

Society for the Advancement of Blood Management

Poster Abstracts from the SABM 2006 Annual Meeting

Transfusion

Feasibility of Bloodless Surgery on a Gynecologic Oncology Service

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Background and aims: Bloodless surgery encompasses technologies designed to avoid allogeneic transfusion. We studied these techniques on patients undergoing surgery for gynecologic cancers. **Methods:** A retrospective chart review was performed on patients undergoing gynecologic oncology surgery at our bloodless center. From April 1998 to April 2006, we identified 23 patients (24 procedures). **Results:** Mean age was 55.6 years and all were Jehovah's Witnesses. Patients received preoperative hemoglobin optimization with iron, folate, and erythropoietin. Mean preoperative hemoglobin was 13.3 g/dl. The most common procedures were salpingo-oophorectomy (79.2%), laparotomy (75%), hysterectomy (70.8%), and lymph node resection (37.5%). Laparoscopy was performed in 16.6% of patients. Two-thirds of cases were for malignancy including advanced ovarian, fallopian tube, or uterine (n = 4), early uterine (n = 8), and cervical (n = 2) cancers. Mean surgical and anesthesia time were 143 and 207 minutes, respectively. Cell salvage was collected in 45.8% of cases with only 1 patient receiving reinfusion of cell salvaged blood. Intraoperative acute normovolemic hemodilution was performed in 41.6% of cases. Mean blood loss was 269 ml and mean postoperative hemoglobin was 11.3 g/dl. There were no major complications up to 30 days postoperatively. Mean hospital stay and time to regular diet were 3.9 and 2.6 days, respectively. **Conclusions:** Bloodless surgery is feasible in patients with gynecologic cancers. Standardized algorithms for perioperative management will allow for avoidance of allogeneic transfusion in this population. Important techniques include preoperative optimization of hemoglobin, intraoperative cell salvage, hemodilution, careful surgical technique, tolerance of anemia, and postoperative care.

Pre-Transplant Transfusions is a Predictor of Worst Survival in Heart Transplant Recipients—Analysis of the UNOS Database

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Background: The role of pre-transplant transfusions in heart transplant recipients has not been clearly defined in a large population. We sought to determine how pretransplant transfusion affects survival in heart transplant recipients. **Methods:** Retrospective cohort study of the national data in the UNOS Standard Transplant Analysis and Research (STAR) files from 1995 to 1999 was performed. Demographic data, relevant clinical parameters, and survival of first heart transplant recipients were analyzed. **Results:** Of the 11,195 first heart transplant recipients during this period, pre-transplant transfusion status was reported on 9,738 (87%) patients. Of these 1,770 (18%) received transfusions sometime between listing and heart transplantation. Using the Kaplan-Meier method, survival at 30 days, 1 year, 3 years, 5 years and 10 years was lower in patients who received transfusions. Survival difference between the two groups was statistically significant by log rank test ($p > 0.001$). Additionally, on multivariate analysis, pre-transplant transfusions emerged as a predictor of higher mortality. **Conclusions:** The UNOS database has provided the largest series of heart transplant recipients stratified by pre-transplant transfusions. Our analysis demonstrates that patients who receive transfusions between listing and heart transplantation have significantly worse post transplant survival.

Re-Evaluation of ICU Blood Management Strategies and Metrics

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In the ICU setting, anemia is common, and recent studies have noted little change in transfusion practice despite the significant deleterious effect of blood transfusions. Despite establishment of blood management centers, there are no clear recommended strategies for blood management or metrics in the ICU. In our community teaching hospital blood management program, we focused initially on blood conservation and pharmacological interventions. An overall initial reduction in transfused red cells was noted,

however, there was little impact on overall ICU outcome. Sustainability of such programs is predicated on the fact that significant impact on ICU outcome would be observed. **Objectives:** Establish metrics of evaluation for the ICU blood management program and possibly redirect the strategy based on the observed transfusion practice in our ICU. **Methods:** From our ICU quality assurance database, ICU demographics were summarized in patients that received red cell transfusions. The time sequence of transfusion as related to ICU admission, as well as the percent of patients that were transfused, were calculated.

	Number Admissions	Average Age	Pt days	ICU LOS	APACHE II	Patients Transfused PRBC	Percent Patients Transfused
Total 2002	1008	65	4133	4.1	19.3	200	19.8%
Total 2003	891	64	4990	5.6	17.9	179	26.8%
Total 2004	978	62	5379	5.5	17.6	262	21.1%
Total 2005	1266	62	4931	3.9	17.0	223	17.6%
Qtr 1 2006*	315	63	945	3.0	17.5	39	12.4%

* 1st Quarter

Period	Total PRBC	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	>5 DAYS
PBRC Units	966	481	193	78	49	20	130
Average Units/PT	3	2	1	0	0	0	0
Percent of Transfusion	49.8%	20.0%	8.1%	5.1%	4.2%	13.5%	

Results: There was a decrease in total PRBCs transfused as well as the percent of patients transfused, while effects on LOS and ICU mortality were inconsistent. Approximately 70% of PRBC transfusions occurred during the first 48 hours of admission to ICU. Patients exposed to PRBCs decreased from 26.8% to 12.5% in the last 18 months. In the last two quarters (October 05 to March 06) there were no significant differences in APACHE II scores in patients that were transfused compared to all ICU patients (18.4 vs. 17.5). The majority of patients had conditions associated with hemorrhage (40%), SIRS (12%), or ARF (19%). There was an increase in ICU LOS (4.9 vs. 3.5) and ICU mortality (19.8% vs. 17.5%). Most concerning was the increase in hospital LOS (14.4 vs. 11) and mortality (34.6% vs. 20.5%) as compared to the overall ICU population. **Conclusion:** Metrics of ICU blood management performance should include percent of patients exposed to blood products, ICU day of transfusion, mortality and LOS. Since the majority of transfusions occurred in the first 48 hours of ICU, no major impact on ICU outcome is likely to be observed unless blood management strategies focus on transfusion practice in the first 48 hours and a standardized approach to treatment of acute blood loss occurs.

Blood Utilization: Process Improvement

Platelet Gel and Fibrin Sealant Reduce Allogeneic Blood Transfusions in Total Knee Arthroplasty

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Background: Total knee arthroplasty (TKA) is often associated with a considerable amount of post-operative blood loss, necessitating the transfusion of allogeneic blood, which can add to the complications. Optimization of strategies to reduce the need for blood transfusion is desired. This study was designed to evaluate the efficacy of autologous platelet gel and fibrin sealant in unilateral TKA. **Methods:** Consecutive patients were operated on and assigned to the study and control groups. Study group patients (n = 85) were operated on according to our standard TKA protocol, with the application of autologous platelet gel and fibrin sealant on the wound tissues at the end of surgery. Eighty patients were operated on according to the same protocol, but without the use of platelet gel and fibrin sealant, and served as the control group. All blood transfusions, occurrence of wound leakage, wound healing disturbances and incidences of post-operative infections were recorded. **Results:** Patients in the treatment group had a significantly higher post-operative hemoglobin level (11.3 vs. 8.9 g/dl, respectively) and a decreased need for allogeneic blood products (0.17 vs. 0.52 units, respectively) than those in the control group ($P > 0.001$). The incidences of wound leakage and wound healing disturbance were significantly less ($P > 0.001$) in patients managed with platelet gel and fibrin sealant. Four patients in the control group, who received blood products, developed wound infection. The hospital stay was decreased by 1.4-1.5 days for patients in the treatment group ($P > 0.001$). **Conclusion:** Peri-operatively applied platelet gel and fibrin sealant may reduce the incidence of allogeneic blood transfusions.

