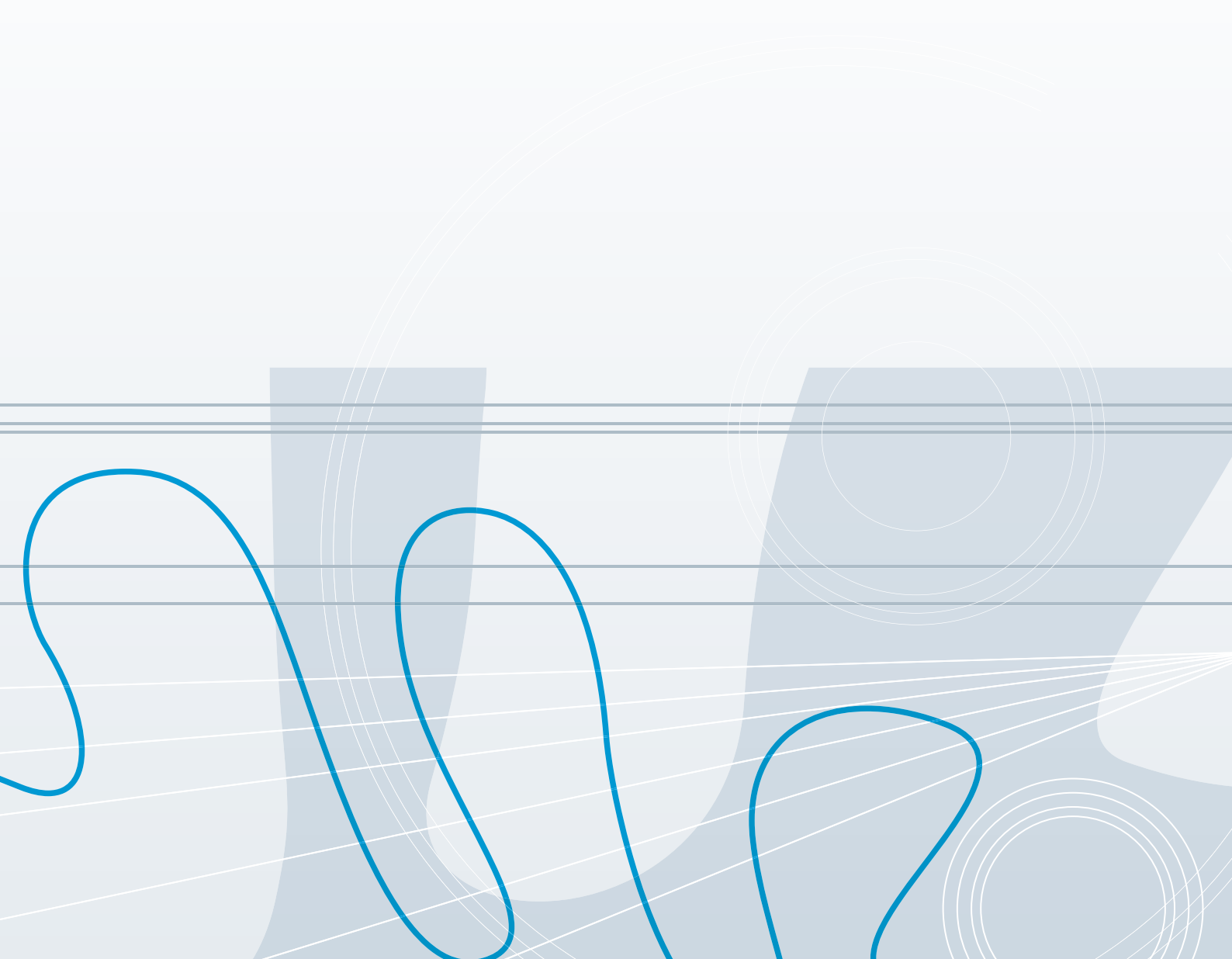




AUTOTRANSFUSION LITERATURE REVIEW



GENERAL SUMMARY

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RISKS OF HOMOLOGOUS BLOOD TRANSFUSION



REFERENCES OVERVIEW

- Adverse effects of homologous blood transfusion:

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- Use of autotransfusion vs homologous blood transfusion based on safety reasons:

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1 PERFUSIONIST STRATEGIES FOR BLOOD CONSERVATION IN PEDIATRIC CARDIAC SURGERY.

Durandy Y.

Yves Durandy, Perfusion and Intensive Care Unit, Pediatric Cardiac Surgery, Institut Hospitalier Jacques Cartier, Massy 91300, France.

ABSTRACT

There is increasing concern about the safety of homologous blood transfusion during cardiac surgery, and a restrictive transfusion practice is associated with improved outcome. Transfusion-free pediatric cardiac surgery is unrealistic for the vast majority of procedures in neonates or small infants; however, considerable progress has been made by using techniques that decrease the need for homologous blood products or even allow bloodless surgery in older infants and children. These techniques involve a decrease in prime volume by downsizing the bypass circuit with the help of vacuum-assisted venous drainage, microplegia, autologous blood predonation with or without infusion of recombinant (erythropoietin), cell salvaging, ultrafiltration and retrograde autologous priming. The three major techniques which are simple, safe, efficient, and cost-effective are: a prime volume as small as possible, cardioplegia with negligible hydric balance and circuit residual blood salvaged without any alteration. Furthermore, these three techniques can be used for all the patients, including emergencies and small babies. In every pediatric surgical unit, a strategy to decrease or avoid blood bank transfusion must be implemented. A strategy to minimize transfusion requirement requires a combined effort involving the entire surgical team with pre-, peri-, and postoperative planning and management.

KEYWORDS: Transfusion Risks, Costs, Homologous Blood, Pediatric Surgery, Cardiac Surgery

Anesthesiology. 2009 Feb;110(2):351-60.

2 EARLY PACKED RED BLOOD CELL TRANSFUSION AND ACUTE RESPIRATORY DISTRESS SYNDROME AFTER TRAUMA.

Chaiwat O, Lang JD, Vavilala MS, Wang J, MacKenzie EJ, Jurkovich GJ, Rivara FP.

Department of Anesthesiology, University of Washington School of Medicine, Seattle, Washington 98195-6540, USA.

ABSTRACT

BACKGROUND: Transfusion of packed red blood cells (PRBCs) is a risk factor for acute respiratory distress syndrome (ARDS) in trauma patients. Yet, there is a paucity of information regarding the risk of ARDS with incremental PRBCs exposure.

METHODS: For this retrospective analysis, eligible patients from National Study on Costs and Outcomes of Trauma were included. Our main exposure was defined as units of PRBCs transfused during the first 24 h after admission. The main outcome was ARDS.

RESULTS: A total of 521 (4.6%) of 14070 patients developed ARDS, and 331 patients (63.5%) who developed ARDS received PRBCs transfusion. Injury severity, thoracic injury, polytrauma, and pneumonia receiving more than 5 units of fresh frozen plasma and 6-10 units of PRBCs were independent predictors of ARDS. Patients receiving more than 5 units of PRBCs had higher risk of developing ARDS (patients who received 6-10 units: adjusted odds ratio 2.5, 95% CI 1.12-5.3; patients who received more than 10 units: odds ratio 2.6, 95% CI 1.1-6.4). Each additional unit of PRBCs transfused conferred a 6% higher risk of ARDS (adjusted odds ratio 1.06; 95% CI 1.03-1.10).

CONCLUSIONS: Early transfusion of PRBCs is an independent predictor of ARDS in adult trauma patients. Conservative transfusion strategies that decrease PRBC exposure by even 1 unit may be warranted to reduce the risk of ARDS in injured patients.

KEYWORDS: Transfusion Risks, Homologous Blood, Trauma, Acute Respiratory Distress Syndrome

World J Surg. 2008 Oct;32(10):2185-9.

3 OUTCOME ANALYSIS OF BLOOD PRODUCT TRANSFUSION IN TRAUMA PATIENTS: A PROSPECTIVE, RISK-ADJUSTED STUDY.

Bochicchio GV, Napolitano L, Joshi M, Bochicchio K, Meyer W, Scalea TM.
R. Adams Cowley Shock Trauma Center Programs in Trauma, 22 South Greene Street, Baltimore, MD 21201, USA. gbochicchio@umm.edu

ABSTRACT

BACKGROUND: Studies have confirmed adverse outcome associated with transfusion of packed red blood cells (PRBCs) in trauma; however, little data are available regarding other blood product transfusion, such as fresh frozen plasma (FFP) and platelets. The objective of this study was to examine risk-adjusted outcome in trauma with stratification by blood product type.

METHODS: Prospective data were collected daily for 1,172 consecutive trauma patients admitted to the intensive care unit (ICU) during a 2-year period, including transfusion rates of blood products (PRBCs, FFP, platelets). Outcome assessment included infection rate, ventilator days (Vdays), ICU and hospital length of stay (LOS), and mortality.

RESULTS: Blood products were transfused in 786 (67%) patients. The study cohort had a mean age of 43 +/- 21 years and Injury Severity Score (ISS) of 24 +/- 13. Although the majority of patients were men, women were more likely to be transfused ($p < 0.001$). Mean transfusion rates of PRBCs (5.5 +/- 9.6 U), FFP (5.4 +/- 11.4), and platelets (3.7 +/- 11.1) were high. Univariate analysis identified that blood product transfusion (any type) was associated with a significantly greater infection rate (34% vs. 9.4%; $p < 0.001$), hospital LOS (18.6 vs. 9 days; $p < 0.001$), ICU LOS (13.7 vs. 7.4 days; $p < 0.001$), Vdays (12.9 vs. 6.3 days; $p < 0.001$), and mortality (19% vs. 8.3%; $p < 0.001$). Multivariate analysis (risk-adjusted for severity of injury by ISS, age, sex, and race, and stratified by blood product type) confirmed that risk of infection increased by 5%, and hospital LOS, ICU LOS, and Vdays increased by 0.64, 0.42, and 0.47 days, respectively, for every unit of PRBCs given. Risk of death increased by 3.5% for every unit of FFP transfused.

CONCLUSION: There is a dose-dependent correlation between blood product transfusion and adverse outcome (increased mortality and infection) in trauma patients.

KEYWORDS: Transfusion Risks, Homologous Blood, Trauma

Yonsei Med J. 2006 Dec 31;47(6):840-6.

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4 A COMPARISON OF AUTOLOGOUS AND HOMOLOGOUS TRANSFUSIONS IN SPINAL FUSION.

Park MS, Moon SH, Kim HS, Hahn SB, Park HW, Park SY, Lee HM.
Department of Orthopaedic Surgery, Ulsan University Hospital, Ulsan University College of Medicine, Korea.

ABSTRACT

Autologous transfusion has been used to overcome adverse effects of homologous transfusion. Clinical studies evaluating general orthopaedic postoperative results have been designed to compare these transfusion methods. However, few studies have evaluated postoperative results in spinal fusion surgeries, which have larger blood loss volumes. The purpose of this study is to determine if there are differences in postoperative infection and clinical results of spinal fusion with autologous, as compared to homologous, blood transfusion. A total of 62 patients who underwent instrumented spinal fusion and received autologous ($n = 30$) or homologous ($n = 32$) transfusions were reviewed. Information on gender, age, preoperative and 3-day postoperative hematologic features, total transfused units, segmental estimated blood loss, transfused units, and surgery time were collected. In addition, postoperative infection data on wound infection, pneumonia, urinary tract infection, cellulitis, and viral disease, incidence and duration of fever, as well as clinical results, fusion rates, and patient feedback were collected. No differences in postoperative infection and clinical results were found between the two types of transfusions; however, homologous transfusion was associated with an increased number of total units transfused, longer duration of fever, and decreased patient satisfaction regarding the transfusion.

KEYWORDS: Transfusion Risks, Autologous Blood, Homologous Blood, Orthopaedic Surgery

Crit Care Clin. 2005 Jul;21(3):479-95.

5 TRANSFUSION-RELATED ACUTE LUNG INJURY AND THE ICU.

Boshkov LK.

Oregon Health & Science University, 3181 SW Sam Jackson Park Road, Portland, OR 97239, USA. boshkovl@ohsu.edu

ABSTRACT

Transfusion-related acute lung injury (TRALI) has been the leading cause of transfusion-related deaths reported to the United States Food and Drug Administration for three consecutive years. Although traditionally TRALI has been viewed as having a one event pathogenesis (passive donor anti-leukocyte antibody interacting with a cognate antigen on the recipients leukocytes), emerging evidence suggests that TRALI is a multifactorial syndrome, and a true two-event subtype of ALI. Both recipient predisposition and biological response modifiers, generated during storage of cellular blood products, appear to play major pathogenetic roles. This review highlights recent advances in our knowledge of the pathophysiology of TRALI and recent progress towards a consensus definition of TRALI. It also guides the reader as to the recognition, investigation, and clinical management of TRALI.

KEYWORDS: Transfusion Risks, Transfusion-Related Acute Lung Injury

Crit Care Med. 2005 Aug;33(8):1749-56.

6 ROLE OF HEMODILUTIONAL ANEMIA AND TRANSFUSION DURING CARDIOPULMONARY BYPASS IN RENAL INJURY AFTER CORONARY REVASCULARIZATION: IMPLICATIONS ON OPERATIVE OUTCOME.

Habib RH, Zacharias A, Schwann TA, Riordan CJ, Engoren M, Durham SJ, Shah A.

Department of Cardiovascular Surgery, St. Vincent Mercy Medical Center, Toledo, OH, USA.

ABSTRACT

OBJECTIVE: Acute renal injury and failure (ARF) after cardiopulmonary bypass (CPB) has been linked to low on-pump hematocrit (hematocrit). We aimed to 1) elucidate if and how this relation is modulated by the duration of CPB (TCPB) and on-pump packed red blood cell transfusions and 2) to quantify the impact of post-CPB renal injury on operational outcome and resource utilization.

DESIGN: Retrospective review.

SETTING: A Northwest Ohio community hospital.

PATIENTS: Adult coronary artery bypass surgery patients with CPB but no preoperative renal failure.

MEASUREMENTS AND MAIN RESULTS: We quantified post-CPB renal injury via 1) the peak postoperative change in serum creatinine (Cr) level relative to pre-CPB values (%DeltaCr) and 2) ARF, defined as the coincidence of post-CPB Cr $>$ or \approx 2.1 mg/dL and $>$ 2 times pre-CPB Cr. The separate effects of lowest hematocrit, intraoperative packed RBC transfusions, and TCPB on %DeltaCr and ARF were derived via multivariate regression, overlapping quintile subgroup analyses, and propensity matching. Lowest hematocrit (22.0% \pm 4.6% sd), TCPB (94 \pm 35 mins), and pre-CPB Cr (1.01 \pm 0.23 mg/dL) varied widely. %DeltaCr varied substantially (24 \pm 57%), and ARF was documented in 89 patients (5.1%). Both %DeltaCr ($p < .001$) and ARF ($p < .001$) exhibited sigmoidal dose-dependent associations to lowest hematocrit that were 1) modulated by TCPB such that the renal injury was exacerbated as TCPB increased, 2) worse in patients with relatively elevated pre-CPB Cr ($>$ or \approx 1.2 mg/dL), and 3) worse with intraoperative packed red blood cell transfusions ($n = 385$; 21.9%), in comparison with patients at similar lowest hematocrit. Operative mortality ($p < .01$) and hospital stays ($p < .001$) were increased systematically and significantly as a function of increased post-CPB renal injury.

CONCLUSIONS: CPB hemodilution to hematocrit $<$ 24% is associated with a systematically increased likelihood of renal injury (including ARF) and consequently worse operative outcomes. This effect is exacerbated when CPB is prolonged with intraoperative packed red blood cell transfusions and in patients with borderline renal function. Our data add to the concerns regarding the safety of currently accepted CPB practice guidelines.

