software (SPSS 14.0, Chicago, IL).

Hemobag®

The Hemobag® Blood Salvage Device (Figure 1) is a special reservoir system that allows the patient's own whole blood to be quickly salvaged, hemoconcentrated and safely reinfused. It efficiently uses the same convenient reservoir system while insuring CPB circuit integrity is safely primed for reinstating bypass safely and securely if necessary emergently.

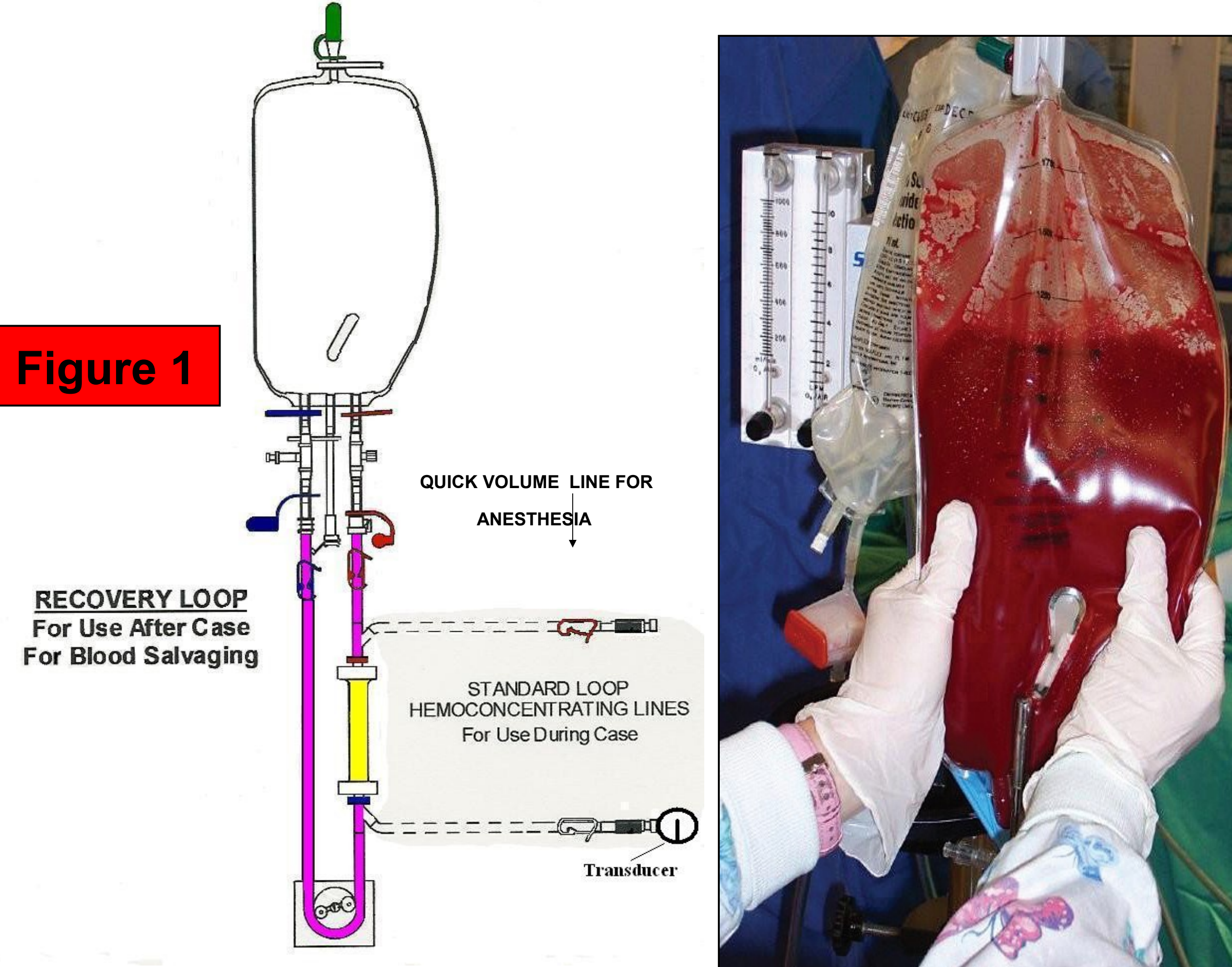


Figure 1

Preserving Blood

Results

The average HBV infused was 1,046mL. Zero percent of patients (n=12) were exposed to allogeneic blood or blood product transfusions immediately post CPB to achieve these impressive changes.