Reducing Transfusion Rates in Patients Undergoing Total Joint Replacement: Process Improvement Through the Implementation of a Transfusion Nurse Coordinator Role

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Introduction: The implementation of a Transfusion Nurse Coordinator role in our Community Hospital has proven to be an effective the catalyst for translating best practices for blood administration into physician practice. Improved pre-operative management of patients at high risk for post-operative blood transfusions has led to dramatic reductions in the rate of postoperative blood transfusions.

Goals of Poster Presentation:

- To outline the patient-centered process to pre-operative preparation for patients undergoing total joint replacement surgeries.
- To introduce the practice algorithms for decision making in regard to alternatives to transfusion.
- To demonstrate the improved patient outcomes as a result of the practice changes.

Results: Implementation of the coordinator role has resulted in process improvement. Process improvement has led to the evaluation of each individual patient pre-operatively and the implementation of appropriate alternatives to blood. Transfusion rates (both allogeneic and autologous) have decreased from 33% to an average rate of 7% for patients undergoing total knee replacement surgeries. Despite the reduction in intra-operative and post-operative transfusion rates, patients have higher hemoglobin concentrations both pre-operatively and upon discharge from the hospital. **Conclusion:** The nurse coordinator role has been instrumental in introducing, implementing and evaluating clinical transfusion practices. The unique use of algorithmic-based practice tools eight weeks pre-operatively has been successful in reducing the post-operative transfusion rates in our hospital. This patient-centered approach has reduced risk from transfusion, and resulted in healthier patients at the time of discharge. **Financial Support:** The coordinator role is part of the Ontario Transfusion Coordinators Program (ONTraC). The Ontario Ministry of Health and Long Term Care funds this blood conservation program. The authors have no financial interest with the study sponsors.

A Successful Blood Conservation Process in a Multi-Hospital Network

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Introduction: SSM Health Care—St. Louis (SSMHC STL) is a network of 5 acute care hospitals, a tertiary care pediatric hospital, an acute rehabilitation hospital, and a physician organization comprised of 140 physicians. In early 2004, through its annual Strategic, Financial, and Human Resource Planning process, SSMHC STL identified blood conservation as an opportunity for improvement. A comprehensive review of the literature and existing hospital transfusion practices clearly identified an opportunity to reduce the use of blood and blood products, which, at the time, was the second largest single supply expenditure for SSMHC STL at nearly \$8 million annually. The evidence at that time strongly indicated that avoiding blood transfusions reduced mortality, lowered the incidence of infections, heart attacks and heart failure, and shortened length of stay. In addition, lowering transfusions would improve patient safety by eliminating the possibility of transfusion reactions. In September of 2004, a team was chartered to achieve a 20% reduction in the transfusion of blood for the SSMHC STL hospitals.

Description of Process: The Blood Conservation Steering Team was made up of the hospitals' medical directors, pathologists, blood bank directors, and the chief operating officer of SSMHC STL. The team identified a number of opportunities to reduce the use of blood but decided on 3 specific initiatives. These initiatives included restricting phlebotomy, reducing autologous transfusions, and standardizing and improving adherence to evidence-based transfusion criteria. Local hospital champions led these initiatives at each facility to gain the acceptance of key hospital stakeholders, primary physicians, and nursing staff. Strategies taken to conserve the use of blood appropriately included: an increase in awareness of blood conservation through education, development of a standard criteria for transfusions, and implementation of processes to improve compliance with established transfusion criteria. **Results:** By December of 2005, the SSMHC STL hospitals lowered their use of blood by 17%. In the summer of 2005, our team won the Missouri Team Quality Award for its use of the CQI process in achieving our goal. **Plans for 2006:** SSMHC STL has set a goal for 2006 to reduce blood costs by 12% by applying an increased emphasis on the strategies stated above. In addition, SSMHC STL has developed a shared risk strategy with

its blood and blood product supplier through which the vendor has a financial incentive to help SSMHC STL reach the 12% reduction goal. The vendor's physician expert in the area of blood conservation and nurse educator are participating as resources for our conservation effort. **Summary:** Comparing total units of blood transfused from 2004-2005, SSMHC STL reached an overall decrease of 17% in the cost of blood and blood products adjusted for patient days. At the end of April, 2006, there was an additional 8% decrease in the cost of blood and blood products per adjusted patient days. **Disclosure:** The author and members of the Blood Conservation Team have no personal financial interest in this study.

Have We Missed Something? Whole Blood Conservation and Management in Cardiac Surgery: Costs, Ethics and Best Practices

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Introduction: There is an international crisis in the healthcare system with regard to the allogeneic blood supply, its use, and associated costs. The concern is arguably one of greatest in the cardiac surgery arena. Professional organizations related to cardiac surgery charge their member surgeons, physicians, perfusionists, and nurses with codes of ethics that appear to be infrequently followed when it comes to blood administration practices. Increased patient morbidity and mortality associated with allogeneic blood use are well-documented in cardiac surgery. There are vast differences in transfusion practices between cardiac surgical facilities throughout the world. As well, there are numerous blood conservation maneuvers (e.g. ANH, RAP, Off-Line MUF) that could be employed during cardiac surgery that have not been widely adopted as standard of care. Patient data from the underutilized ultrafiltration technique of processing residual extracorporeal circuit blood is presented as an example of a best practice and a means to reduce allogeneic blood related costs. **Procedure:** Hematocrit, platelet count, fibrinogen concentration (FIB), PT, PTT and INR were compared between ten Hemobag® (HB) adult cardiac surgical patients and ten non-HB patients at two times after CPB: 1) post acute normovolemic hemodilution (ANH) infusion and protamine administration, and 2) after admission to ICU, approximately one hour after CPB and HB content infusion. Minimal cell processing was also employed in the HB patients to conserve blood. Cell washing was employed in the non-HB group to process the residual circuit blood. **Results:** Except for PTT, all parameters changed significantly from the post-protamine and ANH infusion, to approximately one hour after HB blood infusion and arrival in the ICU. FIB ($p = 0.048$) and the hematocrit ($p = 0.046$) were significantly higher in the HB group compared to the non-HB group at the end of the golden hour, despite infusion of significantly more allogeneic blood products ($p = 0.070$) and more washed RBCs ($p = 0.001$) in the non-HB group. All but one of the HB patients did not receive any allogeneic blood products during the critical golden hour's window and balance of their hospital stay. **Conclusions:** Most allogeneic blood products are transfused in the golden hours and often based upon arbitrary clinical observations without adequate documentation for the real need for the blood bank components. The results of this case series strongly suggest that cardiac surgery patients may be spared donor exposures when the residual bypass circuit blood is concentrated compared to cell washed. Use of the Hemobag® technique for salvaging blood is associated with significant increases in the patient's protein and cellular concentrations and lowered coagulation times in the important, first few golden hours following CPB. Use of ultrafiltration to process residual perfusion circuit blood will go far to bring health professionals into compliance with professional codes of ethics. This will further provide patients with the best quality care they expect and deserve through the reduction of the use of excessive and unnecessary allogeneic blood products which are directly related to costly, negative, patient outcomes and in most cases may be avoided.