KEYWORDS: Transfusion Risks, Homologous Blood, Cardiac Surgery, Cardiopulmonary Bypass Surgery, Acute Renal Failure

Surg Infect (Larchmt). 2004 Winter;5(4):395-404.

7 ALLOGENIC BLOOD TRANSFUSION IN THE FIRST 24 HOURS AFTER TRAUMA IS ASSOCIATED WITH INCREASED SYSTEMIC INFLAMMATORY RESPONSE SYNDROME (SIRS) AND DEATH.

Dunne JR, Malone DL, Tracy JK, Napolitano LM.

University of Maryland School of Medicine and The R. Adams Cowley Shock Trauma Center, Baltimore, MD 21201, USA.

ABSTRACT

BACKGROUND: Previous studies have documented that blood transfusion incites a substantial inflammatory response with the systemic release of cytokines. Furthermore, blood transfusion is a significant independent predictor of multiple organ failure in trauma. The objective of this study was to assess the risk of systemic inflammatory response syndrome (SIRS) and intensive care unit (ICU) admission, length of stay (LOS), and mortality in trauma patients who require blood transfusion.

METHODS: Prospective data were collected on 9,539 trauma patients admitted to the R. Adams Cowley Shock Trauma Center over a 30-month period from January, 1997 to July, 1999. Complete SIRS data were available on 7,602 patients. Patients were stratified by age, gender, race, Glasgow coma scale (GCS), and injury severity score (ISS). A systemic inflammatory response to a wide variety of severe clinical insults (SIRS) was defined as a SIRS score of ≥ 2 , as calculated on admission. Blood transfusion was assessed as an independent predictor of SIRS, ICU admission and length of stay, and mortality.

RESULTS: The mean age of the study cohort was 37 ± 17 years; the mean ISS was 9 ± 9 points. Seventy-one percent of the patients were male, and 85% sustained blunt trauma. Blood transfusion within the first 24 h was administered to 954 patients, comprising 10% of the study cohort. Transfused patients were significantly older (43 ± 20 vs. 36 ± 16 years, $p < 0.00001$), had higher ISS (22 ± 12 vs. 8 ± 7 points, $p < 0.00001$), and lower GCS (12 ± 4 vs. 14 ± 2 points, $p < 0.00001$) than non-transfused patients. Blood transfusion and increased total volume of blood transfusion was associated with SIRS. Blood transfusion was also a significant independent predictor of SIRS, ICU admission, and mortality in trauma patients by multinomial logistic regression analysis. Trauma patients who received blood transfusion had a two- to nearly sixfold increase in SIRS ($p < 0.0001$) and more than a fourfold increase in ICU admission (OR 4.62, 95% CI 3.84-5.55, $p < 0.0001$) and mortality (OR 4.23, 95% CI 3.07-5.84, $p < 0.0001$) compared to those that were not transfused. Linear regression analysis revealed that transfusion was an independent predictor of ICU LOS (Coef. 5.20, SE 0.43, $p < 0.0001$). Transfused patients had significantly longer ICU LOS (16.8 ± 14.9 vs. 9.9 ± 10.6 days, $p < 0.00001$) and hospital LOS (14.5 ± 15.5 vs. 2.5 ± 5.3 days, $p < 0.00001$) compared to non-transfused patients.

CONCLUSIONS: Blood transfusion within the first 24 h was an independent predictor of mortality, SIRS, ICU admission, and ICU LOS in trauma patients. The use of blood substitutes and alternative agents to increase serum hemoglobin concentration in the post-injury period warrants further investigation.

KEYWORDS: Transfusion Risks, Homologous Blood, Trauma

Crit Care Med. 2004 Mar;32(3):666-74.

8 RED BLOOD CELL TRANSFUSION AND VENTILATOR-ASSOCIATED PNEUMONIA: A POTENTIAL LINK?

Shorr AF, Duh MS, Kelly KM, Kollef MH; CRIT Study Group.

Pulmonary and Critical Care Medicine Service, Walter Reed Army Medical Center, Washington, DC, USA.

ABSTRACT

OBJECTIVE: To determine the relationship between packed red blood cell transfusion practice and the development of ventilator-associated pneumonia (VAP).

DESIGN: Secondary analysis of a multicentered, prospective observational study of transfusion practice in intensive care units in the United States.

SETTING: A total of 284 intensive care units in the United States were studied from August 2000 to April 2001.

PATIENTS: Patients without pneumonia at intensive care unit admission and who then required at least 48 hrs of mechanical ventilation were considered at risk for VAP.

MEASUREMENTS AND MAIN RESULTS: VAP was diagnosed based on prospectively defined clinical criteria and represented the primary study end point. Late-onset VAP (VAP arising after ≥ 5 days of mechanical ventilation) represented a secondary end point. Transfusions given during the intensive care unit stay and before the onset of VAP were tracked prospectively. Of 4,892 subjects in the original cohort, 1,518 received mechanical ventilation of ≥ 48 hrs and did not have preexisting pneumonia. VAP was diagnosed in 311 (20.5%) patients. Multivariate analysis revealed that transfusion independently increased the risk for VAP (odds ratio, 1.89; 95% confidence interval [CI], 1.33-2.68). Other factors increasing the risk for VAP included male sex (odds ratio, 1.54; 95% CI, 1.15-2.07), admission after trauma (odds ratio, 1.68; 95% CI, 1.15-2.47), use of continuous sedation (odds ratio, 1.43; 95% CI, 1.07-1.92), and type of nutritional support (e.g., early enteral nutrition: odds ratio, 2.65; 95% CI, 1.93-3.63; total parenteral nutrition: odds ratio, 3.27; 95% CI, 2.24-4.75). The effect of transfusion on late-onset VAP was more pronounced (odds ratio, 2.16; 95% CI, 1.27-3.66) and demonstrated a positive dose-response relationship ($p = .0223$ for trend test).

CONCLUSIONS: Transfusion of packed red blood cells increases the risk of developing VAP. Avoiding the unnecessary use of packed red blood cell transfusions may decrease the occurrence of VAP.

KEYWORDS: Transfusion Risks, Homologous Blood, Ventilator-Associated Pneumonia

Crit Care Med. 2003 Dec;31(12 Suppl):S678-86.

9 RISKS OF BLOOD TRANSFUSION.

Goodnough LT.

Department of Medicine, Washington University School of Medicine, St. Louis, MO 63110-1093, USA.
goodnough@pathbox.wustl.edu

ABSTRACT

OBJECTIVE: To review the current status of risks of blood transfusion.

SYNTHESIS: English-speaking literature, literature search using key works, human data, and follow-up with key bibliographic citations.

CONCLUSIONS: Substantial advances have been achieved in blood safety during the last 20 yrs, particularly for transfusion-transmitted viral infections. Currently, the most serious known risks from blood transfusion are administrative error (leading to ABO-incompatible blood transfusion), transfusion-related acute lung injury, and bacterial contamination in platelet products. Emerging pathogens, such as West Nile virus infection emphasize the need for implementation of proactive strategies, such as pathogen inactivation technologies, as well as reactive strategies, such as nucleic acid testing, to ensure continued advances in blood safety.

KEYWORDS: Transfusion Risks, Homologous Blood

J Trauma. 2003 May;54(5):908-14.

10 ALLOGENEIC BLOOD TRANSFUSION INCREASES THE RISK OF POSTOPERATIVE BACTERIAL INFECTION: A META-ANALYSIS.

Hill GE, Frawley WH, Griffith KE, Forestner JE, Minei JP.

Department of Anesthesiology and Pain Management, Parland Memorial Hospital and University of Texas Southwestern Medical Center at Dallas, 75235-9008, USA.

ABSTRACT

BACKGROUND: Immunosuppression is a consequence of allogeneic (homologous) blood transfusion (ABT) in humans and is associated with an increased risk in cancer recurrence rates after potentially curative surgery as well as an increase in the frequency of postoperative bacterial infections. Although a meta-analysis has been reported demonstrating the relationship between ABT and colon cancer recurrence, no meta-analysis has been reported demonstrating the relationship of ABT to postoperative bacterial infection.

METHODS: Twenty peer-reviewed articles published from 1986 to 2000 were included in a meta-analysis. Criteria for inclusion included a clearly defined control group (nontransfused) compared with a treated (transfused) group and statistical analysis of accumulated data that included stepwise multivariate logistic regression analysis. In addition, a subgroup of publications that included only the traumatically injured patient was included in a separate meta-analysis. A fixed effects analysis was conducted with odds ratios obtained by using the conditional maximum likelihood method and 95% confidence intervals on the obtained odds ratios were determined using the mid-p technique.

RESULTS: The total number of subjects included in this meta-analysis was 13,152 (5,215 in the transfused group and 7,937 in the nontransfused group). The common odds ratio for all articles included in this meta-analysis evaluating the association of ABT to the incidence of postoperative bacterial infection was 3.45 (range, 1.43-15.15), with 17 of the 20 studies demonstrating a value of $p < 0.05$. These results provide overwhelming evidence that ABT is associated with a significantly increased risk of postoperative bacterial infection in the surgical patient. The common odds ratio of the subgroup of trauma patients was 5.263 (range, 5.03-5.43), with all studies showing a value of $p < 0.05$ (0.005-0.0001). These results demonstrate that ABT is associated with a greater risk of postoperative bacterial infection in the trauma patient when compared with those patients receiving ABT during or after elective surgery.

CONCLUSION: These results demonstrate that ABT is an associated and apparently significant and frequently overlooked risk factor for the development of postoperative bacterial infection in the surgical patient. Allogeneic blood transfusion is a greater risk factor in the traumatically injured patient when compared with the elective surgical patient for the development of postoperative bacterial infection.

KEYWORDS: Transfusion Risks, Homologous Blood, Trauma, Postoperative Bacterial Infection

J Trauma. 2003 May;54(5):898-905; discussion 905-7.

11 BLOOD TRANSFUSION, INDEPENDENT OF SHOCK SEVERITY, IS ASSOCIATED WITH WORSE OUTCOME IN TRAUMA.

Malone DL, Dunne J, Tracy JK, Putnam AT, Scalea TM, Napolitano LM.
Department of Surgery, University of Maryland School of Medicine and R Adams Cowley Shock Trauma Center, Baltimore, 21201, USA.

ABSTRACT

BACKGROUND: We have previously shown that blood transfusion in the first 24 hours is an independent predictor of mortality, intensive care unit (ICU) admission, and increased ICU length of stay in the acute trauma setting when controlling for Injury Severity Score, Glasgow Coma Scale score, and age. Indices of shock such as base deficit, serum lactate level, and admission hemodynamic status (systolic blood pressure, heart rate) and admission hematocrit were considered potential confounding variables in that study. **The objectives of this study were to evaluate admission anemia and blood transfusion within the first 24 hours as independent predictors of mortality, ICU admission, ICU length of stay (LOS), and hospital LOS, with serum lactate level, base deficit, and shock index (heart rate/systolic blood pressure) as covariates.**

METHODS: Prospective data were collected on 15,534 patients admitted to a Level I trauma center over a 3-year period (1998-2000) and stratified by age, gender, race, Glasgow Coma Scale score, and Injury Severity Score. Admission anemia and blood transfusion were assessed as independent predictors of mortality, ICU admission, ICU LOS, and hospital LOS by logistic regression analysis, with base deficit, serum lactate, and shock index as covariates.

RESULTS: Blood transfusion was a strong independent predictor of mortality (odds ratio [OR], 2.83; 95% confidence interval [CI], 1.82-4.40; $p < 0.001$), ICU admission (OR, 3.27; 95% CI, 2.69-3.99; $p < 0.001$), ICU LOS ($p < 0.001$), and hospital LOS (Coef, 4.37; 95% CI, 2.79-5.94; $p < 0.001$) when stratified by indices of shock (base deficit, serum lactate, shock index, and anemia). **Patients who underwent blood transfusion were almost three times more likely to die and greater than three times more likely to be admitted to the ICU. Admission anemia (hematocrit $< 36\%$) was an independent predictor of ICU admission ($p = 0.008$), ICU LOS ($p = 0.012$), and hospital LOS ($p < 0.001$).**

CONCLUSION: Blood transfusion is confirmed as an independent predictor of mortality, ICU admission, ICU LOS, and hospital LOS in trauma after controlling for severity of shock by admission base deficit, lactate, shock index, and anemia. The use of other hemoglobin-based oxygen-carrying resuscitation fluids (such as human or bovine hemoglobin substitutes) in the acute postinjury period warrants further investigation.

KEYWORDS: Transfusion Risks, Homologous Blood, Trauma, Anemia

Am Surg. 2002 Jul;68(7):566-72.

12 BLOOD TRANSFUSIONS CORRELATE WITH INFECTIONS IN TRAUMA PATIENTS IN A DOSE-DEPENDENT MANNER.

Claridge JA, Sawyer RG, Schulman AM, McLemore EC, Young JS.
Department of Surgery, University of Virginia Health System, Charlottesville 22908-0709, USA.

ABSTRACT

Infections are a common and significant sequela of major traumatic injury. **The objective of this study was to evaluate the relationship between infections in trauma patients and the transfusion of packed red blood cells (pRBCs) within the first 48 hours of admission. We hypothesized that transfusions of pRBCs were associated with an increased risk of infection in a dose-dependent manner.** All adult patients admitted to the trauma service of a Level I trauma center from November 1996 to December 1999 were studied. Secondary analysis was performed on prospectively collected data. One thousand five hundred ninety-three consecutive patients were studied; of these 12.6 per cent developed at least one infection. The overall transfusion rate was 19.4 per cent. The infection rate in patients who received at least one transfusion was significantly higher ($P < 0.0001$) at 33.0 versus 7.6 per cent in patients receiving no pRBCs. Transfusions per patient ranged from 0 to 46 units. There was a clear exponential correlation in patients receiving between 0 and 15 transfusions ($R^2 = 0.757$). Multivariate logistic regression, which was used to identify risk factors for the development of infection, demonstrated the odds ratio of receiving pRBCs to be 1.084, with a 95 per cent confidence interval of 1.028 to 1.142 ($P = 0.0028$). In summary there is a clear dose-dependent correlation between transfusions of pRBCs and the development of infection in trauma patients. Multivariate analysis further demonstrated that pRBCs were an independent risk factor for the development of infections. Although transfusions are frequently indicated, they should be administered appropriately and with no more pRBCs than absolutely necessary.

KEYWORDS: Transfusion Risks, Homologous Blood, Trauma

Crit Care Med. 2002 Oct;30(10):2249-54.

13 IMPACT OF ALLOGENIC PACKED RED BLOOD CELL TRANSFUSION ON NOSOCOMIAL INFECTION RATES IN THE CRITICALLY ILL PATIENT.

Taylor RW, Manganaro L, O'Brien J, Trottier SJ, Parkar N, Veremakis C.
Department of Critical Care Medicine, St. John's Mercy Medical Center, St. Louis, MO 63141, USA.

ABSTRACT

OBJECTIVE: To determine whether critically ill patients who receive allogenic packed red blood cell transfusions are at increased risk of developing nosocomial infections during hospitalization.

DESIGN: Retrospective database study utilizing Project IMPACT.

SETTING: A 40-bed medical-surgical-trauma intensive care unit in an 825-bed tertiary referral teaching hospital.

PATIENTS: One thousand seven hundred and seventeen patients admitted to the medical-surgical-trauma intensive care unit.