Table 1 presents the results of the statistical analysis of the differences pre and post HBV infusion. Except for aPTT, all parameters changed significantly after the post-protamine HBV infusion.

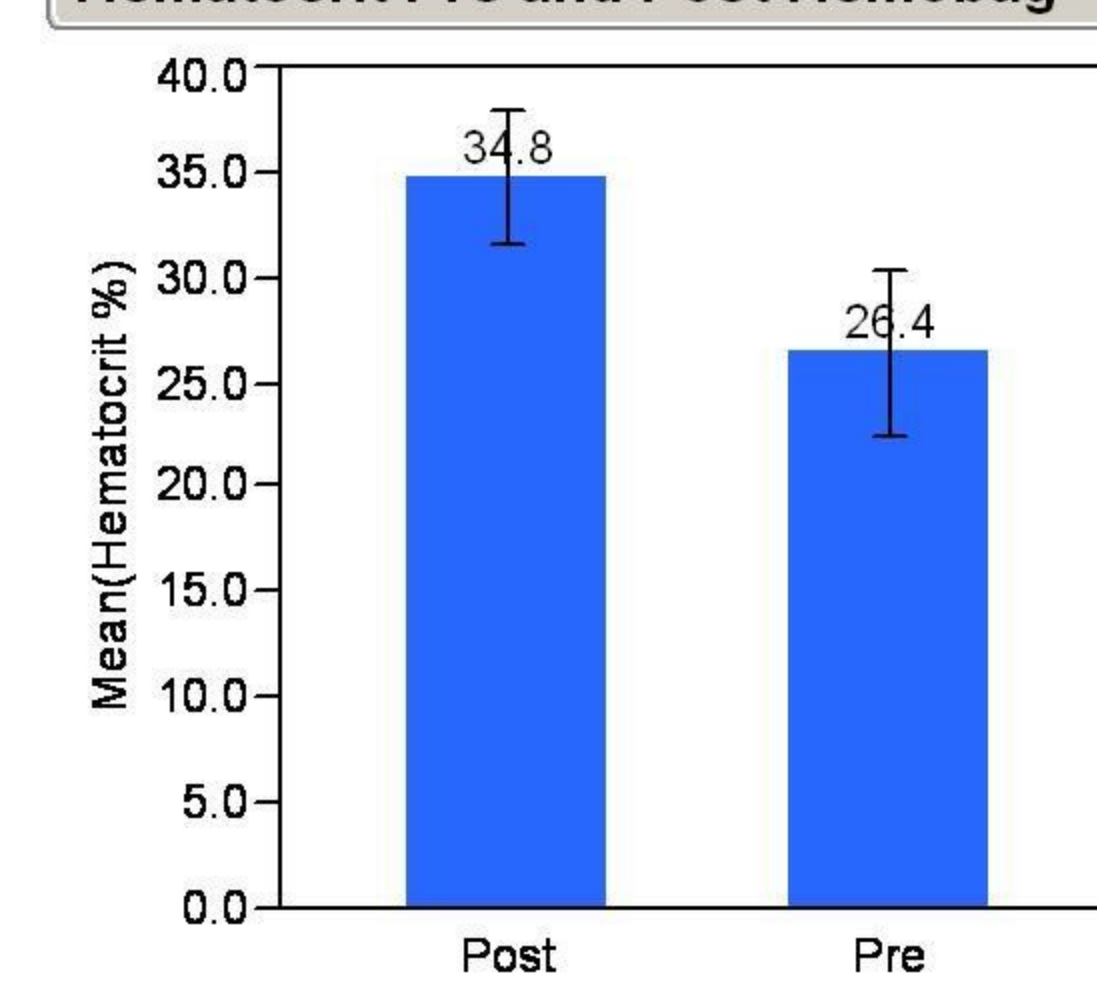
Significant reductions in PT and INR were also observed after HBV content infusion however, there was only a strong trend in decreased average aPTT.