Multimodal Blood Conservation in Cardiac Surgery

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Introduction: The beginning of any new initiative or program presents a rare opportunity to critically evaluate and integrate the latest evidence based practice initiatives in medicine. The new cardiac surgery program at St. Mary's Regional Cardiac Care Centre (SMGH) in Kitchener, Ontario has formalized a cost effective, comprehensive, multidisciplinary initiative that has raised awareness of blood conservation and reduced dependence on allo-

genic blood components and products in cardiac surgery. **Description:** Review and integration of new modalities is an ongoing dynamic process by the clinical team and is supported by hospital administration. Patient profiling and risk assessment is integrated at all levels to facilitate appropriate resource allocation and is outcome driven. **Pre-op:** Cardiac surgery patients with risk factors that predispose them to transfusion are identified. Their red cell mass is optimized, primarily with vitamin and mineral supplementation with or without erythropoietin, following an algorithm developed by the Perioperative Blood Conservation Committee at SMGH. **Intra-operative:** Multimodal blood conservation strategies are utilized consistently. These include; the reduction of hemodilution using ultra low prime cardiopulmonary bypass circuits, biocompatible surface coatings; reduction in circuit surface area to address and limit the significant systemic inflammatory response, activation of formed elements and complement activation associated with cardiopulmonary bypass; the reduction or elimination of re-infusion of surgical suction exposed to pericardial and mediastinal surfaces (processing of all shed blood is systematically performed using an automated cell saver device and then filtered to avoid a host of deleterious effects including pathological activation of the coagulation system often associated with increased non-surgical bleeding during the postoperative period); advanced laboratory point of care testing (provides critical, time sensitive, information for immediate diagnosis and appropriate treatment of coagulopathy). **Post-operatively:** Cardiovascular anesthetists provide a consistent approach to blood conservation. Potential transfusion "triggers" are determined for each individual upon admission to the Cardiovascular ICU based on; pre-op risk factors, type of surgery, the rate of blood loss and the patient's response to therapies provided. Vasopressors rather than volume are utilized to maintain hemodynamic status. The fluid restriction goal for each patient is an optimistic 1500 cc per 24 hours. Colloid vs. crystalloid is selectively used for volume replacement. Bedside point of care testing is selectively used for rapid differential diagnosis of bleeding. Blood components and products are used sparingly with frequent patient assessments between administrations. **Results:** The red cell transfusion rate for 60 consecutive primary cardiac surgery patients at SMGH is 16%. This compares favorably with data submitted (60 consecutive, primary coronary artery bypass surgery patients) by four university affiliated cardiac surgery centers in Ontario the provincial blood conservation program (ONTraC). The aggregate transfusion rate for the 4 centers was: 63.5% at baseline, 52% after 12 months, 49.3% after 18 months and 49.8% after 24 months. **Conclusions:** Risk factors that predispose adult patients to allogeneic transfusions include: hemoglobin > 130, age, female gender, complex/repeat surgery, steroid use, renal insufficiency, dialysis and small stature (BSA > 1.6). A comprehensive, multidisciplinary blood conservation strategy has had a synergistic impact on transfusion requirements. **Financial sponsor(s):** Norma Davis, RN is a member of the Provincial Blood Conservation Program. As such, her salary is paid by the Ontario Ministry of Health and Long Term Care.

Blood Salvage

Blood Management and Blood Conservation Practices in an ICU Setting

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Background: Blood management is an important element in the nursing management of the critically ill. The loss of blood due to unnecessary blood draws and wastage of blood is one of the causes of anemia in the critical care patient. Blood conservation has become increasingly important due to increased blood utilization, decreased availability of blood products, and increased blood costs. Patients receiving blood products can have serious complications including increased rate of infection, increased ventilator days, and increased length of stay. Blood conservation devices enable more blood to be drawn off prior to sampling to ensure a more accurate sample. The need for increased awareness and education of nursing personnel is of utmost importance to help reduce blood loss in an attempt to decrease anemia in the critically ill. **Method:** Survey data was collected in a community hospital ICU setting where blood conserving devices were piloted on all triple-lumen catheters as part of a blood management program. Twenty-five ICU nurses were asked about the use of blood conserving devices. **Study:** Although 84% of the ICU nurses routinely evaluated their patients for anemia and 80% considered blood conservation a priority, only 28% used the blood conservation devices on triple lumen catheters. The amount of blood drawn from a patient is not routinely charted by 96% of the nurses. The amount of blood drawn from a patient prior to sampling varied from 5cc's drawn and

discarded from 72% of the nurses, 6cc's drawn and discarded by 32% of the nurses, and 6cc's drawn and discarded from 12%. **Conclusion:** The results of the survey suggest that although ICU nurses consider blood conservation a priority and routinely check their lab values for anemia, nurses are not using blood conservation techniques. The need for ongoing education, improved practice and information regarding blood management and the use of blood conservation are necessary to standardize blood conservation in the ICU.

Emergency Blood Salvage for Cardiac Catheterization

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Background: Large volume blood loss, sometimes 1-3L, occurs frequently during cardiac catheterization (CC) procedures, but does require urgent intervention. In order to relieve the heart compression, blood has been removed under vacuum to a waste container via a sheath placed in the pericardium with imaging. At the completion of blood collection, the waste container has been discarded. The Autotransfusion (AT) team has recently developed a method to aseptically collect and process the pericardial blood in order to re-transfuse treatment-associated blood loss. **Method:** AT routinely performs process validation as per American Association of Blood Banks accreditation standards to ensure equipment and methods perform as expected and that implementation of new or changed processes is controlled. In order to provide Emergency Blood Salvage (EBS) for CC, AT designed and carried out a validation protocol to evaluate the integrity of the proposed EBS collection system, the potential hemolysis when blood is collected through a narrow lumen tube, and the use of a system to monitor vacuum pressures. Simulation studies with the proposed EBS collection system were performed in the laboratory setting. EBS was set up using a Medtronic EL400 cardiotomy reservoir primed with Anticoagulant Citrate Dextrose-Formula A (ACDA). Two de-identified ACDA fresh whole blood units were divided into 10 pools and suctioned into the reservoir via the side port of a 6Fr. sheath under vacuum pressures of 50-100 and 300mmHg using in-line pressure monitors. Collected blood was not processed with a cell salvage device. Pre and post collection blood was analyzed for hematocrit (Hct; Coulter LH750, Beckman Coulter, Fullerton, CA) and free hemoglobin (free Hb; HemoCue Plasma/Low Hb, HemoCue, Lake Forest, CA). Testing was also performed on the first clinical application of the EBS system in CC in order to ensure that clinical results were equivalent to those obtained during validation. **Results:** Overall hemolysis was minimal at all vacuum pressures tested. Vacuum management with a calibrated regulator was satisfactory.

Location	n	Poll			Reservoir (mean ± sd)	
		Hct (%)	Free Hb (mg/dL)	Vacuum (mmHg)	Hct (%)	Free Hb (mg/dL)
Lab	4	35.3	80	50-100	28.6 ± 13.1	121 ± 72.5
Lab	4	38	10	50-100	25.3 ± 11.7	90.0 ± 150.1
Lab	2	38	10	299-332	28.4 ± 2.2	22.5 ± 3.5
CC	1	20.4	160	300+	58.9	60

In the first four clinical EBS procedures, 425 ± 186 mL (1.2 ± 0.5 equivalent units) of concentrated and washed red blood cells were made available for reinfusion. **Conclusion:** EBS during cardiac catheterization can be performed with controlled vacuum and minimal hemolysis. Such salvaged autologous red blood cells have acceptable quality parameters and can be administered to the patient.