MEASUREMENTS AND MAIN RESULTS: Data were collected by using the Project IMPACT database. Nosocomial infection rates were compared among three groups: the entire cohort, the transfusion group, and the nontransfusion group. We determined the nosocomial infection rates in these groups while adjusting for probability of survival by using Mortality Prediction Model (MPM-0) scores, age, gender, and number of units of packed red blood cells transfused. The average number of units transfused per patient was 4.0. The nosocomial infection rate for the entire cohort was 5.94%. The nosocomial infection rates for the transfusion group (n = 416) and the nontransfusion group (n = 1301) were 15.38% and 2.92%, respectively (p < .005 chi-square). Transfusion of packed red blood cells was related to the occurrence of nosocomial infection, and there was a dose-response pattern (the more units of packed red blood cells transfused, the greater the chance of nosocomial infection; p < 0.0001 chi-square). The transfusion group was six times more likely to develop nosocomial infection compared with the nontransfusion group. In addition, for each unit of packed red blood cells transfused, the odds of developing nosocomial infection were increased by a factor of 1.5. A subgroup analysis of nosocomial infection rates adjusted for probability of survival by using MPM-0 scores showed nosocomial infection to occur at consistently higher rates in transfused patients vs. nontransfused patients. A second subgroup analysis adjusted for patient age showed a statistically significant increase in rates of nosocomial infection for transfused patients regardless of age.

CONCLUSIONS: Transfusion of packed red blood cells is associated with nosocomial infection. This association continues to exist when adjusted for probability of survival and age. In addition, mortality rates and length of intensive care unit and hospital stay are significantly increased in transfused patients.

KEYWORDS: Transfusion Risks, Homologous Blood

Ann Thorac Surg. 2002 Jun;73(6):1704-9.

14 THE INFLUENCE OF PERIOPERATIVE BLOOD TRANSFUSION ON SURVIVAL AFTER ESOPHAGEAL RESECTION FOR CARCINOMA.

Langley SM, Alexiou C, Bailey DH, Weeden DF.
Department of Cardiothoracic Surgery, Southampton General Hospital, Hampshire, United Kingdom.
stephenlangley@dia1.pipex.com

ABSTRACT

BACKGROUND: There is evidence that perioperative blood transfusion may lead to immunosuppression. Our aim was to determine whether blood transfusion influenced survival after esophagectomy for carcinoma.

METHODS: The study group comprised 234 consecutive patients (175 men and 59 women) with a mean age of 66 years who underwent esophagectomy for carcinoma by one surgeon between 1988 and 1998. The impact of 41 variables on survival was determined by means of univariate and multivariate analysis. Follow-up was complete (mean follow-up, 19.2 months; standard deviation, 16 months; range, 0 to 129 months).

RESULTS: The operative mortality rate was 5.6% (13 deaths). Median operative blood loss was 700 mL (range, 150 to 7,000 mL). One hundred sixty-one patients (68.8%) received a blood transfusion postoperatively (mean transfusion, 2.6 units; range, 0 to 12 units). Overall actuarial 1-year, 3-year, and 5-year survival rates inclusive of operative mortality were 58.1%, 28.5%, and 16.1%, respectively. On univariate analysis, positive lymph nodes, pathological TNM stage, transfusion of more than 3 units of blood, incomplete resection, poor tumor cell differentiation, longer tumor, greater weight loss, male sex, and adenocarcinoma were significant (p < 0.05) negative factors for survival. On Cox proportional hazards regression analysis, after excluding operative mortality, lymph node involvement (p = 0.001), incomplete resection (p = 0.0001), poor tumor cell differentiation (p = 0.04), and transfusion of more than 3 units of blood (p = 0.04) were independent adverse predictors of late survival.

CONCLUSIONS: In addition to reaffirming the importance of completeness of resection and nodal involvement, this study demonstrates that blood transfusion (more than 3 units) may have a significant adverse effect on late survival after esophageal resection for carcinoma. Every effort should be made to limit the amount of transfused blood to the absolutely essential requirements.

KEYWORDS: Transfusion Risks, Homologous Blood, Tumor Surgery

Chest. 2001 May;119(5):1461-8.

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15 TRANSFUSION OF BLOOD COMPONENTS AND POSTOPERATIVE INFECTION IN PATIENTS UNDERGOING CARDIAC SURGERY.

Leal-Noval SR, Rincón-Ferrari MD, García-Curiel A, Herruzo-Avilés A, Camacho-Laraña P, Garnacho-Montero J, Amaya-Villar R.
Critical Care Division, Hospital Universitario Virgen del Rocío, Seville, Spain. sramon@cica.es

ABSTRACT

OBJECTIVE: To investigate the influence of blood derivatives on the acquisition of severe postoperative infection (SPI) in patients undergoing heart surgery.

SETTING: The postoperative ICUs of a tertiary-level university hospital.

DESIGN: A cohort study.

METHODS: During a 4-year period, 738 patients, classified as patients with SPIs and patients without SPIs (non-SPI patients), were included in the study. We studied the influence of 36 variables on the development of SPI in general and individually for pneumonia, mediastinitis, and/or septicemia. The influence of the blood derivatives on infections was assessed for RBC concentrates, RBC and plasma, and RBC and platelets.

RESULTS: Seventy patients (9.4%) were classified as having SPIs, and 668 (90.6%) were classified as not having SPIs. After multivariate analysis, the variables associated with SPI (incidence, 9.4%) were reintubation, sternal dehiscence, mechanical ventilation (MV) for ≥ 48 h, reintervention, neurologic dysfunction, transfusion of ≥ 4 U RBCs, and systemic arterial hypotension. The variables associated with nosocomial pneumonia (incidence, 5.9%) were reintubation, MV for ≥ 48 h, neurologic dysfunction, transfusion of ≥ 4 U blood components, and arterial hypotension. The variables associated with mediastinitis (incidence, 2.3%) were reintervention and sternal dehiscence, and those associated with sepsis (incidence, 1.6%) were reintubation, time of bypass ≥ 110 min, and MV for ≥ 48 h. The mortality rate (patients with SPI, 52.8%; non-SPI patients, 8.2%; $p < 0.001$) and mean (\pm SD) length of stay in the ICU (patients with SPI, 15.8 \pm 12.9 days; non-SPI patients, 4.5 \pm 4.4 days; $p < 0.001$) were greater for the infected patients. The transfused patients also had a greater mortality rate (13.3% vs 8.9%, respectively; $p < 0.001$) and a longer mean stay in the ICU (6.1 \pm 7.2 days vs 3.7 \pm 2.8 days, respectively; $p < 0.01$) than those not transfused.

CONCLUSION: The administration of blood derivatives, mainly RBCs, was associated in a dose-dependent manner with the development of SPIs, primarily nosocomial pneumonia.

KEYWORDS: Transfusion Risks, Homologous Blood, Cardiac Surgery

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Ann Thorac Surg. 2001 Nov;72(5):S1832-7.

16 BLOOD TRANSFUSION: THE SILENT EPIDEMIC.

Spiess BD.
Department of Anesthesiology, Virginia Commonwealth University/Medical College of Virginia, Richmond
23298-0695, USA. bdspeiss@hsc.vcu.edu

ABSTRACT

Blood transfusion has been widely studied and the risk/benefit ratio remains unclear. Focus historically has been upon viral transmission, particularly hepatitis and HIV. Today, with advanced screening for these viruses, the risk for such transmission has become vanishingly small. Immunosuppression, with consequent postoperative bacterial infection and ABO incompatibility are now risks that physicians should consider as associated with allogeneic blood transfusion. Other inflammatory events, such as transfusion associated acute lung injury, also occur. The benefits of transfusion have never been well studied and there is scant literature on that area. Therefore, in an evidence-based medical practice the physician should regard transfusion with a skewed risk/benefit ratio. The following article examines that risk/benefit ratio in the post-AIDS era.

KEYWORDS: Transfusion Risks, Homologous Blood

Transfusion. 2000 Oct;40(10):1207-13.

17 TRANSFUSION ERRORS IN NEW YORK STATE: AN ANALYSIS OF 10 YEARS' EXPERIENCE.

Linden JV, Wagner K, Voytovich AE, Sheehan J.

Blood and Tissue Resources Program, Wadsworth Center, New York State Department of Health, Albany, New York 12201-0509, USA. JVL01@health.state.ny.us

ABSTRACT

BACKGROUND: While public focus is on the risk of infectious disease from the blood supply, transfusion errors also contribute significantly to adverse outcomes. This study characterizes such errors.

STUDY DESIGN AND METHODS: The New York State Department of Health mandates the reporting of transfusion errors by the approximately 256 transfusion services licensed to operate in the state. Each incident from 1990 through 1998 that resulted in administration of blood to other than the intended patient or the issuance of blood of incorrect ABO or Rh group for transfusion was analyzed.

RESULTS: Erroneous administration was observed for 1 of 19,000 RBC units administered. Half of these events occurred outside the blood bank (administration to the wrong recipient, 38%; phlebotomy errors, 13%). Isolated blood bank errors, including testing of the wrong specimen, transcription errors, and issuance of the wrong unit, were responsible for 29 percent of events. Many events (15%) involved multiple errors; the most common was failure to detect at the bedside that an incorrect unit had been issued.

CONCLUSION: Transfusion error continues to be a significant risk. Most errors result from human actions and thus may be preventable. The majority of events occur outside the blood bank, which suggests that hospitalwide efforts at prevention may be required.

KEYWORDS: Transfusion Risks, Homologous Blood, Clerical Errors

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Chest. 1999 Nov;116(5):1233-9.

18 IMPACT OF BLOOD TRANSFUSIONS ON INFLAMMATORY MEDIATOR RELEASE IN PATIENTS UNDERGOING CARDIAC SURGERY.

Fransen E, Maessen J, Dentener M, Senden N, Buurman W.

Department of Cardiopulmonary Surgery, University Hospital Maastricht, Maastricht, Netherlands.

ABSTRACT

STUDY OBJECTIVES: This study was conducted to investigate whether intraoperative blood transfusions affect the release of proinflammatory mediators in patients undergoing cardiac surgery. Therefore, we measured plasma levels of bactericidal permeability increasing protein (BPI) as a marker of neutrophil activation, interleukin-6 (IL-6), lipopolysaccharide binding protein (LBP), and C-reactive protein (CRP). In addition, these mediators, except CRP, were also measured in packed red cell units (PCs) administered to these patients.

DESIGN: Prospective study.

SETTING: Cardiopulmonary surgery department in a university hospital.

PATIENTS: One hundred fourteen consecutive patients undergoing cardiac surgery.

INTERVENTIONS: Blood samples were taken at induction of anesthesia, at the start of aortic cross-clamping, at aortic unclamping, and at 0.5, 4, 8, and 18 h thereafter.

RESULTS: Thirty-six patients received PC intraoperatively. BPI levels in patients who received transfusions were significantly higher at 0.5 and 4 h after aortic unclamping than in patients without transfusions ($p < 0.05$), and increased with the number of PC administered. IL-6 levels at 0.5, 4, and 18 h after aortic unclamping were also significantly higher in patients who received transfusions ($p < 0.01$). BPI was found in all units of packed red cells tested at concentrations up to 15 times preoperative plasma levels in patients. However, PC IL-6 could be detected in none of the samples. Plasma levels of LBP and CRP were similar in both patient groups. LBP was found in very low concentrations in all PC. Patients who received intraoperative transfusions had a worse postoperative performance.

CONCLUSIONS: Intraoperative PC transfusions do contribute to the inflammatory response after cardiac surgery both by enhancing part of the response and by directly changing plasma concentrations of inflammatory mediators. Furthermore, these data show that intraoperative PC transfusion is associated with a worse postoperative performance.

KEYWORDS: Transfusion Risks, Homologous Blood, Cardiac Surgery

Transfusion. 1999 Jul;39(7):694-700.

19 RISK OF BACTERIAL INFECTION ASSOCIATED WITH ALLOGENEIC BLOOD TRANSFUSION AMONG PATIENTS UNDERGOING HIP FRACTURE REPAIR.

Carson JL, Altman DG, Duff A, Noveck H, Weinstein MP, Sonnenberg FA, Hudson JI, Provenzano G.
Department of Medicine, University of Medicine and Dentistry of New Jersey, Robert Wood Johnson Medical School, New Brunswick 08903, USA. carson@umdnj.edu

ABSTRACT

BACKGROUND: The relationship between allogeneic blood transfusion and bacterial infection remains uncertain. An increased risk of bacterial infection would represent the most important risk of allogeneic transfusion, because viral disease transmission has become so rare.

STUDY DESIGN AND METHODS: A retrospective cohort study of 9598 consecutive hip fracture patients at least 60 years old who underwent surgical repair was performed. The primary outcome was serious bacterial infection, defined as bacteremia, pneumonia, deep wound infection, or septic arthritis or osteomyelitis. Secondary outcomes included two individual infections, pneumonia and urinary tract infection (UTI), and the cost of infection. Hospital cost of infection was assessed by linking the study population to Medicare data.

RESULTS: Fifty-eight percent of patients received at least one transfusion. Serious bacterial infection occurred in 437 patients (4.6%); 28.8 percent of this group died during the hospital stay. Pneumonia occurred in 361 patients (3.8%) and UTI occurred in 1157 patients (12.1%). The adjusted risk of serious bacterial infection associated with transfusion was 1.35 (95% CI, 1.10-1.66). The adjusted risk for pneumonia was 1.52 (95% CI, 1.21-1.91), and that for UTI was 1.03 (95% CI, 0.91-1.17). A dose-response relationship was present for serious bacterial infection ($p = 0.001$) and pneumonia ($p = 0.001$). The cost of hospitalization was \$14,000 greater for patients with serious infection than for patients without infection.

CONCLUSION: Blood transfusion is associated with a 35-percent greater risk of serious bacterial infection and a 52-percent greater risk of pneumonia. Postoperative infections are costly. The risk of bacterial infection may be the most common life-threatening adverse effect of allogeneic blood transfusion.

KEYWORDS: Transfusion Risks, Costs, Homologous Blood, Orthopaedic Surgery, Hip Surgery, Bacterial Infection

Acta Anaesthesiol Scand. 1996 Apr;40(4):496-501.

20 CYTOKINES IN STORED RED BLOOD CELL CONCENTRATES: PROMOTERS OF SYSTEMIC INFLAMMATION AND SIMULATORS OF ACUTE TRANSFUSION REACTIONS?

Kristiansson M, Soop M, Saraste L, Sundqvist KG.
Department of Anaesthesiology, Huddinge Hospital, Sweden.

ABSTRACT

BACKGROUND: The cytokine network has important implications for the systemic inflammatory and metabolic response in trauma and infection. Cytokines exogenously administered to traumatized and infected patients may have implications for the trauma response in these patients. The main objective of this study was to characterize red blood cell concentrates (RBCs) with regard to cytokine content.

METHODS: We investigated the concentrations of tumor necrosis factor alpha (TNF), interleukin-1 beta (IL-1), interleukin-6 (IL-6) and interleukin-8 (IL-8) in sixteen units of RBCs stored at +4 degrees C during 40 days. Samples from RBCs were taken every tenth day. Healthy volunteers were used as controls.

RESULTS: IL-1 and IL-8 in RBCs were increased compared to controls, $P < 0.01$ - $P < 0.001$ and TNF in RBCs were increased on days 1 and 40 compared to controls, $P < 0.05$. During storage TNF was highest on day 1, 69 (< 3 -1060) pg/ml, median (range). IL-1 concentrations increased during the period of storage from 5 (< 2 - 205) pg/ml to 174 (< 2 - 2180) pg/ml, $P < 0.01$. IL-6 was 6 (< 2 - 210) pg/ml on day 1 and did not change over the period of storage. IL-8 was highest on day 40, 164 (15 - 790) pg/ml and compared to day 1 the concentrations were increased on day 10 and day 40, $P < 0.05$ for both comparisons.

CONCLUSIONS: The results indicate the presence of TNF, IL-1, IL-6 and IL-8 in stored RBCs, though there was a great variability over the period of storage and between units of RBCs. In some samples of RBCs the content of cytokines reached levels that may be anticipated to contribute to systemic inflammation and the symptomatology of acute transfusion reactions.

KEYWORDS: Transfusion Risks, Homologous Blood, Stored RBCs

Arch Surg. 1993 Feb;128(2):171-6; discussion 176-7.

21 BLOOD TRANSFUSION INCREASES THE RISK OF INFECTION AFTER TRAUMA.

Agarwal N, Murphy JG, Cayten CG, Stahl WM.
Institute for Trauma and Emergency Care, New York Medical College, Valhalla.