Table 1: Results of coagulation parameter changes after administration of concentrated ECC residual whole blood using the Hemobag®

Parameter	Post Change	Std Err	t value	p value
Hematocrit	34.5 %	+8.2	0.7	11.24 <0.0001
Platelet count	150 K/ μ l	+34	7.8	4.33 0.0012
Fibrinogen	284 mg/dl	+60	9.5	6.37 <0.0001
aPTT	32.8 sec	-1.8	0.98	-1.79 0.1011
PT	17.3 sec	-2.6	0.32	-8.03 <0.0001
INR	1.4	-0.2	0.03	-8.00 <0.0001

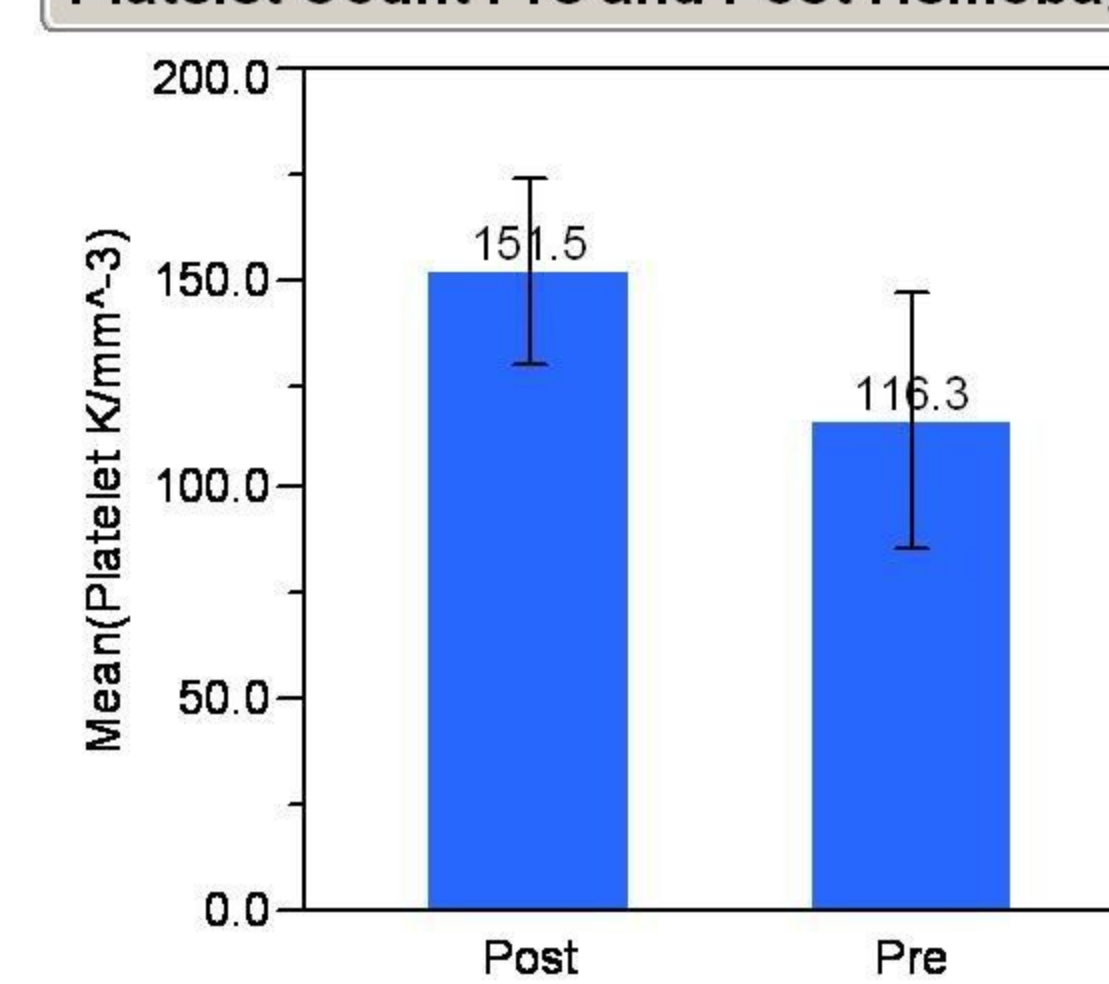
Legend: Coagulation parameter values for 12 patients (df=11) receiving an average of 1046 ml of concentrated ECC residual whole blood and 169 ml of processed washed cells are listed with the results of t-test analysis between pre and post-administration.