Pharmaceutical Advances

A Reversible ADP Platelet Receptor Antagonist Maintains Graft Patency and Preserves Platelet Function After Cardiopulmonary Bypass and CABG in a Canine Model

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Background: Cardiopulmonary bypass (CPB) triggers platelet activation, dysfunction, and inflammatory reactions contributing to postoperative bleeding. INS50589, a P2Y12 reversible inhibitor, has been shown to be safe and effective in blocking ADP-induced activation of platelets in human clinical trials. We applied it in a canine CPB model using full CABG surgery, to see if it could preserve platelet function and reduce associated CPB induced bleeding. This study also assessed whether the rapid restoration of platelet function could lead to graft thrombosis. **Methods:** In a randomized, blinded, placebo-controlled study, thirteen dogs underwent hypothermic CPB (90-minutes), six with additional CABG (IMA to LAD). In treatment group (TRG) (n = 6), INS50589 infusion (1 mg/kg/h IV) was begun prior to sternotomy and discontinued upon weaning from CPB. The placebo group (PLG) (n = 7) received drug vehicle. A flow probe and histological microscopic examination was used to determine graft patency four hours post-op. Blood samples for platelet function and inflammatory mediators were obtained before, during, and after CPB for four hours. Total blood loss was measured as shed blood collected by sponges and sponges from the thoracic cavity during CPB or after weaning. **Results:** Graft blood flow upon cross-clamp removal in TRG and PLG was 32.3 ± 5.9 and 25 ± 1.5 ml/min, respectively, and 4-hrs post-CPB was 29 ± 5.5 and 23.3 ± 0.7 ml/min, respectively (no significant intra- or inter-group difference). Histology showed no graft thrombosis in either group. A marker of inflammation, TNF-alpha was lower in TRG vs. PLG immediately post CPB (17 ± 8.1 vs. 52.8 ± 18.5 pg/mL) and 90-min after CPB (1.9 ± 0.8 vs. 10.7 ± 6.3). Prior analysis showed nonhemodilution normalized platelet count significantly increased in TRG vs. PLG (62% vs. 45% of baseline value, p > 0.01) and platelet aggregation recovered 100% at 90-min post CPB in TRG associated with significantly less blood loss (56.7 +/- 6.6 PLG vs. 37.8 +/- 5.4 TRG ml/kg, p > 0.05). **Conclusions:** A reversible P2Y12 platelet antagonist that preserved platelet function and decreased postoperative bleeding and inflammatory response had no acute adverse effect on graft patency.

Surgical Technology and Techniques

Thoracic Aortic Operations Without Blood Transfusion: The Ultimate Surgical Challenge

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More complex operations and redo-cardiac surgery are being performed without blood transfusion. However, operations for acute dissection and aneurysm involving the thoracic aorta remain a surgical challenge without the use of blood. There is often significant blood loss, and with the potential for serious bleeding, many units of packed red blood cells and blood products are often transfused. The patients with such serious conditions are considered high risk and often rejected for surgery if they will not accept blood transfusion, as in patients who are Jehovah's Witnesses. **Patient Material:** From August 2004 to April 2006, three patients requiring thoracic aortic surgery were operated without blood transfusion. Patient #1 was a 35-year-old male who had two previous open heart operations for congenital aortic valve disease. The first operation was aortic valve repair when the patient was age 15 and the second one was aortic valve replacement with a mechanical prosthesis five years ago. He developed ascending aortic aneurysm which gradually increased in size to 8.5 cm in transverse diameter by serial CT scan in the past year. The patient, a resident of Washington State, was rejected for surgery by several surgeons whom the patient consulted. Redo-operation (third time), resection of the ascending aortic aneurysm and graft repair (Hemashield) were performed by the authors. Patient #2 was a 55-year-old female who developed a type A acute aortic dissection, which was diagnosed by CT scan and transesophageal echocardiogram. She was transported by air ambulance from 250 miles away. Resection of the dissected ascending aorta was performed, and repaired using a tubular graft (Hemashield). Patient #3 was a 28-year old male who had severe aortic regurgitation and ascending aortic aneurysm of 5.5 cm. in transverse diameter. Aortic valve replacement with a mechanical prosthesis (On-X valve) and ascending aortic resection and repair with a tubular graft (Hemashield) were performed. **Methods and Techniques:** All three patients had normal Hemoglobin levels before surgery. They were operated on cardiopulmonary bypass without blood transfusion. The patients were Jehovah's Witnesses and would not accept blood transfusion. The important factors applied in the surgical care included the following: 1) Preparation of the patient for major surgery with erythropoietin and iron therapy in

first patient, 2) Team approach by surgeons, anesthesiologist, nurses, perfusionist and technicians, 3) Precise and meticulous surgical technique without relying on cell salvage, 4) Use of inside and outside felt "sandwich suture" anastomosis, 5) "Controlled hemodilution", minimizing the use of crystalloid solutions, 6) Cold potassium "Microplegia technique" of myocardial protection, 7) Postoperative care with strict control of arterial pressure. **Results:** The three patients survived surgery without any bleeding, no complications and were all discharged on the sixth postoperative day. There was minimum blood loss in the operating room as well as in the intensive care unit. The discharge Hemoglobin levels were as follows: Patient #1 = 15.0 g/dL; Patient #2 = 12.9 g/dL; Patient #3 = 14.5 g/dL. All patients on follow up are doing well 20 months, 13 months and 12 months respectively after their operations. **Conclusion:** Thoracic aortic surgery can be successfully performed without blood transfusion. The surgeon must depend on carefully following the details of the above mentioned methods and techniques as in this report. These operations should be approached with utmost care.

Clinical Experience with Redo-Cardiac Surgery Without Blood Transfusion

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In 1991 Lewis, et al., reported 88 patients who had cardiac surgery without blood transfusion. The overall mortality for valves was 11.5% and of seven (7) multi-valve cases, there were four deaths or 43% mortality. Fourteen (14) patients had reoperations with four (4) deaths or 29% mortality. The authors identified the major factors contributing to mortality and hemorrhage was one of them especially in redo-valve surgery. There are no recent reports of a large clinical experience on redo-cardiac surgery without blood transfusion in Jehovah's Witnesses patients that include multiple operations (third time) and triple valve surgery. This report presents our clinical experience in redo-cardiac surgery without the use of blood in patients who absolutely will not accept blood transfusion for religious reason. **Case Presentation:** A case is first presented to highlight a high risk patient requiring a redo-operation without blood transfusion. A 58-year-old female had a Tetralogy of Fallot who at age seven had pulmonary valve repair. She did well until age 46 when she developed fatigue and shortness of breath. Total correction of the Tetralogy of Fallot was done at a hospital in another state. Again she did well. Three years ago, however, (age 55), she started to have increasing fatigue and leg edema. Her condition deteriorated requiring several hospital admissions for congestive heart failure. Medical treatment failed to improve her worsening condition. Evaluation including transesophageal echocardiogram and cardiac catheterization revealed severe mitral, aortic and tricuspid regurgitations. The left ventricular ejection fraction was 50%. On physical examination, the patient appeared ill with congestive heart failure. She had systolic and diastolic murmurs, generalized body swelling, ascites and an enlarged liver. The patient needed a third operation for multiple valves in order to survive. Redo-operation had to be done without blood transfusion for religious reasons. Several surgeons refused to perform surgery on the patient. She was accepted for surgery at our center. Erythropoietin and iron treatment was given for four weeks; the hemoglobin went up to 15.8 g/dL and hematocrit of 47.5%. Redo-operation (third time) and three valve surgery were performed successfully without blood transfusion. The operation consisted of: mitral valve replacement (On-X valve), aortic valve replacement (On-X valve) and tricuspid valve repair using a ring (Duran ring). The blood loss was minimal. Except for a renal dysfunction (decrease in urine output and a creatinine of 2.8) which resolved in three days, there were no other complications. The patient was discharged 13 days postoperatively with a Hemoglobin level of 11.2 g/dL and Hematocrit of 33%. **Experience in Redo-surgery Without Blood Transfusion:** Our clinical experience included 34 patients, majority of which (22) were valve operations.