ABSTRACT

To determine whether blood transfusion influences infection after trauma, we analyzed data on 5366 consecutive patients hospitalized for more than 2 days at eight hospitals over a 2-year period. The incidence of infection was significantly related to the mechanism of injury: penetrating injuries, 8.9%; blunt injuries, 12.9%; and low falls, 21.4%. Stepwise logistic regression analyses of infection using the variables age, sex, respiration rate in the emergency department, Glasgow Coma Scale in the emergency department, Injury Severity Score, shock (systolic blood pressure < 90 mm Hg on admission to the emergency department), and log of total amount of blood transfused during hospitalization showed that amount of blood received and Injury Severity Score were the only two variables that were significant predictors of infection across groups. Even when patients were stratified by Injury Severity Score, the infection rate increased significantly with increases in numbers of units of blood. Blood transfusion in the injured patients is an important independent statistical predictor of infection. Its contribution cannot be attributed to age, sex, or the underlying mechanism of severity of injury.

KEYWORDS: Transfusion Risks, Homologous Blood, Trauma

Transfusion. 1992 Jul-Aug;32(6):517-24.

22 A CLINICAL AND IMMUNOLOGIC STUDY OF BLOOD TRANSFUSION AND POSTOPERATIVE BACTERIAL INFECTION IN SPINAL SURGERY.

Triulzi DJ, Vanek K, Ryan DH, Blumberg N.
Department of Pathology and Laboratory Medicine, University of Rochester Medical Center, New York.

ABSTRACT

Allogeneic blood transfusion has been implicated as an independent risk factor for postoperative bacterial infection in clinical and animal studies. The association among transfusion, quantitative immunologic factors, and infection was examined in 102 patients undergoing 109 spinal fusion procedures. In 60 procedures, patients received autologous blood only; in 24 procedures, they received at least 1 unit of allogeneic blood, and in 25 procedures, they received no transfusions. Twenty-two patients developed bacterial infections, in 8 cases while in hospital and in 14 cases after discharge. Univariate analysis revealed that patients who received any allogeneic blood and those who received no allogeneic blood differed significantly in the rate of hospital-acquired infection (20.8 vs. 3.5%), length of stay (12.3 vs. 9.7 days), days of fever greater than or equal to 38 degrees C (4.0 vs. 2.9), days on antibiotics (3.9 vs. 2.5), duration of surgery (309 vs. 231 min), blood loss (1343 vs. 887 mL), surgeon, and postoperative drop in natural killer (NK) cells (-174 vs. -42/microL). Multivariate logistic and linear regressions revealed that the number of allogeneic units transfused was the only significant predictor of in-hospital infection ($p = 0.016$) or days on antibiotics and length of stay. None of the clinical, surgical, or transfusion variables was significantly associated with posthospital infection, although a significantly greater drop in NK cells had occurred in patients who developed infection ($p = 0.0035$). These data strongly implicate allogeneic transfusion as a risk factor for in-hospital postoperative bacterial infection.

KEYWORDS: Transfusion Risks, Homologous Blood, Spinal Surgery, Bacterial Infection





COSTS OF HOMOLOGOUS AND AUTOLOGOUS BLOOD



REFERENCES OVERVIEW

- Costs of homologous blood transfusion:

1 2 3 4 5 6 7 8 9 10 12 13 14

- Use of autotransfusion vs homologous blood transfusion based on costs reasons:

3 4 5 10 11 12

1 IMPACT OF BLEEDING-RELATED COMPLICATIONS AND/OR BLOOD PRODUCT TRANSFUSIONS ON HOSPITAL COSTS IN INPATIENT SURGICAL PATIENTS.

Stokes ME, Ye X, Shah M, Mercaldi K, Reynolds MW, Rupnow MF, Hammond J.
United BioSource Corporation, Montréal, QC, Canada. michael.stokes@unitedbiosource.com

ABSTRACT

BACKGROUND: Inadequate surgical hemostasis may lead to transfusion and/or other bleeding-related complications. This study examines the incidence and costs of bleeding-related complications and/or blood product transfusions occurring as a consequence of surgery in various inpatient surgical cohorts.

METHODS: A retrospective analysis was conducted using Premier's Perspective™ hospital database. Patients who had an inpatient procedure within a specialty of interest (cardiac, vascular, non-cardiac thoracic, solid organ, general, reproductive organ, knee/hip replacement, or spinal surgery) during 2006-2007 were identified. For each specialty, the rate of bleeding-related complications (including bleeding event, intervention to control for bleeding, and blood product transfusions) was examined, and hospital costs and length of stay (LOS) were compared between surgeries with and without bleeding-related complications. Incremental costs and ratios of average total hospital costs for patients with bleeding-related complications vs. those without complications were estimated using ordinary least squares (OLS) regression, adjusting for demographics, hospital characteristics, and other baseline characteristics. Models using generalized estimating equations (GEE) were also used to measure the impact of bleeding-related complications on costs while accounting for the effects related to the clustering of patients receiving care from the same hospitals.

RESULTS: A total of 103,829 cardiac, 216,199 vascular, 142,562 non-cardiac thoracic, 45,687 solid organ, 362,512 general, 384,132 reproductive organ, 246,815 knee/hip replacement, and 107,187 spinal surgeries were identified. Overall, the rate of bleeding-related complications was 29.9% and ranged from 7.5% to 47.4% for reproductive organ and cardiac, respectively. Overall, incremental LOS associated with bleeding-related complications or transfusions (unadjusted for covariates) was 6.0 days and ranged from 1.3 to 9.6 days for knee/hip replacement and non-cardiac thoracic, respectively. The incremental cost per hospitalization associated with bleeding-related complications and adjusted for covariates was highest for spinal surgery (\$17,279) followed by vascular (\$15,123), solid organ (\$13,210), non-cardiac thoracic (\$13,473), cardiac (\$10,279), general (\$4,354), knee/hip replacement (\$3,005), and reproductive organ (\$2,805).

CONCLUSIONS: This study characterizes the increased hospital LOS and cost associated with bleeding-related complications and/or transfusions occurring as a consequence of surgery, and supports implementation of blood-conservation strategies.

KEYWORDS: Costs, Transfusion Risks, Homologous Blood, Cardiac Surgery, Orthopedic Surgery, Spinal Surgery

Transfusion. 2010 Apr;50(4):753-65. Epub 2009 Dec 9.

2 ACTIVITY-BASED COSTS OF BLOOD TRANSFUSIONS IN SURGICAL PATIENTS AT FOUR HOSPITALS.

Shander A, Hofmann A, Ozawa S, Theusinger OM, Gombotz H, Spahn DR.
The Institute for Patient Blood Management and Bloodless Medicine at Englewood Hospital and Medical Center, Englewood, New Jersey, USA. aryeh.shander@ehmc.com

ABSTRACT

BACKGROUND: Blood utilization has long been suspected to consume more health care resources than previously reported. Incomplete accounting for blood costs has the potential to misdirect programmatic decision making by health care systems. Determining the cost of supplying patients with blood transfusions requires an in-depth examination of the complex array of activities surrounding the decision to transfuse.

STUDY DESIGN AND METHODS: To accurately determine the cost of blood in a surgical population from a health system perspective, an activity-based costing (ABC) model was constructed. Tasks and resource consumption (materials, labor, third-party services, capital) related to blood administration were identified prospectively at two US and two European hospitals. Process frequency (i.e., usage) data were captured retrospectively from each hospital and used to populate the ABC model.

RESULTS: All major process steps, staff, and consumables to provide red blood cell (RBC) transfusions to surgical patients, including usage frequencies, and direct and indirect overhead costs contributed to per-RBC-unit costs between \$522 and \$1183 (mean, \$761 +/- \$294). These exceed previously reported estimates and were 3.2- to 4.8-fold higher than blood product acquisition costs. Annual expenditures on blood and transfusion-related activities, limited to surgical patients, ranged from \$1.62 to \$6.03 million per hospital and were largely related to the transfusion rate.

CONCLUSION: Applicable to various hospital practices, the ABC model confirms that blood costs have been underestimated and that they are geographically variable and identifies opportunities for cost containment. Studies to determine whether more stringent control of blood utilization improves health care utilization and quality, and further reduces costs, are warranted.

KEYWORDS: Costs, Homologous Blood

3 COST BENEFITS OF INTRAOPERATIVE CELL SALVAGE IN RADICAL CYSTECTOMY.

Ubee SS, Manikandan R, Gudimetla AR, Singh G.
Department of Urology, Southport District and General Hospital, Southport, UK.

ABSTRACT

OBJECTIVE: We have looked into the clinical and financial benefits of using intra-operative cell salvage (ICS) as a method to reduce the amount of autologous blood transfusion (ABT) requirement for our radical cystectomy (RC) patients.

MATERIALS AND METHODS: Fifteen consecutive patients undergoing radical cystectomy received cell salvaged blood (ICS), while 15 did not (NCS). The cost of using the cell saver, number of homologous transfusions, survival, and recurrences were recorded and compared using paired t-test and chi-square test between the two groups. A Dideco Electa® (Sorin Group, Electa, Italy) cell saver machine was used for all the patients in the ICS group and leukocyte filters were used on the salvaged blood before the autologous transfusion.

RESULTS: The mean age was 63 years (53-72 years), 66 years (46-79 years) in ICS and NCS groups, respectively ($P = 0.368$). All 15 (100%) patients in the NCS group required an allogenic transfusion compared to 9/15 (60%) in the ICS group ($P = 0.08$). There was a significant reduction in the mean volume of allogenic blood transfused with the use of cell saver. Median follow-up was 23 and 21 months in the ICS and NCS group with 10 and 4 patients alive at last follow-up, respectively. There was a saving of 355 pounds per patient in the ICS group compared to the NCS group.

CONCLUSION: Our initial study shows that cell salvage is feasible and safe in patients undergoing radical cystectomy. It does not adversely affect the medium term outcome of patients undergoing RC and is also cost effective.

KEYWORDS: Costs, Homologous Blood, Cystectomy, Sorin Group Electa

Transfus Med. 2009 Aug;19(4):202-6.

4 EFFICACY AND COST-EFFECTIVENESS OF CELL SAVING BLOOD AUTOTRANSFUSION IN ADULT LUMBAR FUSION.

Savvidou C, Chatziioannou SN, Pilichou A, Pneumaticsos SG.
B' Department of Orthopaedic Surgery, University of Athens Medical School, Athens, Greece.

ABSTRACT

The objective of this study was to explore the use of cell saver blood autotransfusion in spinal surgery and to evaluate the efficacy and cost-effectiveness of cell saver blood autotransfusion during lumbar spine fusion in adults. Specific indications for the use of cell saver in adult lumbar fusion surgery have not yet been clearly determined. A total of 50 consecutive candidates for posterolateral fusion with internal fixation were prospectively randomized into either receiving perioperatively cell saving autotransfusion (Group A: 25 patients) or not (Group B: 25 patients). The use of cell saving technique did not exclude the use of allogenic blood transfusion. Surgical indications were spinal stenosis, spondylolisthesis, adolescent idiopathic scoliosis, degenerative scoliosis and fractures. Medical and financial data were recorded. A cost-analysis was performed. Patients in Group A received 880 +/- 216 mL from cell saver and 175 +/- 202 mL allogenic blood. The patients in Group B received 908 +/- 244 mL allogenic blood. Blood volumes data collected were expressed in mean +/- SD values. The cost of blood transfusion in Group A was 995 +/-euro447 per patient and 1220 +/- 269 in Group B ($P < 0.05$). In elective lumbar fusion blood requirements can be satisfied with the use of autotransfusion. The use of cell saver appears to be useful and cost-effective during most elective lumbar fusions.

KEYWORDS: Costs, Homologous Blood, Orthopaedic Surgery, Spinal Surgery

5 AN ECONOMIC ANALYSIS OF COSTS ASSOCIATED WITH DEVELOPMENT OF A CELL SALVAGE PROGRAM.

Waters JR, Meier HH, Waters JH.
Nance College of Business Administration, Cleveland State University, Cleveland, OH, USA.

ABSTRACT

BACKGROUND: The increasing cost of blood products and associated risks of transfusion have lead to a heightened interest in techniques which reduce or replace allogeneic blood transfusion. The use of cell salvage is being explored in a number of institutions. We present financial information which may be useful to institutions that are considering the addition of a cell salvage service.

METHODS: A review of the cell salvage data from 2328 patients was used to estimate the average cost of a packed red blood cell unit equivalent processed by cell salvage equipment. In addition, an analysis was performed to assess the break-even point of establishing a cell salvage service.

RESULTS: Initial capital outlay to establish a cell salvage service at this institution was \$103,551. The annual fixed operating cost was \$250,943. The average cost of transfusion of an allogeneic packed red blood cell unit was \$200. For an equivalent cell salvage unit, the cost was \$89.46. The payback period was 1.9 mo.

CONCLUSION: This analysis suggests that cell salvage can be significantly less expensive than allogeneic blood. The cost of cell salvage in other institutions will vary depending upon case volume, expected levels of blood loss per case, and initial investment costs. A step-by-step formula is provided to assist in the evaluation of a cell salvage service in hospitals of various sizes.

KEYWORDS: Costs, Homologous Blood

Best Pract Res Clin Anaesthesiol. 2007 Jun;21(2):271-89.

6 ESTIMATING THE COST OF BLOOD: PAST, PRESENT, AND FUTURE DIRECTIONS.

Shander A, Hofmann A, Gombotz H, Theusinger OM, Spahn DR.
Department of Anesthesiology and Critical Care, New Jersey Institute for the Advancement of Bloodless Medicine and Surgery Englewood Hospital and Medical Center, 350 Engle Street, Englewood, NJ 07631, USA.
aryeh.shander@ehmc.com

ABSTRACT

Understanding the costs associated with blood products requires sophisticated knowledge about transfusion medicine and is attracting the attention of clinical and administrative healthcare sectors worldwide. To improve outcomes, blood usage must be optimized and expenditures controlled so that resources may be channeled toward other diagnostic, therapeutic, and technological initiatives. Estimating blood costs, however, is a complex undertaking, surpassing simple supply versus demand economics. Shrinking donor availability and application of a precautionary principle to minimize transfusion risks are factors that continue to drive the cost of blood products upward. Recognizing that historical accounting attempts to determine blood costs have varied in scope, perspective, and methodology, new approaches have been initiated to identify all potential cost elements related to blood and blood product administration. Activities are also under way to tie these elements together in a comprehensive and practical model that will be applicable to all single-donor blood products without regard to practice type (e.g., academic, private, multi- or single-center clinic). These initiatives, their rationale, importance, and future directions are described.

KEYWORDS: Costs, Homologous Blood

Int J Technol Assess Health Care. 2006 Summer;22(3):338-43.

7 THE ECONOMICS OF BLOOD: GIFT OF LIFE OR A COMMODITY?

Kanavos P, Yfantopoulos J, Vondoros C, Politis C.
LSE Health, London School of Economics, UK. p.g.kanavos@lse.ac.uk

ABSTRACT

OBJECTIVES: To calculate the costs of blood collection, testing, storage, and transfusion in Greece.

METHODS: Costing information was collected from two large public hospitals, in Athens and Crete, that also act as blood banks. Given that private health care accounts for 40 percent of total health spending, the same costs were also considered in a private setting by collecting key reagent cost data from a leading private hospital in Athens. Mainly direct costs were considered (advertising campaigns, personnel, storage and maintenance, reagent costs, transportation costs from blood bank to end-use hospitals, and cross-matching and transfusion costs in receiving hospitals) and some indirect costs (opportunity cost of blood donorship).

RESULTS: Captive donorship accounts for over 50 percent of the national blood supply. A unit of blood transfused would cost between Euro 294.83 and Euro 339.83 in public hospitals and could reach Euro 413.93 in a private facility. This figure may be an underestimate, as it excludes opportunity costs of blood transfusion for patients and the healthcare system.