Hematocrit Pre and Post Hemobag



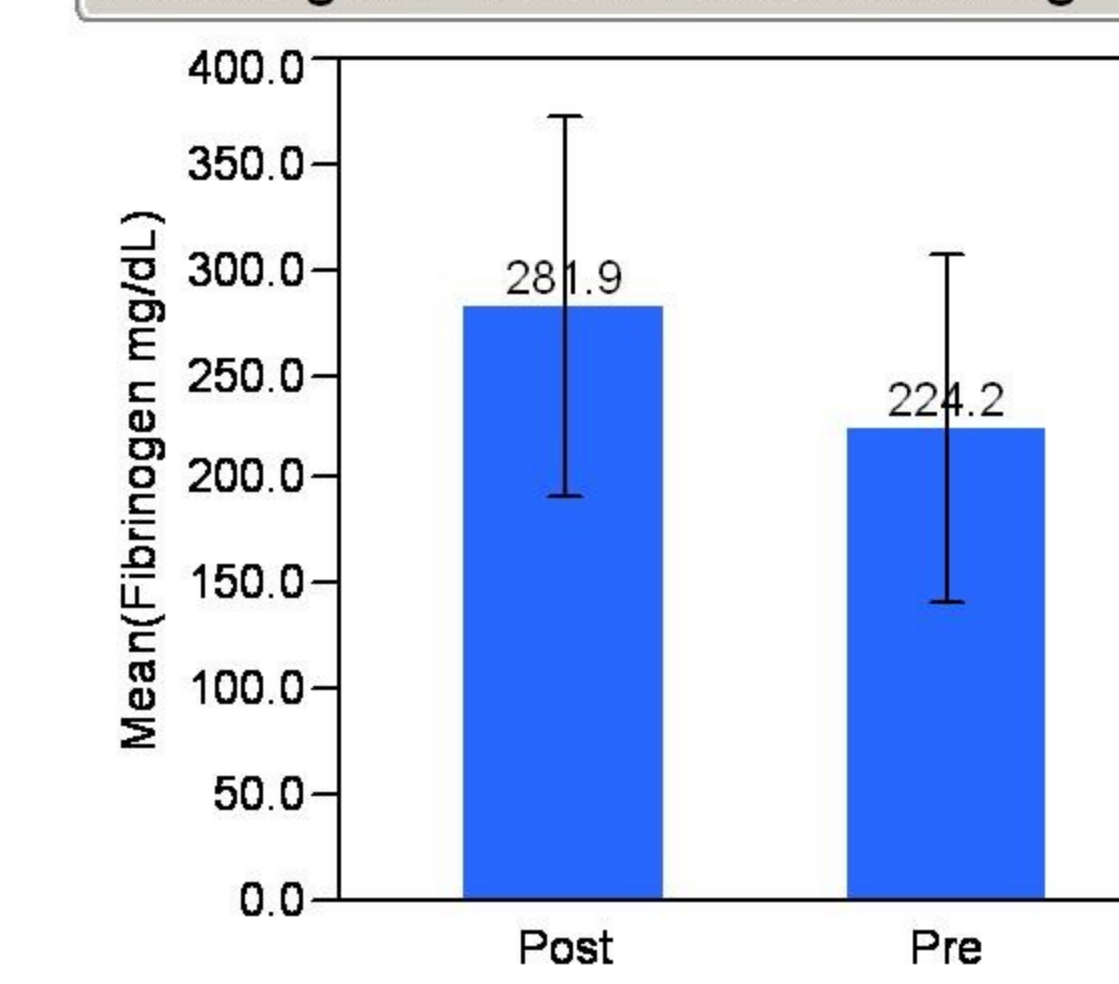
Two-sample t (11) = 11.24, mean diff = 8.2, p < 0.0001
Error bar is one standard deviation from the mean