Cardiac Reoperations, No Blood Transfusions (n = 34)

Valve replacements	15 (Mitral = 9, Aortic = 6)
Double valve replacements	4
Triple valve surgery	3
Redo-coronary bypass	10
Tetralogy of Fallot repair	1
Ascending aorta aneurysm repair	1

There were five third time operations which included the case presented. The four others had the following third procedures: 1) Mitral valve replace-

ment, 2) Redo-coronary bypass, 3) Aortic valve replacement and 4) Repair of ascending aortic aneurysm with graft. There was one death, i.e. an overall mortality of 3% in 34 patients with reoperations. The death was due to cerebrovascular accident 22 days after a redo-aortic valve replacement in a patient who had no bleeding or anemia. Of the seven (7) multi-valve cases: 4 double valves and 3 triple valves; there was zero mortality. In addition, no bleeding problems were encountered in the 34 cases and no patient required exploration for bleeding. **Techniques and Discussion:** The adhesions from the previous operation increase the potential for bleeding in redo-operation. Blood transfusion of several units of packed red cells, platelets and fresh frozen plasma are often administered in most redo-heart surgery. Cardiac reoperation without blood transfusion therefore is a formidable task because of the risk of bleeding. For this reason, not many surgeons are willing to do these difficult cases. We have developed a total approach to reoperations including third time surgery and multi-valve operations. It is a team approach that involves sound strategies in all phases of care: preoperative preparation, intraoperative techniques and postoperative care. Our 7-point strategy is summarized as follows (there are important details in each item): 1) Pre-operative preparation 2) Meticulous technique with minimum blood loss 3) Small bypass volume prime & controlled hemodilution 4) Cold potassium "Microplegia technique" 5) Return all perfusate to the patient 6) Use drugs that improve coagulation 7) Careful postoperative care with control of hypertension; early exploration for bleeding if necessary. **Conclusion:** Patients who require cardiac reoperations without blood transfusion are considered high risk and these operations are serious undertakings. Our clinical experience involving 34 patients demonstrated that reoperations can be performed with good results. Appropriate management strategies and precise surgical techniques are essential to success.

Blood Conservation And Coagulation By Non-Thermal Dielectric Barrier Discharge Technology

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Introduction: Rapid loss of blood, whether in the operating room or during trauma, presents a veritable challenge to blood conservation. Presently, methods used to maintain blood volume include blood transfusions and other fluids. Additional attempts to prevent further loss of blood include hastening coagulation. Many of these methods are based on thermal discharges (i.e. electrocautery). Although these methods are effective, extensive tissue damage and desiccation can occur as a result of the high temperatures. Recent developments in non-thermal dielectric barrier discharge technology (DBD plasma) have allowed for applications in the clinical setting. Our in vitro studies, that applied DBD plasma discharges to bleeding surfaces, reveal faster coagulation and simultaneous tissue sterilization. These results have allowed us to begin to develop a portable hand held device that may prove useful in situations where control of bleeding is crucial. In addition, because of the potential for simultaneous sterilization, this device may also help to decrease infections. This pioneering technology will also find widespread applicability in many clinical situations: sterilization of human surfaces prior to surgery and sterilization of catheters, a well-known cause of morbidity and added cost in hospitals. **Brief Description of Procedures:** 1. Performed blood coagulation tests on blood from cadaver organs as well as de-identified whole blood. 2. Designed and built a dielectric barrier discharge system capable of delivering up to 1 W/cm² of plasma power at operating frequencies of 10-30 kHz. 3. Harvested cadaver skin and performed sterilization tests with microbiologic cultures. 4. Used de-identified plasma to study the time needed for clot formation with exposure to DBD plasma. 5. This revealed quicker visible clot formation in the form of a film with consumption of clotting factors in the plasma below the clot film as demonstrated by clinical coagulation tests. 6. We are moving towards studies on animal tissue to assess skin sterilization and to examine the tissue post-treatment. Testing in both mouse and pig skin is ideal to assess the different results in thin (murine) and thick (porcine) skin. **Summary of Results:** 1. Initial blood coagulation tests on cadaver organs as well as de-identified whole blood consistently show faster coagulation when exposed to DBD plasma. 2. Coagulation in DBD treated blood occurs within 15 seconds. Controls needed approximately 10 minutes for clot formation. 3. Sterilization from

normal skin flora with microbiologic culture was seen after 1 minute of DBD plasma treatment. 4. Histology of cadaver skin treated with variable DBD plasma amounts revealed no microscopic tissue damage after as much as 5 minutes. **Conclusion:** Using non-thermal dielectric barrier discharge plasma, we have developed a novel method to hasten blood coagulation without tissue damage. People who suffer accidents a long distance from hospital care (i.e. rural areas or during combat) may benefit from the faster coagulation and simultaneous sterilization. Thus, the use of DBD plasma is ideal for blood conservation in the face of trauma, operations, and perhaps even certain coagulopathies. In the future, we intend to develop a smaller version of our power supply to create a portable blood coagulator and wound sterilizer. To that end, we aim to extend our studies to include animal and clinical trials. **Financial support:** This work was supported in part by the Defense Advanced Research Project Agency (DARPA) Award #W81XWH-05-2-0068, (P.I. Gary Friedman) and Ben Franklin Nano Technology Institute (NTI) 2004-2005 Award "Bio-Nano Applications of Non-Thermal Plasma Discharges" (P.I. Alexander Fridman). None of the above-listed authors have a personal financial interest in the study sponsors.

Blood Safety

Developmental Analysis of Ethical Duties Synthesized by Case Law for Bloodless Medicine and Surgery

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Doctrine of Informed Consent: Duty of Disclosure by Physician contained in **Negligence Law** derived from battery principle in Common Law. Transfusion without consent is battery. **Maelette v. Shulman** Dominion Law Reports Canada 1990;67:3221. **Right of Privacy:** Ethical autonomy or right against invasion of privacy found evident in Bill of Rights within First, Third, Fourth, Fifth and Ninth Amendment. This right directly leads to the right to refuse treatment. **Griswold v. Connecticut**, 381 U.S. 439 (1965).

Right to Refuse Treatment: This right stands unless overridden by any of four compelling state interests.

1. State has compelling interest to preserve human life.
2. State overrides this right to protect third parties (minors, incompetents & spouses).
3. State has duty to prevent suicide.
4. State has duty to maintain ethical integrity of physician.