CONCLUSIONS: Blood has a significant cost to the health system. Policy makers and practitioners should encourage its rational use, build on current policies to further improve collection and distribution, encourage further volunteer donorship in Greece, and also consider alternatives to blood where the possibility exists.

KEYWORDS: Costs, Homologous Blood

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J Clin Oncol. 2000 Jul;18(14):2755-61.

8 COST OF OUTPATIENT BLOOD TRANSFUSION IN CANCER PATIENTS.

Crémieux PY, Barrett B, Anderson K, Slavin MB.
Analysis Group/Economics, Cambridge, and Dana-Farber Cancer Institute, Boston, MA, USA. pcremieux@ag-inc.com

ABSTRACT

PURPOSE: To determine the cost of outpatient RBC transfusion from the provider's perspective at a major urban, academic cancer center.

PATIENTS AND METHODS: We retrospectively studied 517 cancer patients with hematologic or solid tumors who received blood during fiscal year 1995 to 1996. A process-flow diagram was developed, and cost and utilization data for 12 months were collected and analyzed. A structured interview process was used to identify all direct and indirect costs from within the inpatient unit, blood bank, and outpatient clinic. Average costs were computed for the entire sample and for specific subgroups.

RESULTS: In 1998 dollars, the average cost per RBC unit was \$469 for adults and \$568 for pediatric cancer patients. Adults and children generally received two and one RBC units per transfusion, respectively. Therefore, the average cost of a two-unit transfusion was \$938 for adults. Patients with hematologic tumors required more RBC units (7.1 RBC units per year) at a higher average cost (\$512 per RBC unit) than patients with solid tumors (4.7 RBC units per year, \$474 per RBC unit). Further variations across tumor types were observed. Overhead, direct material, and direct labor represented 46%, 19%, and 35% of total costs respectively.

CONCLUSION: The cost of outpatient RBC transfusions in cancer patients is higher than previously reported, in part because overhead costs and fixed costs might have been underestimated in previous studies. Furthermore, age, tumor type, and geographic variations in the cost of fixed assets and labor have a substantial impact on the cost of blood. The results indicate that the cost-effectiveness of alternatives to transfusions in the management of cancer patients may have been underestimated in the existing literature.

KEYWORDS: Costs, Homologous Blood, Tumor Surgery

J Clin Oncol. 1998 Jul;16(7):2364-70.

9 COSTS OF BLOOD TRANSFUSION: A PROCESS-FLOW ANALYSIS.

Cantor SB, Hudson DV Jr, Lichtiger B, Rubenstein EB.

Department of Medical Specialties, Ambulatory and Supportive Care Oncology Research Program, University of Texas M.D. Anderson Cancer Center, Houston 77030-4095, USA. sbcantor@mdanderson.org

ABSTRACT

PURPOSE: To determine the cost of transfusing 2 units (U) of packed RBCs at a comprehensive cancer center.

METHODS: We performed a process-flow analysis to identify all costs of transfusing 2 U of allogeneic packed RBCs on an outpatient basis to patients with either (1) solid tumor who did not undergo bone marrow transplantation (BMT), (2) solid tumor who underwent BMT, (3) hematologic malignancy who did not undergo BMT, (4) hematologic malignancy who underwent allogeneic BMT, or (5) hematologic malignancy who underwent autologous BMT. We conducted structured interviews to determine the personnel time used and physical resources necessary at all steps of the transfusion process.

RESULTS: The mean cost of a 2-U transfusion of allogeneic packed RBCs was \$548, \$565, \$569, \$569, and \$566 for patients with non-BMT solid tumor, BMT solid tumor, non-BMT hematologic malignancy, allogeneic BMT hematologic malignancy, and autologous BMT hematologic malignancy, respectively. Sensitivity analysis showed that total transfusion costs were sensitive to variations in the amount of clinician compensation and overhead costs, but were relatively insensitive to reasonable variations in the direct costs of blood tests and the blood itself, or the probability or extent of transfusion reaction.

CONCLUSION: The costs of the transfusion of packed RBCs are greater than previously analyzed, particularly in the cancer care setting.

KEYWORDS: Costs, Homologous Blood, Tumor Surgery

Ann Thorac Surg. 1998 May;65(5):1248-54.

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10 SHED MEDIASTINAL BLOOD TRANSFUSION AFTER CARDIAC OPERATIONS: A COST-EFFECTIVENESS ANALYSIS.

Kilgore ML, Pacifico AD.

Department of Pathology, University of Alabama at Birmingham 35233-7331, USA. kilgore@wp.path.uab.edu

ABSTRACT

BACKGROUND: Cardiac surgical patients consume a significant fraction of the annual volume of allogeneic blood transfused. Scavenged autologous blood may serve as a cost-effective means of conserving donated blood and avoiding transfusion-related complications.

METHODS: This study examines 834 patients after cardiac operations at the University of Alabama Hospital. Data were collected on patients receiving unwashed, filtered, autologous transfusions from shed mediastinal drainage and those receiving allogeneic transfusions. The data were incorporated into clinical decision models; confidence intervals for parameters were estimated by bootstrapping sample statistics. Costs were estimated for transfusing both allogeneic and autologous blood.

RESULTS: The study found a 54% reduction in transfusion risk or a mean reduction of 1.41 allogeneic units per case (95% confidence interval, 1.04 to 1.79 units). The process saved between \$49 and \$62 per case.

CONCLUSIONS: The use of autologous blood has the potential to significantly reduce the costs and risks associated with transfusing allogeneic blood after cardiac operations.

KEYWORDS: Costs, Homologous Blood, Cardiac Surgery

Semin Hematol. 1997 Jul;34(3 Suppl 2):34-40.

11 ALLOGENEIC TRANSFUSION AND INFECTION: ECONOMIC AND CLINICAL IMPLICATIONS.

Blumberg N.
Department of Pathology and Laboratory Medicine, University of Rochester Medical Center, NY 14642, USA.

ABSTRACT

An increased incidence of postoperative infection and risk of cancer recurrence in patients who have received allogeneic blood transfusions suggests that such transfusions may be associated with clinically significant immunomodulatory effects. Allogeneic transfusion increase humoral immunity and decrease cell-mediated immunity. The mechanism of allogeneic transfusion-induced immunomodulation may involve altered cytokine regulation with a shift toward a type-2 (Th2) immune response. In patients undergoing hip replacement or spine surgery, the postoperative infection rate with allogeneic blood transfusion appears to be 7- to 10-fold higher than with autologous blood or no transfusion. The occurrence of postoperative infection is largely abrogated through the use of autologous or leukocyte-depleted blood. In our orthopedic surgery patients, use of allogeneic blood was associated with a significantly increased length of hospital stay, resource consumption, and attendant hospital charges. Allogeneic, but not autologous, blood transfusion were associated in a dose-dependent manner with longer hospital stays and higher costs. Multiple linear regression analyses demonstrated that the number of units of allogeneic blood transfused, rather than surgeon and type of surgery, was the most statistically significant predictor of length of stay and hospital charges. Using data reported in the literature, we estimate that the death rate from allogeneic transfusion-related postoperative infection and cancer recurrence combined (215 deaths with 1% causality to 21,500 with 100% causality) may exceed the death rate due to all other transfusion risks combined. Improved clinical outcomes may result from techniques that minimize allogeneic blood use or its immunologic effects (e.g., autologous transfusion or other blood-sparing approaches in surgery, leukodepletion of allogeneic blood, and the use of growth factors [eg, epoetin alfa]).

KEYWORDS: Costs, Transfusion Risks, Homologous Blood, Orthopedic Surgery, Hip Surgery, Spinal Surgery, Leucocyte Depletion Filter

Am J Surg. 1996 Mar;171(3):324-30.

12 A COST ANALYSIS OF AUTOLOGOUS AND ALLOGENEIC TRANSFUSIONS IN HIP-REPLACEMENT SURGERY.

Blumberg N, Kirkley SA, Heal JM.
Department of Pathology, University of Rochester Medical Center, New York, USA.

ABSTRACT

PURPOSE: To analyze the cost consequences of autologous versus allogeneic transfusions.

METHODS: Costs were determined when allogeneic transfusions were given in addition to, or instead of, autologous transfusions. Hospital charges were used to estimate costs for hip-replacement surgery. The main outcome measure was estimated incremental hospital costs per unit transfused.

RESULTS: Among donors of autologous blood, mean total charges were \$7,200 greater for recipients of both autologous and allogeneic transfusions than for recipients of autologous transfusion only ($P=0.0001$). Each allogeneic transfusion was associated with additional costs of \$1,480. In a second cohort of patients receiving identical amounts of either allogeneic or autologous blood (mean=2.3 units), total hospital charges were a mean of \$4,800 greater ($P=0.0001$) for allogeneic recipients. The per unit excess costs associated with each unit of allogeneic blood cohort were \$1,043.

CONCLUSIONS: Allogeneic transfusions are associated with incremental hospital costs of about \$1,000 to \$1,500 per unit transfused when compared with costs for similar patients receiving no transfusions or 1 to 5 units of autologous blood.

KEYWORDS: Costs, Homologous Blood, Orthopedic Surgery, Hip Surgery

Am J Med. 1993 May;94(5):509-14.

13 ECONOMIC IMPACT OF INAPPROPRIATE BLOOD TRANSFUSIONS IN CORONARY ARTERY BYPASS GRAFT SURGERY.

Goodnough LT, Soegiarso RW, Birkmeyer JD, Welch HG.
Department of Medicine and Pathology, Washington University, St. Louis, MO.

ABSTRACT

PURPOSE: In addition to historically important issues of blood inventory and blood safety, the costs of blood transfusion are anticipated to have an increasingly important impact on transfusion practices. To address this, we analyzed costs of blood support given to patients undergoing coronary artery bypass graft (CABG) surgery, along with costs of blood components whose transfusions were identified to be unnecessary.

PATIENTS AND METHODS: Blood components transfused as part of a previously reported national, multicenter audit of 30 adult patients each at 18 institutions undergoing primary, elective CABG surgery were reviewed.

RESULTS: The range of blood purchase costs among institutions was broad, varying over two-fold. The range of red cell units transfused varied over 10-fold, and the range of total components transfused varied over 40-fold. The number of blood components transfused unnecessarily represented 27% of all blood units transfused, ranging from 7% to 43% among institutions. Inappropriate transfusions accounted for 47%, 32%, and 15% of all platelet, plasma, and red cell units transfused. The mean institutional cost for all blood components transfused per patient was \$397 +/- \$244. The cost per patient of components transfused inappropriately was 24% of this, or \$96 +/- \$89 (mean +/- SD).

CONCLUSION: These costs could be reduced with practice guidelines and quality improvement programs aimed at reducing the number of inappropriate transfusions.

KEYWORDS: Costs, Homologous Blood, Cardiac Surgery, Cardiopulmonary Bypass Surgery

Transfusion. 1991 May;31(4):318-23.

14 BLOOD TRANSFUSION COSTS: A MULTICENTER STUDY.

Forbes JM, Anderson MD, Anderson GF, Bleecker GC, Rossi EC, Moss GS.
Northfield Laboratories, Inc., Evanston, Illinois.

ABSTRACT

The cost of delivering a unit of blood (whole blood or red cells) to a hospitalized patient was examined in 19 United States teaching hospitals. The average hospital acquisition cost was calculated by using the prices charged by regional blood centers for blood products. To this cost was added an estimate of costs incurred by hospitals for handling, testing, and administering blood. Across study sites, the average hospital cost per unit transfused was \$155 and the average charge to the patient was \$219. Acquisition cost, the price that hospitals pay for blood, was 37 percent of the total cost to the hospital; the other 63 percent of the hospital cost included costs for blood bank handling (13%), laboratory tests (43%), and blood administration (7%). Significant variations in blood transfusion cost were found within our sample. Most of the variability can be attributed to geographic location of the blood supply source, type of red cell product transfused, prices charged by blood transfusion services, and the frequency of laboratory tests. The results of this transfusion cost study may be helpful in determining the costs of health care delivery, especially when blood transfusions are indicated.

KEYWORDS: Costs, Homologous Blood





CARDIAC SURGERY



REFERENCES OVERVIEW

- Autotransfusion in on-pump CABG surgery:

1 2 3 4 6 7 9 11 12 13 15 16

- Autotransfusion in off-pump CABG surgery:

5 6 8

- Use of autotransfusion to treat cardiotomy suction blood:

5 10 11 12 13 14

Anesth Analg. 2009 Aug;109(2):320-30.

1 THE EFFICACY OF AN INTRAOPERATIVE CELL SAVER DURING CARDIAC SURGERY: A META-ANALYSIS OF RANDOMIZED TRIALS.

Wang G, Bainbridge D, Martin J, Cheng D.

Department of Anesthesia and Perioperative Medicine, London Health Sciences Centre, University of Western Ontario, London, Ontario, Canada.

ABSTRACT

BACKGROUND: Cell salvage may be used during cardiac surgery to avoid allogeneic blood transfusion. It has also been claimed to improve patient outcomes by removing debris from shed blood, which may increase the risk of stroke or neurocognitive dysfunction. In this study, we sought to determine the overall safety and efficacy of cell salvage in cardiac surgery by performing a systematic review and meta-analysis of published randomized controlled trials.

METHODS: A comprehensive search was undertaken to identify all randomized trials of cell saver use during cardiac surgery. MEDLINE, Cochrane Library, EMBASE, and abstract databases were searched up to November 2008. All randomized trials comparing cell saver use and no cell saver use in cardiac surgery and reporting at least one predefined clinical outcome were included. The random effects model was used to calculate the odds ratios (OR, 95% confidence intervals [CI]) and the weighted mean differences (WMD, 95% CI) for dichotomous and continuous variables, respectively.

RESULTS: Thirty-one randomized trials involving 2282 patients were included in the meta-analysis. During cardiac surgery, the use of an intraoperative cell saver reduced the rate of exposure to any allogeneic blood product (OR 0.63, 95% CI: 0.43-0.94, $P = 0.02$) and red blood cells (OR 0.60, 95% CI: 0.39-0.92, $P = 0.02$) and decreased the mean volume of total allogeneic blood products transfused per patient (WMD -256 mL, 95% CI: -416 to -95 mL, $P = 0.002$). There was no difference in hospital mortality (OR 0.65, 95% CI: 0.25-1.68, $P = 0.37$), postoperative stroke or transient ischemia attack (OR 0.59, 95% CI: 0.20-1.76, $P = 0.34$), atrial fibrillation (OR 0.92, 95% CI: 0.69-1.23, $P = 0.56$), renal dysfunction (OR 0.86, 95% CI: 0.41-1.80, $P = 0.70$), infection (OR 1.25, 95% CI: 0.75-2.10, $P = 0.39$), patients requiring fresh frozen plasma (OR 1.16, 95% CI: 0.82-1.66, $P = 0.40$), and patients requiring platelet transfusions (OR 0.90, 95% CI: 0.63-1.28, $P = 0.55$) between cell saver and noncell saver groups.

CONCLUSIONS: Current evidence suggests that the use of a cell saver reduces exposure to allogeneic blood products or red blood cell transfusion for patients undergoing cardiac surgery. Subanalyses suggest that a cell saver may be beneficial only when it is used for shed blood and/or residual blood or during the entire operative period. Processing cardiectomy suction blood with a cell saver only during cardiopulmonary bypass has no significant effect on blood conservation and increases fresh frozen plasma transfusion.

KEYWORDS: Cardiac Surgery, Cardiopulmonary Bypass Surgery, Neurocognitive Dysfunction

Eur J Cardiothorac Surg. 2008 Aug;34(2):350-3. Epub 2008 Jun 9.

2 DO REPEATED RUNS OF A CELL SAVER DEVICE INCREASE THE PRO-INFLAMMATORY PROPERTIES OF WASHED BLOOD?

Vermeijden WJ, Hagenaars A, van Oeveren W, de Vries AJ.