Platelet Count Pre and Post Hemobag



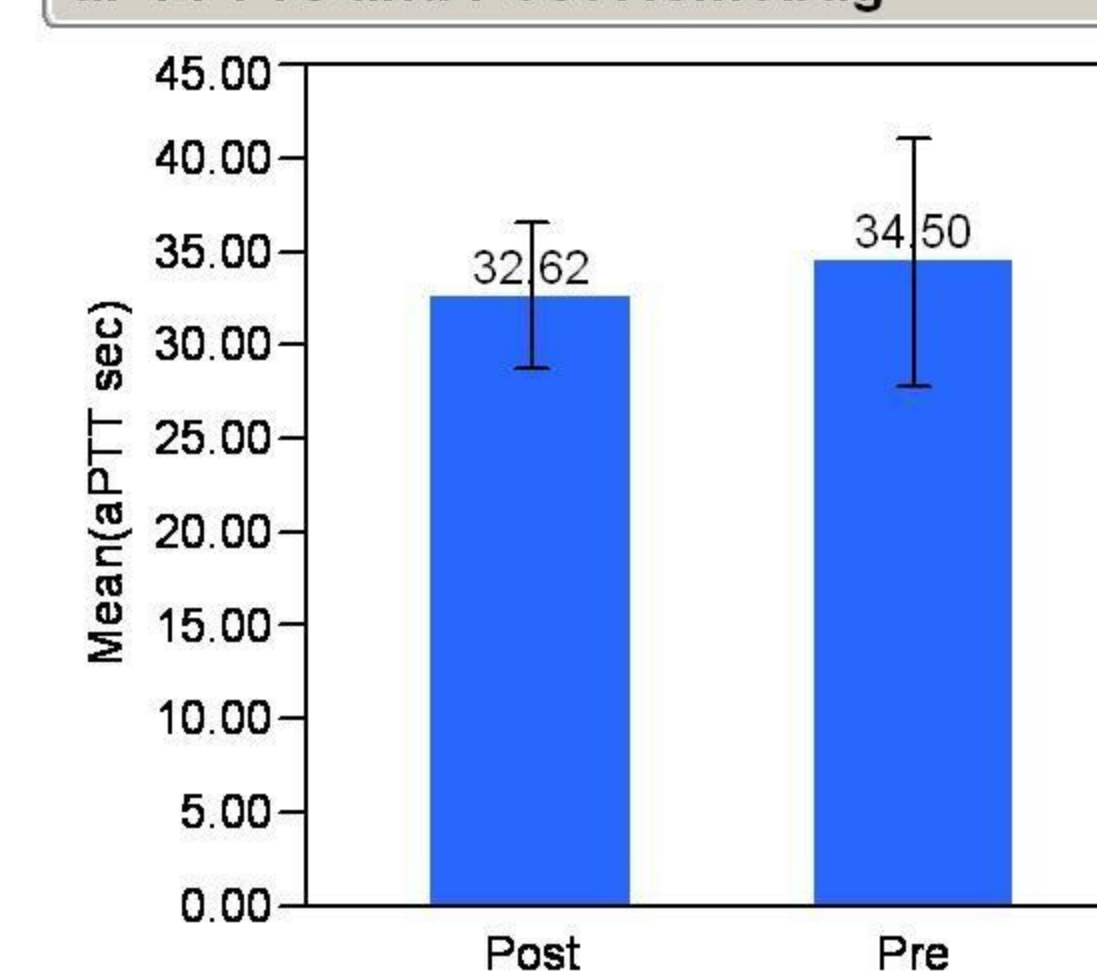
Two-sample t (11) = 4.33, mean diff = 33.8, p = 0.0012
Error bar is one standard deviation from the mean