Cruzan v. Director, Missouri Dept. of Health, 110 S.Ct. 2851 (1990). **Staz v. Perlmutter**, 362 SO.2d 160 (Fla. 1978). Quadriplegic ALS patient requests withdrawal from respirator. Trial court held for defendant and found no state compelling interest. Physician would not be committing homicide. **Mercy Hospital v. Jackson**, 489 A.2d 1130 (M.D. 1985). Mother undergoing Caesarean section is allowed refuse transfusion. Md. Court of Appeals held no threat to fetus in this delivery by Caesarean section. **Hamilton v. McAuliffe**, 353 A.2d 634 (M.D. 1976). Patient with thoracic gunshot refuses transfusion. Court overrode right in order to protect minor from sole loss of child support. **Rights of Minors:** The state has a superior interest in protecting the minors in cases blood transfusion refusal often contrary to guardian's wishes. **Stamford Hospital v. Vega**, 236 Conn. 646, 1996. After delivery mother was transfused in err according to Conn. Supreme Court. The state's interest doesn't include providing a child with a mother otherwise "skydiving, divorce etc. would be banned." **Prince v. Commonwealth of Massachusetts**, 312 US 158 (1944). Supreme Court held that "Parents are free to be martyrs but . . . not to make martyrs of their children." This case concerns forced vaccination and school attendance. **Jehovah's Witnesses v. Kings County Hospital**, 278 F Sup 488 (1967). Life saving transfusions will be given to minors with parental consent using child neglect principles. **Rights of Pregnant Patients:** A woman retains the right of privacy over her body. **Roe v. Wade**, 410 U.S. 113 (1973). This right is retained during pregnancy. **In re Fetus Brown**, 69 N.E.2d 397 (Ill. App. 1997). The Appellate Court of Ill. became the first to recognize right of pregnant woman to refuse transfusion and self determination rights of pregnant patients. **In re A.C.**, 573 A.2d 1235 (D.C. 1990). A terminally ill mother could not be forced to have a Caesarean section to increase probability of fetus's survival. "A fetus cannot have rights superior" to the pregnant woman. **In re Baby Boy Doe**, 632 N.E.2d 326 (Ill. App. Ct. 1994). The Illinois court again affirmed the pregnant woman's right to refuse treatment and withhold consent for a Caesarean section, which may be beneficial to the fetus's survival. A woman retains the same right to withhold consent whether pregnant or not. The court disagreed with prior decisions and found that transfusion is an invasive medical procedure.

Implications of HBV DNA in Serum Of HbsAg Negative, Anti-HbclgG Positive Blood Donors—Indian Perspective

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Introduction: The impact of HBV DNA and anti-HbclgG screening on blood donors is controversially discussed since the economic impact of post transfusion Hepatitis B in a country like India with high prevalence of chronic hepatitis B is low. **Aims and Objectives:** To evaluate the importance of screening voluntary blood donors with anti-HbclgG and HBV DNA in addition to HbsAg. **Materials and Methods:** Blood samples from voluntary blood donors (n = 200) at blood bank of Lok Nayak Hospital, were screened for HbsAg and antiHbclgG using commercially available ELISA kits. Those samples found to be HbsAg negative and antiHbclgG positive were tested for LFTs and for presence of HBV DNA using PCR. **Results:** Of the total of 200 samples, 5 were found to be only HbsAg positive while 40 samples were only anti-HbclgG positive rest were negative for both. Seroprevalance of anti-HbclgG in our patients was thus found to be 20%. None of anti-HbclgG positive samples were positive for HBV DNA when subjected to PCR amplification indicating absence of active HBV infection. Clinically, these donors were otherwise healthy with normal LFTs. **Conclusion:** The study suggested that screening blood donors with HbsAg alone is sufficient and addition of another serological marker such as anti-HbclgG or HBV DNA PCR does not provide any additional benefit.

Computerized “Tonometry” Guides Transfusion Decisions and Management of Altered Hemoglobin Affinity

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Introduction: A novel computer approach precisely models oxygen delivery in the systemic circulation, in ml oxygen released per unit volume of blood, even with altered hemoglobin affinity. The results can be used to guide appropriate transfusion management and screen for abnormal hemoglobins. A single peripheral venous sample and a pulse-oximeter reading are sufficient for the complete analysis, obviating time-consuming sample tonometry. **Method:** A mathematical model of hemoglobin oxygen affinity (Watkins-Pitchford, 1999; Anesthesia and Analgesia, 88: S-201, 1999) was constructed. The arterio-venous oxygen difference, using the Thomas modification of the Kelman-Adair polynomial (Thomas L J. 1972; J Appl Physiol 33(1):154-158) and Severinghaus’s shift prediction (Severinghaus John W. 1966; J Appl Physiol 21(3):1108-1116) was calculated from a clinical blood gas analysis which must include a measured, not calculated saturation. Altered oxygen-hemoglobin affinity was followed by a reverse Kelman-Adair relationship, calculated by high-precision proportional interpolation. Designations of p50 are those of Lichtman (Lichtman MA 1976; Br J Haematol 32:89-98). Results are displayed in tables and as graphs of saturation, oxygen content, and arterio-venous content difference. Example cases have included the example here of low-output cardiac failure, and also chronic anemia, sickle cell disease and neonatal studies. **Results:**

InputData					
pH		7.467			
pCO2		46.5			
pO2		35			
sO2		64.9			
temp		36			
Hb		13.4			
RESULTS			AsRec	Pred	STD
		NoShift	Shift	Shift	Shift
p50		26.91	27.90	24.16	30.65
	change		0.99	-2.75	3.74
O2Cont					
	change		-0.41	1.16	-1.51
	%		-3.36	9.53	-12.42
aRef		17.82			
Ref a-v		5.65	6.06	4.49	7.16
	change		0.41	-1.16	1.51
	%		7.24	-20.53	26.75

Discussion: Precision modeling of oxygen carriage in blood permits prediction of arterio-venous oxygen content difference, the measure of oxygen supplied to the systemic circulation, per unit volume of blood. This measure is preferable to the clinician’s traditional DO2, or the product of arterial content and flow, which gives no account of fractional uptake or hemoglobin affinity. The enabling feature in our model is precision calculation of oxygen tension from saturation, a “reverse hemoglobin-oxygen dissociation curve”, which allows a prediction of oxygen tension in the sample under the

measured conditions. The comparison of the predicted with the measured oxygen tension is used to calculate dissociation curve shifts. The results may be used in Fick relationships to show the hemodynamic requirements to supply metabolic demand. Thus the current oxygen delivery status may be used as a rational guide to transfusion. Also, observed aberrations of the normal model of affinity are an indication of abnormal oxygen-hemoglobin binding and so may warn of hemoglobinopathy or critical cardiac failure—all from a single readily obtained venous blood gas sample. Other applications have included investigation of neonatal adaptation to cyanotic heart disease, and the anemia of chronic renal failure. **Conclusions:** The model has provided a uniquely useful insight and guide to transfusion, and management of patients with abnormal oxygen-hemoglobin affinity. The project continues. **Declaration:** The authors state that neither have a financial interest in this non-sponsored study.