Department of Anesthesiology, University Medical Centre Groningen, University of Groningen, The Netherlands. verm0030@planet.nl

ABSTRACT

OBJECTIVE: Intra-operative cell salvage is increasingly used, especially in longer cases with continuing blood loss. However it is unknown if the quality of processed blood is affected when larger quantities of blood are processed. We hypothesized that the quality of the washed blood decreases after multiple runs.

METHODS: Intra-operative cell salvage was performed in 42 consecutive patients undergoing cardiac surgery. When 1250 ml of blood was collected in the blood collection reservoir, this was processed and returned to the patient. In 21 patients more than 2500 ml of blood was collected during the whole procedure, thus allowing at least two subsequent runs with the auto-transfusion device. Blood samples were drawn from the blood collection reservoir of the cell saver device before, and from the processed blood after each run.

RESULTS: After the first run interleukin-6 concentrations were reduced with 85% (from 21 ± 35 microg/l to 3.1 ± 4.4 microg/l), whereas after the second run 72% was removed (63 ± 69 microg/l to 17.6 ± 25.3 microg/l). Leukocyte counts almost doubled after both processing runs (from $2.6 \pm 1.5 \times 10(9)/l$ to $5 \pm 3.6 \times 10(9)/l$) and from $3.9 \pm 2.2 \times 10(9)/l$ to $7.7 \pm 5.9 \times 10(9)/l$), hemoglobin concentration (14.8 ± 1.6 mmol/l vs 15.0 ± 1.1 mmol/l), free hemoglobin (2.3 ± 1.6 g/l vs 2.1 ± 1.4 g/l) and platelet counts ($18 \pm 9 \times 10(9)/l$ vs $28 \pm 23 \times 10(9)/l$) were not different between the two runs.

CONCLUSIONS: Our results suggest, based on interleukin-6 and free hemoglobin washout that the quality of the processed blood remains constant with multiple runs of the cell saver device.

KEYWORDS: Cardiac Surgery, Systemic Inflammatory Response

Circulation. 2007 Oct 23;116(17):1888-95. Epub 2007 Oct 8.

Free full text article available online **3 CONTINUOUS-FLOW CELL SAVER REDUCES COGNITIVE DECLINE IN ELDERLY PATIENTS AFTER CORONARY BYPASS SURGERY.**

Djaiani G, Fedorko L, Borger MA, Green R, Carroll J, Marcon M, Karski J.
Department of Anesthesia, Toronto General Hospital, University Health Network, 200 Elizabeth St, Toronto, Ontario, M5G 2C4, Canada. george.djaiani@uhn.on.ca

ABSTRACT

BACKGROUND: Cerebral microembolization during cardiopulmonary bypass may lead to cognitive decline after cardiac surgery. Transfusion of the unprocessed shed blood (major source of lipid microparticulates) into the patient during cardiopulmonary bypass is common practice to reduce blood loss and blood transfusion. Processing of shed blood with cell saver before transfusion may limit cerebral microembolization and reduce cognitive decline after surgery.

METHODS AND RESULTS: A total of 226 elderly patients were randomly allocated to either cell saver or control groups. Anesthesia and surgical management were standardized. Epiaortic scanning of the proximal thoracic aorta was performed in all patients. Transcranial Doppler was used to measure cerebral embolic rates. Standardized neuropsychological testing was conducted 1 week before and 6 weeks after surgery. The raw scores for each test were converted to Z scores, and then a combined Z score of 10 main variables was calculated for both study groups. The primary analysis was based on dichotomous composite cognitive outcome with a 1-SD rule. Cognitive dysfunction was present in 6% (95% confidence interval, 1.3% to 10.7%) of patients in the cell saver group and 15% (95% confidence interval, 8% to 22%) of patients in the control group 6 weeks after surgery ($P=0.038$). The severity of aortic atheroma and cerebral embolic count were similar between the 2 groups.

CONCLUSIONS: The present report demonstrates that processing of shed blood with cell saver results in clinically significant reduction in postoperative cognitive dysfunction after cardiac surgery. These findings emphasize the clinical importance of lipid embolization in contributing to postoperative cognitive decline in patients exposed to cardiopulmonary bypass.

KEYWORDS: Cardiac Surgery, Coronary Artery Bypass Graft Surgery, Neurocognitive Dysfunction

Ann Thorac Surg. 2007 May;83(5 Suppl):S27-86.

Free full text article available online **4 PERIOPERATIVE BLOOD TRANSFUSION AND BLOOD CONSERVATION IN CARDIAC SURGERY: THE SOCIETY OF THORACIC SURGEONS AND THE SOCIETY OF CARDIOVASCULAR ANESTHESIOLOGISTS CLINICAL PRACTICE GUIDELINE.**

Society of Thoracic Surgeons Blood Conservation Guideline Task Force

ABSTRACT

BACKGROUND: A minority of patients having cardiac procedures (15% to 20%) consume more than 80% of the blood products transfused at operation. Blood must be viewed as a scarce resource that carries risks and benefits. A careful review of available evidence can provide guidelines to allocate this valuable resource and improve patient outcomes.

METHODS: We reviewed all available published evidence related to blood conservation during cardiac operations, including randomized controlled trials, published observational information, and case reports. Conventional methods identified the level of evidence available for each of the blood conservation interventions. After considering the level of evidence, recommendations were made regarding each intervention using the American Heart Association/American College of Cardiology classification scheme.

RESULTS: Review of published reports identified a high-risk profile associated with increased postoperative blood transfusion. Six variables stand out as important indicators of risk: (1) advanced age, (2) low preoperative red blood cell volume (preoperative anemia or small body size), (3) preoperative antiplatelet or antithrombotic drugs, (4) reoperative or complex procedures, (5) emergency operations, and (6) noncardiac patient comorbidities. Careful review revealed preoperative and perioperative interventions that are likely to reduce bleeding and postoperative blood transfusion. Preoperative interventions that are likely to reduce blood transfusion include identification of high-risk patients who should receive all available preoperative and perioperative blood conservation interventions and limitation of antithrombotic drugs. Perioperative blood conservation interventions include use of antifibrinolytic drugs, selective use of off-pump coronary artery bypass graft surgery, routine use of a cell-saving device, and implementation of appropriate transfusion indications. An important intervention is application of a multimodality blood conservation program that is institution based, accepted by all health care providers, and that involves well thought out transfusion algorithms to guide transfusion decisions.

CONCLUSIONS: Based on available evidence, institution-specific protocols should screen for high-risk patients, as blood conservation interventions are likely to be most productive for this high-risk subset. Available evidence-based blood conservation techniques include (1) drugs that increase preoperative blood volume (eg, erythropoietin) or decrease postoperative bleeding (eg, antifibrinolytics), (2) devices that conserve blood (eg, intraoperative blood salvage and blood sparing interventions), (3) interventions that protect the patient's own blood from the stress of operation (eg, autologous predonation and normovolemic hemodilution), (4) consensus, institution-specific blood transfusion algorithms supplemented with point-of-care testing, and most importantly, (5) a multimodality approach to blood conservation combining all of the above.

KEYWORDS: Cardiac Surgery

Ann Thorac Surg. 2007 Feb;83(2):578-85.

5 CELL SALVAGE ALTERS THE SYSTEMIC INFLAMMATORY RESPONSE AFTER OFF-PUMP CORONARY ARTERY BYPASS GRAFTING SURGERY.

Allen SJ, McBride WT, McMurray TJ, Phillips AS, Penugonda SP, Campalani G, Young IS, Armstrong MA.
 Department of Clinical Anaesthesia, Royal Group of Hospitals Trust, Belfast, Ireland.
 stephen.allen@royalhospitals.n-i.nhs.uk

ABSTRACT

BACKGROUND: Retransfused cardiomy suction blood contains elevated inflammatory markers and is a bypass independent source of inflammatory mediators. We hypothesized that, during off-pump coronary artery bypass (OPCAB) grafting surgery, avoiding retransfusion of unwashed cardiomy suction blood would beneficially alter both urinary and plasma cytokine concentrations and be renoprotective.

METHODS: Thirty-seven OPCAB surgery patients were randomly allocated to control (retransfusion of unwashed shed blood) and treatment (retransfusion of washed shed blood or discarding of unwashed blood) groups. Over 72 hours we measured plasma (tumor necrosis factor- α [TNF- α], interleukin-8, interleukin-6, interleukin-10, TNF soluble receptor-2, and interleukin-1 receptor antagonist) and urinary TNF soluble receptor-2 and interleukin-1 receptor antagonist and markers of renal injury and dysfunction (N-acetyl beta D glucosaminidase and α 1-microglobulin).

RESULTS: We demonstrated elevated proinflammatory cytokines in cardiomy suction blood, which were effectively eliminated by cell salvage. After retransfusion, in comparison with controls, the treatment group had reduced plasma TNF soluble receptor-2. As compared with controls, treatment group patients also demonstrated significantly reduced levels of the urinary anti-inflammatory cytokine TNF soluble receptor-2. There were no between group differences in markers of renal injury or dysfunction.

CONCLUSIONS: We have demonstrated that the management of shed mediastinal blood alters perioperative, systemic, plasma and urinary cytokine homeostasis at OPCAB surgery but does not impact on subclinical renal injury or dysfunction in this low risk group of patients.

KEYWORDS: Cardiac Surgery, Off-Pump Coronary Artery Bypass Surgery, Suction Blood Separation

Eur J Cardiothorac Surg. 2006 Aug;30(2):271-7. Epub 2006 Jul 7.

6 EFFECTS OF CELL SAVER AUTOLOGOUS BLOOD TRANSFUSION ON BLOOD LOSS AND HOMOLOGOUS BLOOD TRANSFUSION REQUIREMENTS IN PATIENTS UNDERGOING CARDIAC SURGERY ON- VERSUS OFF-CARDIOPULMONARY BYPASS: A RANDOMISED TRIAL.

Niranjan G, Asimakopoulos G, Karagounis A, Cockerill G, Thompson M, Chandrasekaran V.
 Cardiothoracic Department, St. George's, Hospital, London, United Kingdom. drnij@hotmail.com

ABSTRACT

OBJECTIVE: Off-pump CABG is potentially associated with reduced intraoperative blood loss and homologous blood transfusion in comparison to on-pump CABG. In this randomised controlled study we investigated the effects of autologous cell saver blood transfusion on blood loss and homologous blood transfusion requirements in patients undergoing CABG on- versus off-CPB.

METHODS: Eighty patients were randomised into one of four groups: (A) on-CPB with cell saver blood transfusion (CSBT), (B) on-CPB without CSBT, (C) off-pump with CSBT and (D) off-pump without CSBT. Volume of intraoperative autologous blood transfusion, postoperative mediastinal blood loss and homologous blood transfusion requirements were measured. Homologous blood was transfused when haemoglobin concentration fell below 8 g/dl postoperatively. Pre- and postoperatively prothrombin time and partial thromboplastin time were measured.

RESULTS: Preoperative patient characteristics were well matched among the four groups. The amount of salvaged mediastinal blood available for autologous transfusion was significantly higher in the on-pump group (A) compared to the off-CPB group (C) (433 \pm 155 ml vs 271 \pm 144 ml, $P=0.001$). Volume of homologous blood transfusion was significantly higher in group B vs groups A, C and D (595 \pm 438 ml vs 179 \pm 214, 141 \pm 183 and 230 \pm 240 ml, respectively, $P<0.005$). The cell saver groups (A and C) received significantly less homologous blood than the groups without cell saver (160 \pm 197 ml vs 413 \pm 394 ml, respectively, $P<0.005$). Patients undergoing off-CPB surgery received significantly less homologous blood than those undergoing on-CPB CABG irrespective of cell saver blood transfusion (184 \pm 214 ml vs 382 \pm 397 ml, $P<0.05$). Postoperative blood loss was similar in the four groups (842 \pm 276, 1023 \pm 291, 869 \pm 286 and 903 \pm 315 ml in groups A to D, respectively, $P>0.05$). Clotting test results revealed no significant difference between the groups. There was no significant difference in postoperative morbidity between groups.

CONCLUSION: Off-pump CABG is associated with significant reduction in intraoperative mediastinal blood loss and homologous transfusion requirements. Autologous transfusion of salvaged washed mediastinal blood reduced homologous transfusion significantly in the on-CPB group. Cell saver caused no significant adverse impact on coagulation parameters in on- or off-CPB CABG. Postoperative morbidity and blood loss were not affected by the use of CPB or autologous blood transfusion. We recommend the use of autologous blood transfusion in both on- and off-pump CABG surgery.

KEYWORDS: Cardiac Surgery, Off-Pump Coronary Artery Bypass Graft Surgery, Sorin Group Electa

7 RANDOMIZED CONTROLLED TRIAL OF PERICARDIAL BLOOD PROCESSING WITH A CELL-SAVING DEVICE ON NEUROLOGIC MARKERS IN ELDERLY PATIENTS UNDERGOING CORONARY ARTERY BYPASS GRAFT SURGERY.

Carrier M, Denault A, Lavoie J, Perrault LP. Department of Surgery, Biomedical Laboratory, Montreal Heart Institute, Montreal, Quebec, Canada. michel.carrier@icm-mhi.org

ABSTRACT

BACKGROUND: Processing of pericardial shed blood with a cell-saving device was claimed to prevent lipid microembolization and to protect from neurocognitive dysfunction after cardiopulmonary bypass. The present study tested the hypothesis that processing of pericardial shed blood with a cell-saving device during cardiopulmonary bypass would significantly decrease serum levels of protein S100B, and improve brain oxygen saturation and neurologic outcome, all markers of brain injury in elderly patients.

METHODS: Forty patients, 65 years of age and older, undergoing coronary artery bypass graft with cardiopulmonary bypass, were prospectively randomly assigned to processing of pericardial shed blood with a cell-saving device or to conventional use of a standard closed venous reservoir where cardiectomy blood was collected and reinfused through the arterial circuit (control group). Serum S100B was measured 30 minutes, 4 hours, 24 hours, and 48 hours after surgery. Near-infrared spectroscopy monitoring was performed during the procedure and the National Institutes of Health stroke scale was measured before surgery and at the time of discharge of the hospital.

RESULTS: Patients in the cell-saving device group averaged 72 \pm 3 years of age and underwent 3.1 \pm 0.7 coronary artery grafts with a mean of 62 \pm 20 minutes of cardiopulmonary bypass time. Patients in the control group averaged 75 \pm 4 years of age (p = 0.03) and underwent 3.3 \pm 0.6 coronary artery grafts (p = 0.49) with a mean of 75 \pm 25 minutes of cardiopulmonary bypass time (p = 0.12). The quantity of blood administered from the cell-saving device averaged 281 \pm 162 mL per patient. Serum protein S100B levels averaged 0.06 \pm 0.03 before surgery and 0.51 \pm 0.23 microg/L 30 minutes after surgery in the cell-saving device patients compared with 0.076 \pm 0.04 before surgery (p = 0.32) and 1.48 \pm 0.66 (p < 0.0001) in the control patients. The near-infrared spectroscopy baseline mean value of left and right cortical region was 58% \pm 12% and 55% \pm 7% in the cell-saving device group versus 59% \pm 7% and 53% \pm 6% in the control group (p = 0.67 and 0.36), and no difference occurred over time in each group. The National Institutes of Health stroke score before and after surgery was similar in the two groups. There was one cerebrovascular complication in the control group (1 of 20, 5%) after surgery.

CONCLUSIONS: The difference between the two groups occurred 30 minutes after surgery, at which time serum levels of protein S100B were significantly higher in the control group compared with cell-saving device patients. Although use of the cell-saving device was not associated with higher brain oxygen saturation nor changes in the National Institutes of Health stroke score, it is associated with lesser release of nonspecific markers of brain injury in elderly patients.