Fibrinogen Pre and Post Hemobag



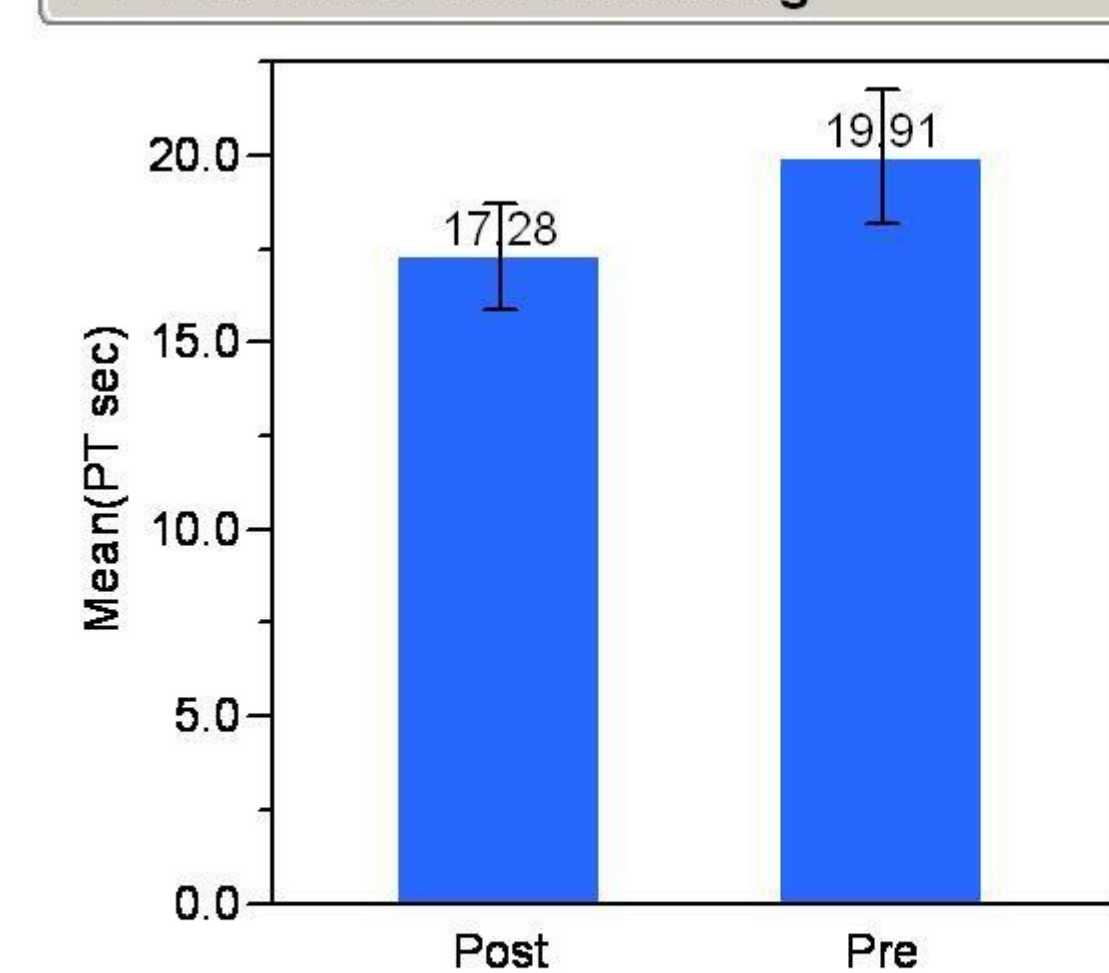
Two-sample t (11) = 6.37, mean diff = 60.2, p < 0.0001
Error bar is one standard deviation from the mean