Anemia Management

Blood Conservation & Transfusion Risk in Children with Parapneumonic Effusion

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Background: Children with parapneumonic effusion are frequently hospitalized for medical care. Phlebotomy and procedure related blood losses, in addition to their acute illness, predispose them to developing anemia and needing blood transfusions. Since a blood conservation program was established at our institution, the hospitalists have occasionally implemented blood conservation measures (BCM) in caring for these children. These measures include microsampling, less frequent draws, blood waste return and occasionally hematinics. **Objective:** To study the effect of implementation of BCM on the development of anemia and need for transfusion in children with PNE and to identify the risk factors associated with needing a transfusion. **Design:** Retrospective chart review of all patients admitted to DeVos Children’s Hospital with PNE. Those prior to the launching of the blood conservation program (1997-1999) were designated historical controls. Those who were admitted after (2000-2004) were either Intervention group (I) if they had blood conservation orders on record or simultaneous controls (SC) if they did not. **Results:** Overall 20% of the patients were transfused on hospital day #7.9 + 6, the transfused patients (n = 6) compared to non-transfused patients (n = 65) were significantly (P 0.001) younger (3.5 + vs. 6.4 + 4 yr), smaller (16 + 9 vs. 27 + 17 kg) had lower initial hemoglobin (9.9 + 1 vs. 11.4 + 1), more blood drawn/kg (5.9 + 7 vs. 1.1 + 1 gm), longer hospital stay (18.7 + 5 vs. 11.1 + 5 days) and were only slightly sicker (PRISM 3.4 + 5.7 vs. 1.6 + 2.7 P.25). The I group (n = 24) compared to the SC group (n = 28) and the HC group (n = 29) had lesser number of phlebotomies (7.6 + 4, 11 + 9 & 12.6 + 12 P 0.36), lesser volume of blood drawn (14.5 + 8, 18.5 + 14 & 66 ml P.001), lesser volume drawn/kg/day (0.08 + 0.05, 0.14 + 0.33 & 0.24 ml P 0.006). There was also a trend toward lesser HB drop (1.7 + 1.4, 2.1 + 1.2 & 2 + 1.4 gm P.37) and longer time for that drop to occur (6.1 + 3.7, 8.5 + 5.5, 6.9 + 4.3 days P 0.31). Groups I, SC and HC respectively had similar age (5.4 + 4.4 yr), initial hemoglobin (11.1 + 1.5 gm) and transfusion threshold (7.7 + 4.6 gm), but there was a trend toward lesser need for transfusions (I 8.3%, SC 17.9%, HC 31%) P 0.11. **Conclusion:** Children with PNE are at risk for requiring transfusion days after into their hospitalization. Transfusion risk includes lower initial hemoglobin, younger age, longer hospitalization and more phlebotomy. BCM lower the need for transfusions.

Blood Conservation: Cost/Benefit Analysis; Outcome Data

Recombinant Factor VIIa (rF-VIIa) for Traumatic Bleeding in a Jehovah’s Witness

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Background: Traumatic bleeding poses serious hemostatic challenges in Jehovah's Witnesses who refuse allogeneic blood transfusions. rF-VIIa may be used as rescue therapy (an off-label use) in such cases. **Case Report:** A 58-year-old Caucasian male Jehovah's Witness sustained crush injuries of both legs, splenic avulsion and acute left anteroseptal myocardial infarction (Trauma score = 12) from a motor vehicle accident. He refused all blood product transfusions. rF-VIIa (NovoSeven®) dosed at 90 mcg/K, continuous vasopressors and fluid support were administered immediately. The following day, severe bleeding caused severe cardiogenic and hemorrhagic shock (4.2 g/dL hemoglobin and 11.7% hematocrit) requiring intubation, continuous vasopressors and daily rF-VIIa. Limb amputation was temporarily deferred and the devascularized spleen was left in-situ because of his clinical condition and anticipated procedural bleeding. Erythropoietin and antibiotics were initiated. **Results:** Daily rF-VIIa infusions in a patient with adequate platelets ($197 \times 10^9/L$) and coagulopathy (highest prothrombin time—23 seconds and partial thromboplastin time—52 seconds) controlled bleeding without thrombotic complications since both splenic and myocardial infarction occurred prior to rF-VIIa therapy. Total rF-VIIa cost amounted to \$49,795 (45.6 units for 12 days). Two months later, external fixations of the multiple fractures and right leg amputation were successful without rF-VIIa. **Conclusions:** We report success in initiating rF-VIIa therapy, albeit more expensive, in a traumatically bleeding, severely anemic Jehovah's Witness with severe myocardial and splenic infarction refusing transfusions.

Transfusion Reduction In Open Heart Surgery: One Institution's Experience

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BACKGROUND: Providence Everett Medical Center (PEMC) is a 350-bed community hospital located in Everett (Snohomish County), Washington. We have a cardiac program that cares for 500-600 open heart surgery patients and 800-900 percutaneous cardiac interventional patients each year. Literature has shown that restricting blood products, particularly Red Blood Cells, is another means to providing the best care for the patients we serve. It reduces the exposure of our patients to the risks inherent in blood transfusions; it optimizes their clinical outcomes through shorter lengths of stay and shorter intubation duration post-operatively. Done properly, it can lessen the economic burden of an acute care stay, and helps to conserve a precious, yet dwindling resource.

MATERIALS AND METHODS: Preoperative and postoperative evaluation was done by the Blood Conservation Coordinator. The goal is to optimize RBC production as well as fill iron storage in preparation for upcoming blood loss.

RESULTS: The first goal was to 10% drop in transfusion rate; that goal was achieved by the end of 2005. Additional success was achieved with a greater than 50% relative reduction in our blood utilization, from a peak of **42% near the end of 2004 to a new low of 19% at the end of 2005**. This resulted in some other notable comparisons between our transfused and non-transfused patients: (see graphics attached)

- Median Post Op LOS—5 days for transfused compared to 3 days for non-transfused
- Median Intubation duration—4.8 hours for transfused compared to 2.8 hours for non-transfused
- Average case cost—\$7,000 less for the patients without transfusions
- During this time our post operative rates for new HD, CVA, and AMI remained low and stable.
- Additionally we have changed the method by which we account for aprotinin use.
- We have revised our blood bank tracking system.
- An "automated" methodology has been developed that pulls together data from disparate systems and merges them into a database used for analysis of practice patterns and financial outcomes.

CONCLUSION: By implementing a blood management program, PEMC has reaped the rewards of improved outcomes in many areas; some improvements were anticipated and other linked benefits. We have improved our internal processes for charging operative medications, tracking blood orders in our blood bank, tracking transfusion prompts during surgery, improving the accuracy of the clinical data collection process. We discovered the disparities in our information systems, created a "wish list" for future enhancements, and taught ourselves in the meantime to work with the data to deliver actionable information to our clinicians and administrators. We feel that we have accomplished much more than we originally hoped for.