KEYWORDS: Cardiac Surgery, Coronary Artery Bypass Graft Surgery, Neurocognitive Dysfunction

8 SAFETY, EFFICACY, AND COST OF INTRAOPERATIVE CELL SALVAGE AND AUTOTRANSFUSION AFTER OFF-PUMP CORONARY ARTERY BYPASS SURGERY: A RANDOMIZED TRIAL.

Murphy GJ, Rogers CS, Lansdowne WB, Channon I, Alwair H, Cohen A, Caputo M, Angelini GD. Bristol Heart Institute, University of Bristol, Bristol BS2 8HW, UK.

ABSTRACT

OBJECTIVE: We evaluated, in a randomized controlled trial, the safety and effectiveness of intraoperative cell salvage and autotransfusion of washed salvaged red blood cells after first-time coronary artery bypass grafting performed on the beating heart.

METHODS: Sixty-one patients undergoing off-pump coronary artery bypass grafting surgery were prospectively randomized to autotransfusion (n = 30; receiving autotransfused washed blood from intraoperative cell salvage) or control (n = 31; receiving homologous blood only as blood-replacement therapy). Homologous blood was given according to unit protocols.

RESULTS: The groups were well matched with respect to demographic and comorbid characteristics. Patients in the autotransfusion group had a significantly higher 24-hour postoperative hemoglobin concentration (11.9 g/dL; SD, 1.41 g/dL) than those in the control group (10.5 g/dL; SD, 1.37 g/dL) (mean difference, 1.02 g/dL; 95% confidence interval, 1.60-0.44 g/dL; P = .0007), as well as a 20% reduction in the frequency of homologous blood product use (11/31 vs 5/30; P = .095). Autotransfusion of washed red blood cells was not associated with any derangement of thromboelastograph values or laboratory measures of clotting pathway function (prothrombin time, activated partial thromboplastin time, and fibrinogen levels), increased postoperative bleeding, fluid requirements, or adverse clinical events. There was no statistical difference between groups in the total operation, hospitalization, and management costs per patient (median difference, USD 1015.90; 95% confidence interval, -USD 2260 to USD 206; P = .11).

CONCLUSIONS: Intraoperative cell salvage and autotransfusion was associated with higher postoperative hemoglobin concentrations, a modest reduction in transfusion requirements, no adverse clinical or coagulopathic effects, and no significant increase in cost compared with controls. This study supports its routine use in off-pump coronary artery bypass grafting surgery.

KEYWORDS: Cardiac Surgery, Off-Pump Coronary Artery Bypass Graft Surgery, Costs

Ann Thorac Surg. 2004 May;77(5):1553-9.

9 SAFETY AND EFFICACY OF PERIOPERATIVE CELL SALVAGE AND AUTOTRANSFUSION AFTER CORONARY ARTERY BYPASS GRAFTING: A RANDOMIZED TRIAL.

Murphy GJ, Allen SM, Unsworth-White J, Lewis CT, Dalrymple-Hay MJ.
Department of Cardiothoracic Surgery, Derriford Hospital, Plymouth, United Kingdom.
gavinmurphy@hotmail.com

ABSTRACT

BACKGROUND: The aim of this study was to ascertain whether cell salvage and autotransfusion after first time elective coronary artery bypass grafting is associated with a significant reduction in the use of homologous blood, a clinically significant derangement of postoperative clotting profiles, or an increased risk of postoperative bleeding.

METHODS: Patients were randomized to autotransfusion (n = 98) receiving autotransfused washed blood from intraoperative cell salvage and postoperative mediastinal fluid cell salvage after coronary artery bypass surgery or control (n = 102) receiving stored homologous blood only after coronary artery bypass surgery.

RESULTS: There was no statistical difference between the groups in terms of demographics, comorbidity, risk stratification, or operative details. Mean volume of blood autotransfused was 367 +/- 113 mL. Patients in the autotransfusion group were significantly less likely to receive a homologous blood transfusion compared with controls (odds ratio 0.40, 95% confidence interval [CI] 0.22-0.71) and received significantly fewer units of blood per patient compared with controls (0.43 +/- 1.5 vs 0.90 +/- 2.0 U, p = 0.02). There was no difference between the groups in terms of postoperative blood loss, fluid requirements, blood product requirements, or in the incidence of adverse clinical events (p = NS chi(2)). Autotransfusion did not produce any significant derangement of thromboelastograph values or laboratory measures of clotting pathway function (prothrombin time, activated partial thromboplastin time, fibrinogen, and fibrinogen D-dimer levels) when compared with the effect of homologous blood transfusion (p = NS, repeated measures analysis of variance [MANOVA]).

CONCLUSIONS: Autotransfusion is a safe and effective method of reducing the use of homologous bank blood after routine first time coronary artery bypass grafting.

KEYWORDS: Cardiac Surgery, Coronary Artery Bypass Graft Surgery

Scand Cardiovasc J. 2003 Jun;37(3):158-64.

10 THE INFLAMMATORY RESPONSE TO RECYCLED PERICARDIAL SUCTION BLOOD AND THE INFLUENCE OF CELL-SAVING.

Svenmarker S, Engström KG.
Department of Surgical and Perioperative Science, Umeå University Hospital, Sweden.

ABSTRACT

OBJECTIVE: To investigate the inflammatory and cellular response attributed to conventional cardiomy suction vs cell-saver during cardiac surgery.

DESIGN: Thirty-three (n = 33) low-risk patients admitted for routine coronary artery bypass grafting were randomly assigned to two groups: cardiomy suction or cell-saver for salvage of pericardial blood. The groups were compared with reference to proinflammatory cytokines, complement activation, leukocyte pattern, and haemolysis during and after cardiopulmonary bypass.

RESULTS: Pericardial suction blood contained significantly increased concentrations of free plasma haemoglobin, C3a, IL-6, IL-8, TNF-alpha, eosinophils and basophils compared with the systemic circulation. No differences were found for the terminal complement complex and lymphocytes, whereas overall concentrations of leukocytes, platelets and haemoglobin were decreased. Recycling of pericardial suction blood gave no systemic effects except from that of free plasma haemoglobin, which increased significantly. The cell-saver eliminated plasma haemoglobin, but no other effects could be demonstrated.

CONCLUSION: Cardiomy suction is a major cause of haemolysis, but contributes insignificantly to the systemic inflammatory response. Treatment of shed mediastinal blood with a cell-saver reduces haemolysis and may lower the dose load of inflammatory components.

KEYWORDS: Cardiac Surgery, Coronary Aortic Bypass Graft Surgery, Systemic Inflammatory Response, Suction Blood Separation

Eur J Cardiothorac Surg. 2003 Apr;23(4):633-6.

11 A PROSPECTIVE RANDOMISED COMPARISON OF CARDIOTOMY SUCTION AND CELL SAVER FOR RECYCLING SHED BLOOD DURING CARDIAC SURGERY.

Jewell AE, Akowuah EF, Suvana SK, Braidley P, Hopkinson D, Cooper G.
Department of Cardiothoracic Surgery, The Northern General Hospital, Herries Road, Sheffield S5 7AU, UK

ABSTRACT

OBJECTIVE: Post-operative neuropsychological complications correlate with intra-operative microemboli in the middle cerebral artery. When severe neurological complications follow cardiac surgery, diffuse cerebral fat emboli are present at autopsy. Recycling shed blood with cardiomy suction is an important source of cerebral fat microemboli. A cell saver may reduce this.

METHODS: Twenty patients were prospectively randomised to assess the amount of fat in blood salvaged from the pericardium and returned to the patient with either cell saver or cardiomy suction. Blood samples were taken before and after filtration in the cardiomy suction group or cell saver processing in the cell saver group. After centrifuging samples, fat content was graded on a scale of 0-3 by a blinded independent observer. Fat content was also quantified by weight.

RESULTS: Compared with cardiomy suction, cell saver removed significantly more fat from shed blood. Median fat grading after cell saver was 0 (0-1) compared with 1 (1-2) for cardiomy suction ($P=0.0001$). Percentage reduction in fat weight achieved by cell saver or cardiomy suction was 87% compared to 45% ($P=0.007$). There was no difference in the post-operative use of blood or blood products, haemoglobin, or bleeding between the two groups.

CONCLUSION: Use of cell saver results in less fat being recycled during cardiopulmonary bypass.

KEYWORDS: Cardiac Surgery, Cardiopulmonary Bypass Surgery, Suction Blood Separation

J Thorac Cardiovasc Surg. 2002 May;123(5):951-8.

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12 TISSUE FACTOR AS THE MAIN ACTIVATOR OF THE COAGULATION SYSTEM DURING CARDIOPULMONARY BYPASS.

De Somer F, Van Belleghem Y, Caes F, François K, Van Overbeke H, Arnout J, Taeymans Y, Van Nooten G.
Heart Centre, University Hospital Gent, Belgium.

ABSTRACT

OBJECTIVE: This study investigates the influence of foreign material and blood aspirated from nonvascular structures on activation of coagulation, hemolysis, and blood loss.

METHODS: The series comprises 3 randomized groups (groups C, S, and S+P) of 10 patients undergoing routine coronary artery bypass grafting with cardiopulmonary bypass. In group C, the control group, all aspirated blood was returned into the circulation. In group S suction blood was discarded, whereas group S+P was identical to group S, with surfaces coated with phosphorylcholine. Plasma concentrations of beta-thromboglobulin, thrombin generation, haptoglobin, and free hemoglobin, as well as blood loss, were measured.

RESULTS: A steady increase in free plasma hemoglobin, as well as an increased generation of thrombin, was noticed in group C. Moreover, a close correlation ($r = 0.916$) between the generation of thrombin and its inhibition (thrombin-antithrombin complexes) was observed. Platelets were clearly activated in group C and, to a lesser extent, in group S. In contrast, platelet activation in group S+P was negligible, resulting in a 30% decrease in blood loss ($P = .05$).

CONCLUSIONS: Aspirated blood contaminated by tissue contact is the most important activator of the coagulation system and the principal cause of hemolysis during cardiopulmonary bypass. Contact with a foreign surface is not a main variable in the procoagulant effect of bypass. Mimicking the outer cell membrane structure resulted in decreased platelet activation and decreased blood loss.

KEYWORDS: Cardiopulmonary Bypass Surgery, Coronary Artery Bypass Graft Surgery, Suction Blood Separation

Perfusion. 2001 Nov;16(6):519-24.

13 HAEMOLYSIS DURING CARDIOPULMONARY BYPASS: HOW TO REDUCE THE FREE HAEMOGLOBIN BY MANAGING THE SUCTIONED BLOOD SEPARATELY.

Pierangeli A, Masieri V, Bruzzi F, De Toni E, Grillone G, Boni P, Delnevo A.
Department of Heart Surgery, St. Orsola University Hospital, Bologna, Italy.

ABSTRACT

During cardiopulmonary bypass (CPB) the collection of the patient's blood from the operating area is of fundamental importance. This blood is collected in the cardiotomy reservoir using field suckers and can be managed in different ways. It can be filtered in the cardiotomy reservoir and redirected to the venous reservoir, then oxygenated and returned to the patient, or it can be managed separately: collected in the cardiotomy reservoir, treated at the end of the operation and only after this, returned to the patient. The aim of this study is to determine in vivo the effect of a separate management of the suction blood from the operative field, using the Avant D903 oxygenator (Dideco, Mirandola, Italy). Twenty-one patients undergoing coronary artery bypass graft surgery with CPB were selected and put into two groups at random. In the control group (n = 10) the suction blood in the cardiotomy reservoir was filtered and immediately redirected into the venous reservoir, oxygenated and returned to the patient. In the study group (n = 11) the suctioned blood was collected in the D903 Avant's (Dideco) cardiotomy reservoir and returned to the patient only after having been washed at the end of the operation, using a Compact Advanced (Dideco), as required. Clinical data demonstrated that while in the study group it was possible to keep the free plasma haemoglobin (FPH) concentrations the same as at the beginning, in the control group there was a significant increase in FPH from 5.0 +/- 3.5 mg/dl (baseline) to 37 +/- 16.7mg/dl (120min after CPB).

KEYWORDS: Cardiac Surgery, Cardiopulmonary Bypass Surgery, Sorin Group Compact Advanced, Suction Blood Separation

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Ann Thorac Surg. 2000 Oct;70(4):1296-300.

14 PROCESSING SCAVENGED BLOOD WITH A CELL SAVER REDUCES CEREBRAL LIPID MICROEMBOLIZATION.

Kincaid EH, Jones TJ, Stump DA, Brown WR, Moody DM, Deal DD, Hammon JW Jr.
Department of Cardiothoracic Surgery, Wake Forest University School of Medicine, Winston-Salem, North Carolina 27157, USA.

ABSTRACT

BACKGROUND: Microembolization during cardiopulmonary bypass (CPB) can be detected in the brain as lipid deposits that create small capillary and arteriolar dilations (SCADs) with ischemic injury and neuronal dysfunction. SCAD density is increased with the use of cardiotomy suction to scavenge shed blood. Our purpose was to determine whether various methods of processing shed blood during CPB decrease cerebral lipid microembolic burden.

METHODS: After hypothermic CPB (70 minutes), brain tissue from two groups of mongrel dogs (28 to 35 kg) was examined for the presence of SCADs. In the arterial filter (AF) group (n = 12), shed blood was collected in a cardiotomy suction reservoir and reinfused through the arterial circuit. Three different arterial line filters (Pall LeukoGuard, Pall StatPrime, Bentley Durafluo) were used alone and in various combinations. In the cell saver (CS) group (n = 12), shed blood was collected in a cell saver with intermittent precessing (Medtronic AutoLog model) or a continuous-action cell saver (Fresenius Continuous Auto Transfusion System) and reinfused with and without leukocyte filtration through the CPB circuit.

RESULTS: Mean SCAD density (SCAD/cm²) in the CS group was less than the AF group (11 +/- 3 vs 24 +/- 5, p = 0.02). There were no significant differences in SCAD density with leukocyte filtration or with the various arterial line filters. Mean SCAD density for the continuous-action cell saver was 8 +/- 2 versus 13 +/- 5 for the intermittent-action device.

CONCLUSIONS: Use of a cell saver to scavenge shed blood during CPB decreases cerebral lipid microembolization.

KEYWORDS: Cardiac Surgery, Cardiopulmonary Bypass Surgery, Leukocyte Depletion Filter, Neurocognitive Dysfunction, Medtronic Autolog, Fresenius CATS

15 THE IMPACT OF INTRAOPERATIVE AUTOTRANSFUSION ON CARDIAC SURGERY. A PROSPECTIVE RANDOMIZED DOUBLE-BLIND STUDY.

Laub GW, Dharan M, Riebman JB, Chen C, Moore R, Bailey BM, Fernandez J, Adkins MS, Anderson W, McGrath LB.

Department of Surgery, Deborah Heart and Lung Center, Browns Mills, NJ 08015.

ABSTRACT

The effect of intraoperative autotransfusion during coronary artery bypass grafting was studied in a randomized double-blind trial involving 38 patients. Nineteen patients had the collected RBCs washed and autotransfused (autotransfusion group), while the remaining patients had their washed cells discarded (control group). Postoperative hemoglobin and hematocrit values were similar. Exposure to banked blood was markedly decreased in the autotransfusion group compared with the control group. In addition, the mean volume of banked packed RBCs transfused per patient was significantly less in the autotransfusion group compared with the control group. Platelet utilization also was markedly decreased in the autotransfusion group. Cryoprecipitate and fresh frozen plasma utilization also was less in the autotransfusion group than in the control group, but this did not reach statistical significance. We conclude that the intraoperative use of autotransfusion decreases the volume of homologous blood products transfused, which results in reduced exposure of the patients to banked blood products.

KEYWORDS: Cardiac Surgery, Cardiopulmonary Bypass Surgery

ASAIO Trans. 1990 Jul-Sep;36(3):M179-81.