aPTT Pre and Post Hemobag



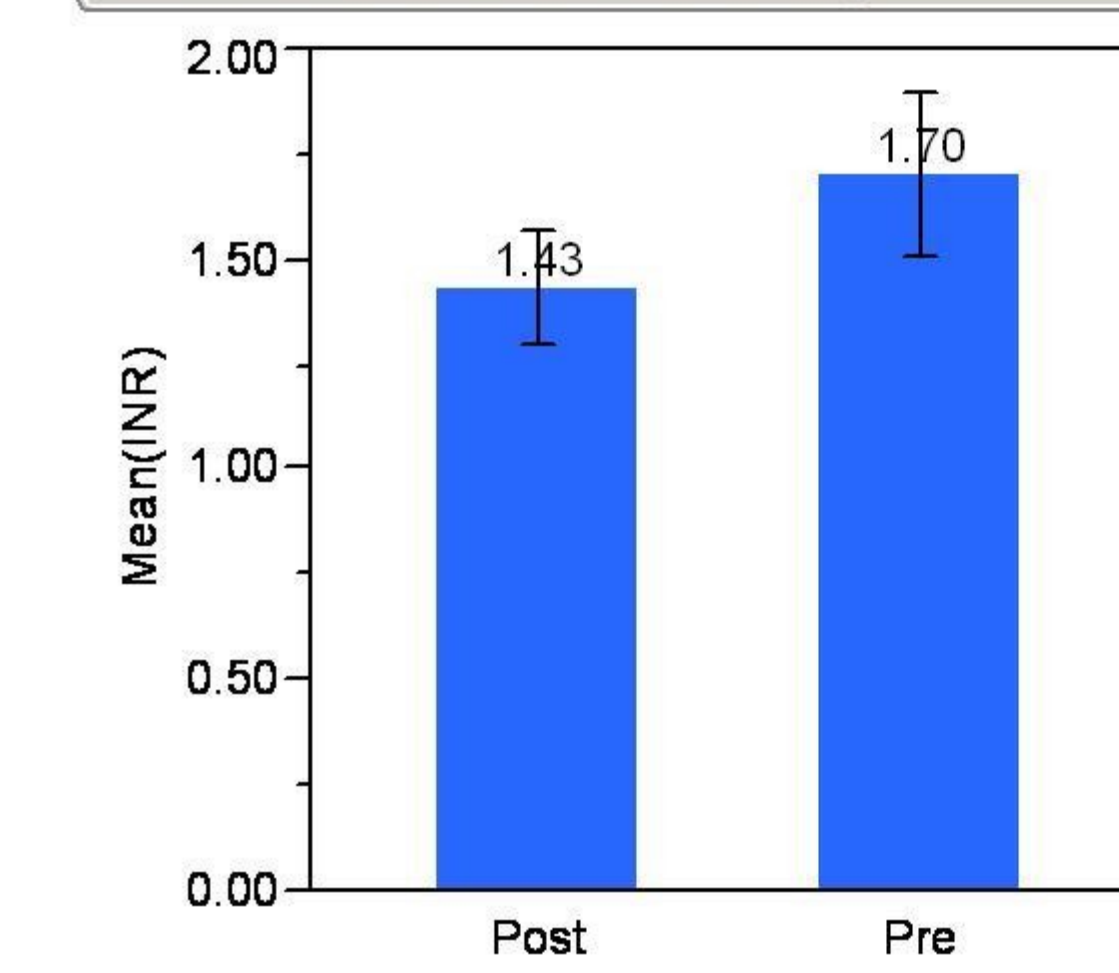
Two-sample t (11) = -1.79, mean diff = -1.8, p = 0.1011
Error bar is one standard deviation from the mean

PT Pre and Post Hemobag



Two-sample t (11) = -8.03, mean diff = -2.6, p < 0.0001
Error bar is one standard deviation from the mean

INR Pre and Post Hemobag



Two-sample t (11) = -8.00, mean diff = -0.3, p < 0.0001
Error bar is one standard deviation from the mean

Discussion

Most allogeneic blood products are transfused in the first few perioperative hours and often based upon arbitrary clinical observations without adequate documentation of the need for blood bank components (5).

Overall improvements were seen in all measured parameters. Statistically significant improvements in coagulation studies, platelet count and hematocrit levels were observed. aPTT although reduced, was not statistically significant.

The administration of concentrated autologous whole blood using this technique following CPB, significantly improved the coagulation state in these patients. Optimizing coagulation can be achieved with this technology minimizing the risks and the hazards of exposure to precarious donated blood products after coronary bypass surgery (20-26).

These results strongly suggest that cardiac surgery patients may be spared donor exposures when this efficient, "Off-Line MUF" technique is implemented and the residual bypass circuit blood is highly concentrated and quickly reinfused as compared to cell washing technologies (9-10).

Use of the Hemobag® for salvaging blood is associated with significant increases in the patient's protein and cellular concentrations. These proteins would have normally been discarded by cell washing at an average cost of about \$4,000 USD (15) thus lowering coagulation times in the important, first few hours following CPB. (11-14,22,25)

Use of "multi-pass" ultrafiltration to process the residual perfusion circuit blood far exceeds the results of "single-pass" ultrafiltration and direct infusion methods (28,34). This technology has improved our blood administration practices and greatly reduced unnecessary donor transfusions.

The Hemobag® provides patients with improved quality of care through the reduction of excess IV fluid and allogeneic blood products. Frequently, transfusions are directly related to costly, negative, patient outcomes and in many cases can be avoided (2,26,28,30).

Conclusion, the Hemobag® technology offers both the Anesthesiologist and Perfusionist an easy and improved method for optimizing both Coagulation and Fluid Shifts (Homeostasis) immediately after decannulation, which lasts for hours after the termination of cardiopulmonary bypass well into the ICU recovery phase. The Hemobag® infusion helps to reduce exposures to donor (allogeneic) blood products in cardiac surgery which improves outcomes.