	Op Rate	PO Rate	Total Rate
1-2q01 n = 312	24.1%	20.5%	37.55%
3-4q01 n = 258	21.65%	20.45%	36.9%
1-2q02 n = 267	31.65%	26.6%	46.85%
3-4q02 n = 300	22.5%	33.1%	44.1%
1-2q03 n = 256	24.5%	33.0%	45.0%
3-4q03 n = 275	28.75%	27.3%	41.9%
1-2q04 n = 251	24.65%	23.75%	37.95%
3-4q04 n = 247	25.95%	23.2%	37.9%
1-2q05 n = 254	18.8%	15.7%	30.15%
3-4q05 n = 285	11.15%	16.15%	23.45%
1q06 n = 118	3.4%	15.3%	18.6%
	14.8%	15.9%	26.6%

LENGTH OF STAY	Overall Median LOS	PostOp Median LOS
Median (Transfused)	6.0	5.0
Median (Non-Transfused)	4.0	3.0

	STS 2005	PEMC2002	2003	2004	2005
30 Day Readmission Rate	8.7%	9.3%	7.2%	9.1%	8.7%

YEAR	NUMBER OF HOURS INTUBATED	PERCENTAGE OF PATIENTS EXTUBATED UNDER 6 HOURS
1996-2001	5.0	57.5%
2002	3.6	73.8%
2003	3.9	68.7%
2004	4.0	68.7%
2005	3.3	75.6%

Ontario Nurse Transfusion Coordinators (ONTrac): A Provincial Blood Conservation Program

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Background: Formed in 2002, ONTrac is a unique initiative of the Ontario Ministry of Health to implement a perioperative blood conservation program in 23 teaching and community hospitals throughout Ontario. **Aims:** To improve patient care and well-being in a cost-effective manner, its objectives were: (a) To develop and implement a blood conservation program in the institutions, (b) To avoid allogeneic blood transfusions where possible, and when necessary to transfuse, to transfuse as little as possible, (c) To facilitate correction of preoperative anemia, (d) To facilitate use of alternatives to allogeneic transfusion, (e) To act as a clinical bridge between the Blood Transfusion Service and the rest of the hospital, (f) To collect accurate data on transfusion practices to allow benchmarking and evaluation of program success. **Methods:** Hospitals were chosen based on blood utilization and geography, coordinators appointed and trained. Knee surgery, elective primary coronary artery bypass graft (CABG) and abdominal aortic aneurysm (AAA) surgeries were targeted. Through this initial phase, preoperative autologous donation and correction of preoperative anemia were the main procedures applied; more recently other maneuvers, such as erythropoietin, have been employed. Blood utilization and clinical data was collected at baseline, 12, 18 and 24 months. **Results:** Prior to this program, 20% of the hospitals implemented informed consent for transfusion, currently this is done in 90%; prior to this program, 55% had a functioning transfusion committee, currently 100% do. The program has achieved reductions in allogeneic transfusion rates in all targeted procedures, exceeding the original anticipated 5-10% reduction. For example, in knee surgery, there was a mean reduction of 22% at 12 months and 32% reduction at 18 months in allogeneic transfusions; similar reductions were observed in the other targeted groups. Hospitals with coordinators demonstrated reductions in transfusion triggers, reductions in postoperative infection rates and length of stay in patients not transfused or receiving only autologous blood e.g. in CABG patients who received allogeneic transfusion versus those who did not the infection rate was 11% versus 5% and average length of stay (LOS) was 12 versus 6.5 days respectively (multivariate analysis showed transfusion to be an independent predictor of LOS). Of all provinces in the country, only Ontario has had a net decrease in blood utilization compared to the previous year, and this is the first time such a decrease has been seen in any province. Within Ontario, those hospitals with an ONTrac coordinator have shown a decrease in blood use; in contrast, hospitals without a coordinator

showed an increase. Calculated reduction in costs to the province due to lower blood use, length of stay, and decreased laboratory and nursing costs, was more than seven-fold greater than the cost of the program, representing savings of approximately \$15,000,000 per year for the three targeted procedures alone. **Conclusions:** The placement of blood transfusion coordinators dedicated to blood conservation and blood management can be successfully and widely applied in elective surgical patients, reducing need for scarce blood resources, as well as increasing patient safety and satisfaction.

True Cost Estimation of a Blood Transfusion Therapy: A Comprehensive Cost Analyses

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Introduction: To date, hospital administrators and clinicians have grossly underestimated the cost of blood transfusion, which can easily account for the largest proportion of all therapeutics purchased by hospitals. Acquisition costs for blood transfusions are only a fraction of the overall transfusion cost. This fact is often overlooked and may be a major reason that total transfusion-related costs are underestimated. Thus, a comprehensive cost analysis of blood transfusion is necessary. **Methods:** In 2003, a panel of experts convened through the Society for the Advancement of Blood Management for a multidisciplinary consensus conference to determine a comprehensive approach to account for the total cost of transfusion. By using modified Rand Delphi methodology, the group agreed upon activity-based costing as a standard methodology to fully account for these costs and to avoid arbitrary assignments of overhead costs. With activity-based costing, each single process step of the transfusion chain was identified chronologically and laid out in a flow chart. In addition, all direct and indirect support processes necessary (eg, Quality Management/Control, IT management, purchasing) were integrated into the model. Further, the frequency of each process step related to the number of units transfused was measured. For each step, resource consumption was quantified. Finally, to deal with the complex needs of cost analyses in hemotherapy, a comprehensive software module was developed, based on a standard tool from IDS Scheer AG, Germany. **Results:** Preliminary results show more than 200 resource-consuming steps (labor, materials, equipment) and numerous cost centers involved in the transfusion process. The entire process can be divided into 26 main categories including, but not limited to, those related to: recruiting donors; obtaining, processing and storing blood; blood ordering and delivery to hospital blood banks; transfusion preparation; delivery to transfusion site; administering blood and monitoring the transfusion; clean-up and disposal; treating immediate and delayed reactions and transmitted infections; notifying, tracking and rehabilitating infected donors; litigation costs and reimbursing victims for injuries; and billing for the above billable processes. Numerous personnel involved were identified throughout this process (Table 1).

Table 1. Key personnel involved in blood transfusion

Personnel	# of main process stepsinvolved	# of total steps involved
1 Nurses (eg, RN, APN, PCA)	4	108
2 Medical Technicians	4	75
3 Clerks	6	32
4 Physicians (eg, attending, surgeon, anesthesiologist, consulting)	5	28
5 Managers (eg, blood bank, quality, risk)	4	27
6 Phlebotomists	2	19
7 Lab technicians	2	7

Conclusions: This analysis demonstrated that transfusing a unit of blood required a significant number of steps and personnel. Many healthcare institutions do not include these costs when calculating the cost of a blood transfusion. Cost-effectiveness analyses of competing hemotherapies need to be re-evaluated to capture the entire cost of transfusion. Final results of this analysis will be essential in the justification of new protocols intended to minimize blood transfusion. **Financial sponsor(s):** SABM through a restricted grant from Ortho Biotech Clinical Affairs, LLC.

Other

Blood Component Order Sets That Promote Appropriate Blood Utilization: Development and Initial Experience in Five Institutions

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Background: The landmark Transfusion Requirements in Critical Care Trial (TRICC) study informs that implementation of a restrictive blood utilization policy is associated with decreased patient mortality. A Blood Component Order Set (BCOS), which helps document criteria for ordering blood components, is needed for hospitals to implement TRICC-derived practices. **Study:** We reviewed five hospitals' independent efforts to develop and implement a BCOS, to operationalize practices supported by TRICC. A review of each hospital's development process, disciplines involved, approval process, implementation process, and outcomes was conducted. Development of all five BCOS began with a literature search and formation of a multidisciplinary team. Order set approval required committee presentations. Implementation involved letters, posters, and in-services. Physicians' completion of the form was problematic at all five hospitals. However, when utilized, the BCOS made tracking and review of blood component use more efficient and timely. After the implementation phase, each institution began to plan benchmarking and performance improvement, based on the data collected. **Conclusion:** The results of this review suggest that a BCOS, once implemented, can facilitate transfusion tracking and may promote literature-based blood utilization.