16 COMPLEMENT ACTIVATION AND USE OF A CELL SAVER IN CARDIOPULMONARY BYPASS.

Deleuze P, Intrator L, Liou A, Contremoulins I, Cachera JP, Loisanse DY.

Surgical Research Laboratory, CNRS, URA 1431, Créteil, France.

ABSTRACT

Complement activation was evaluated in ten patients undergoing cardiopulmonary bypass (CPB) and intraoperative blood salvage with a cell saver (CS) to assess the inflammatory response related to the CS. The washed red blood cell concentrate was reinfused after protamine injection. Plasma C3a was measured by radioimmunoassay preoperatively, 5 min before CPB, at 5, 60, and 90 min during CPB, 5 min after protamine infusion, at the end of surgery, and after 24 hr. In addition, a clinical score based on renal, pulmonary, neurologic, and myocardial postoperative evolution was given (0-8) to every patient. Results were compared with the C3a changes and clinical scores obtained from 26 routine (no CS) cardiac surgical patients. Results showed maximal C3a generation after protamine and no further activation in cases of CS concentrate reinfusion, which ranged from 400 ml to 2,000 ml. No difference in clinical score was observed between the CS (1 +/- 1) and control (0.85 +/- 0.6) groups. The authors conclude that the CS does not enhance complement activation resulting from extracorporeal circulation and can be safely used as a blood saving strategy in cardiac surgery.

KEYWORDS: Cardiac Surgery, Cardiopulmonary Bypass Surgery, Systemic Inflammatory Response



ORTHOPAEDIC SURGERY



REFERENCES OVERVIEW

- Autotransfusion in major orthopaedic surgery:

3 4 12 13 19

- Autotransfusion in hip surgery:

1 5 6 7 8 9 10 11 16 17 18 20 21

- Autotransfusion in knee surgery:

1 6 8 10 11 15 16 21

- Autotransfusion in spinal surgery:

2 7 14 21

Anesthesiology. 2010 Aug;113(2):482-95.

1 ANEMIA AND PATIENT BLOOD MANAGEMENT IN HIP AND KNEE SURGERY: A SYSTEMATIC REVIEW OF THE LITERATURE.

Spahn DR.

Institute of Anesthesiology, University Hospital and University of Zurich, Zurich, Switzerland. donat.spahn@usz.ch

ABSTRACT

A systematic search was conducted to determine the characteristics of perioperative anemia, its association with clinical outcomes, and the effects of patient blood management interventions on these outcomes in patients undergoing major orthopedic surgery. In patients undergoing total hip or knee arthroplasty and hip fracture surgery, preoperative anemia was highly prevalent, ranging from 24 +/- 9% to 44 +/- 9%, respectively. Postoperative anemia was even more prevalent (51% and 87 +/- 10%, respectively). Perioperative anemia was associated with a blood transfusion rate of 45 +/- 25% and 44 +/- 15%, postoperative infections, poorer physical functioning and recovery, and increased length of hospital stay and mortality. Treatment of preoperative anemia with iron, with or without erythropoietin, and perioperative cell salvage decreased the need for blood transfusion and may contribute to improved patient outcomes. High-impact prospective studies are necessary to confirm these findings and establish firm clinical guidelines.

KEYWORDS: Orthopaedic Surgery, Hip Surgery, Knee Surgery, Anemia

Spine (Phila Pa 1976). 2010 Jan 15;35(2):246-51.

2 EFFICACY OF INTRAOPERATIVE CELL SALVAGE SYSTEMS IN PEDIATRIC IDIOPATHIC SCOLIOSIS PATIENTS UNDERGOING POSTERIOR SPINAL FUSION WITH SEGMENTAL SPINAL INSTRUMENTATION.

Bowen RE, Gardner S, Scaduto AA, Eagan M, Beckstead J.

Shriners Hospitals for Children, Los Angeles, USA. rbowen@laoh.ucla.edu

ABSTRACT

STUDY DESIGN: Retrospective case-control study.

OBJECTIVE: Determine whether intraoperative cell salvage system use during pediatric posterior spinal fusion (PSF) with segmental spinal instrumentation for idiopathic scoliosis decreases intraoperative and perioperative (intraoperative plus postoperative) allogeneic blood transfusion.

SUMMARY OF BACKGROUND DATA: Intraoperative cell salvage and reinfusion can reduce or obviate perioperative allogeneic blood transfusion. Despite these benefits, their efficacy in pediatric PSF is unclear. Reported complications include transient hematuria, altered hemostasis, and electrolyte imbalance.

METHODS: A total of 54 consecutive idiopathic scoliosis patients were studied: 21 non-cell saver and 33 cell saver patients. Data included age, body mass index, Cobb angle, perioperative hemoglobin levels, mean arterial pressure, surgical time, levels fused, perioperative estimated blood loss, and perioperative transfusions. A chi2 and t tests were performed for intraoperative and perioperative allogeneic transfusion between groups. A regression analysis was performed between selected covariates and allogeneic transfusion. Relative risk analysis examined significant covariates regarding allogeneic transfusion rate.

RESULTS: Allogeneic transfusion rates were lower in the cell saver group (6% vs. 55% intraoperative and 18% vs. 55% perioperative, $P < 0.05$). Mean allogeneic transfusion volumes (mL/kg) were also lower (0.4 vs. 9.1 intraoperative and 1.9 vs. 11.1 perioperative, $P < 0.05$). Multivariate analysis confirmed these differences were independent of perioperative blood loss, and also demonstrated that surgical time and blood loss were significantly related to allogeneic transfusion volume. The allogeneic transfusion relative risk was 2.04 in patients with surgery >6 hours and 5.87 in patients not receiving cell saver blood. All patients with surgeries >6 hours and estimated blood loss >30% of total blood volume received cell saver system blood.

CONCLUSION: Cell saver use decreased allogeneic transfusion, particularly in surgeries >6 hours with estimated blood loss >30% of total blood volume. This study confirms the utility of routine cell saver use during PSF with segmental spinal instrumentation for idiopathic scoliosis.

KEYWORDS: Orthopaedic Surgery, Pediatric Surgery, Spinal Surgery

Transfusion. 2009 Nov;49(11):2374-83.

3 PREOPERATIVE AUTOLOGOUS BLOOD DONATION VERSUS INTRAOPERATIVE BLOOD SALVAGE: INTRAINDIVIDUAL ANALYSES AND MODELING OF EFFICACY IN 1103 PATIENTS.

Singbartl G, Schreiber J, Singbartl K.
SI_AIT, Soltau, Germany.

ABSTRACT

BACKGROUND: Preoperative autologous blood donation (PABD) and intraoperative blood salvage (IBS) represent established blood conservation measures. However, data comparing PABD to IBS are very sparse.

STUDY DESIGN AND METHODS: We analyzed data from 1103 patients undergoing PABD and subsequent major orthopedic surgery in one center. We then used a validated model to compare PABD to IBS. We calculated maximal allowable blood losses (MABLs) for both IBS and PABD. We also identified criteria for efficacious use of either PABD or IBS. Our calculations were based on exclusive application of either technique, complete exhaustion of predeposited or salvaged blood, and one round of IBS.

RESULTS: The vast majority of patients would have tolerated greater MABLs if subjected to IBS rather than PABD (425 of 432 with 1 PABD unit, 580 of 664 patients with 2 PABD units, 3 of 7 patients with 3 PABD units). For a few patients, however, our model demonstrated greater MABL with PABD than with IBS. These patients were characterized by 1) lower initial hematocrit (Hct), 2) recovery from PABD with return to baseline Hct or above by the time of surgery, and 3) longer time between first PABD and surgery.

CONCLUSION: IBS appears to be the superior blood conservation technique if PABD cannot be performed under optimal conditions. Tolerable predonation anemia and sufficient time for regeneration appear to be crucial for post-PABD erythropoiesis. If these goals cannot be accomplished, PABD should be abandoned and be replaced by IBS.

KEYWORDS: Orthopaedic Surgery

Zhonghua Wai Ke Za Zhi. 2008 Jan 15;46(2):118-21.

4 EFFECTIVENESS OF PREOPERATIVE AUTOLOGOUS PLATELETPHERESIS COMBINED WITH INTRAOPERATIVE AUTOTRANSFUSION ON THE BLOOD COAGULATION IN ORTHOPAEDIC PATIENTS.

Zhang XF, Dong JM, Gong ML, Shen SM, Zhou Y, Pan YF, Mao JP.
Department of Anesthesiology, Longsai Hospital, Zhenhai, Ningbo 315200, China. xiafei1003@126.com

ABSTRACT

OBJECTIVE: To investigate the effectiveness of preoperative plateletpheresis combined with intraoperative autotransfusion on the blood coagulation of orthopaedic patients.

METHODS: Sixty patients (ASA I-II) undergoing selective orthopaedic surgery were randomized into three groups (n = 20), that is, preoperative plateletpheresis combined with intraoperative autotransfusion for group I, intraoperative autotransfusion for group II, and group III without any managements of blood conservation. Coagulation parameters (prothrombin time, partial thromboplastin time, fibrinogen), hemoglobin and hematocrit values, platelet counts and aggregability were evaluated before the anaesthesia, 10 minutes after plateletpheresis, 10 minutes before the infusion of platelet rich plasma or autologous blood, 10 minutes after infusion, 24 and 48 hours postoperation. Intra- and postoperation blood loss and homologous blood transfusion requirements were also recorded.

RESULTS: Among three groups, there were no differences in intraoperative blood loss, perioperative haemoglobin level (Hb and Hct). As compared with group I, significant lower level of platelet counts and aggregability were observed in group II and III at the time of 24 and 48 hours after operation ($P < 0.05$), while postoperation blood loss and homologous blood-transfusion requirements increased at the same period ($P < 0.01$).

CONCLUSIONS: Preoperative plateletpheresis combined with intraoperative autotransfusion can ameliorate the blood coagulation in orthopaedic patients, and it is an effective way to decrease blood loss and homologous blood-transfusions requirements.

KEYWORDS: Orthopaedic Surgery, Preoperative Sequestration

J Bone Joint Surg Am. 2007 Feb;89(2):270-5.

5 INTRAOPERATIVE RED BLOOD-CELL SALVAGE IN REVISION HIP SURGERY. A CASE-MATCHED STUDY.

Bridgens JP, Evans CR, Dobson PM, Hamer AJ.

Lower Limb arthroplasty Unit, Department of Trauma and Orthopaedics, Northern General Hospital, Herries Road, Sheffield S5 7AU, United Kingdom. jpbbridgens@doctors.org.uk

ABSTRACT

BACKGROUND: Revision hip arthroplasty is commonly associated with substantial blood loss and the subsequent need for transfusion. This leads to an increased risk of blood-borne infection and hemolytic reactions. The purpose of this study was to demonstrate whether the use of intraoperative red blood-cell salvage in revision hip arthroplasty reduces the overall rate of allogeneic transfusion.

METHODS: Forty-seven patients who had undergone revision hip arthroplasty with the use of intraoperative cell salvage were identified. A computer database was used to individually match these patients, for age, sex, and eleven operative variables, to control patients who had undergone revision hip arthroplasty in the same unit without intraoperative cell salvage. Data gathered included the total allogeneic transfusion requirement for each patient, preoperative and postoperative hemoglobin levels, and operative time.

RESULTS: The total allogeneic transfusion requirement was significantly lower in the group that had intraoperative cell salvage than in the control group (median, 2 compared with 6 U of packed red blood cells, $p = 0.0006$), with a median reduction in allogeneic transfusion of 4 U. There was no significant difference in preoperative or postoperative hemoglobin levels between the groups.

CONCLUSIONS: The use of intraoperative cell salvage significantly lowered the allogeneic transfusion requirement, which can lead to substantial cost savings. To our knowledge, this is the first study in which the use of intraoperative red blood-cell salvage in revision hip arthroplasty was evaluated by matching patients on the basis of age, sex, and operative variables.

KEYWORDS: Orthopaedic Surgery, Hip Surgery

Orthopedics. 2004 Jun;27(6 Suppl):s663-8.

6 INTRAOPERATIVE BLOOD MANAGEMENT IN JOINT REPLACEMENT SURGERY.

Tenholder M, Cushner FD.

Insall Scott Kelly Institute for Orthopaedics and Sports Medicine, New York, NY, USA.

ABSTRACT

Interest is growing in blood conservation and avoidance of transfusion in patients undergoing orthopedic surgery, especially in the field of joint replacement. Several methods have proven successful in reducing intraoperative blood loss, which can translate into lessened allogeneic and autologous transfusion requirements. Available techniques include acute normovolemic hemodilution, hypotensive anesthesia, intraoperative blood salvage, specialized cautery, topical hemostatic agents, and pharmacologic agents given in the perioperative period. The greatest potential benefit arises in operations with greater expected blood loss or in special situations such as in patients with religious issues, bilateral joint replacement, coagulation disorders, or significant preoperative anemia.

KEYWORDS: Orthopaedic Surgery, Hip Surgery, Knee Surgery

Semin Hematol. 2004 Jan;41(1 Suppl 1):145-56.

7 STRATEGIES FOR MINIMIZING BLOOD LOSS IN ORTHOPEDIC SURGERY.

Tobias JD.

Department of child Health, Division of Pediatric Critical Care, University of Missouri, Columbia, MO, 65212, USA.

ABSTRACT

Several major orthopedic surgical procedures including hip arthroplasty, femoral osteotomy, and spinal fusion may result in significant blood loss and the need for allogeneic blood transfusions. Due to the heightened awareness of the potential deleterious effects of allogeneic blood product administration, several techniques have been evaluated to determine their efficacy in limiting perioperative blood loss. The following article will discuss the options to limit the need for allogeneic blood product administration during orthopedic surgical procedures. These techniques include: general considerations, autologous transfusion therapy, intraoperative and postoperative blood salvage, pharmacologic manipulation of the coagulation cascade, and controlled hypotension. Undoubtedly, many of these techniques are effective alone; however, the goal of performing major orthopedic surgical procedures without the use of allogeneic blood products can only be accomplished by combining several of these techniques.

KEYWORDS: Orthopaedic Surgery, Hip Surgery, Femoral Surgery, Spinal Surgery

J Bone Joint Surg Am. 2003 Nov;85-A(11):2147-51.

8 EFFICACY OF INTRAOPERATIVE BLOOD COLLECTION AND REINFUSION IN REVISION TOTAL HIP ARTHROPLASTY.

Zarin J, Grosvenor D, Schurman D, Goodman S.

Department of Orthopaedic Surgery, Stanford University Medical Center, 300 Pasteur Drive, Room R-144, Stanford, CA 94305, USA.

ABSTRACT

BACKGROUND: Patients undergoing revision total hip arthroplasty frequently require perioperative blood transfusion, increasing the risk for blood-borne disease and anaphylactic and hemolytic reactions. The purpose of this retrospective study was to evaluate the effect of intraoperative blood collection and reinfusion on net blood loss in patients undergoing revision hip arthroplasty.

METHODS: The medical records of 126 patients who had had a revision total hip arthroplasty with intraoperative blood salvage, with use of a collection and reinfusion device, during a twenty-eight-month period were reviewed. For comparison, the medical records of ninety-six patients who had undergone revision hip arthroplasty without intraoperative blood salvage were reviewed. Each of the 222 patients was categorized into a group on the basis of the type of revision.

RESULTS: Patients who had a revision of the femoral and acetabular components (Group C) had significantly higher mean intraoperative and total blood loss than did those who had a revision of the femoral component only (Group A [$p = 0.009$ and $p = 0.02$, respectively]) or a revision of the acetabular component only (Group B [$p = 0.0001$ for both]). Total blood loss was not significantly different between Groups A and B. The mean amount of blood reinfused intraoperatively was 356 mL for the patients in Group A, 374 mL for the patients in Group B, and 519 mL for the patients in Group C. Regression analysis showed a significant decrease in net blood loss with intraoperative collection and reinfusion in Groups B ($p = 0.002$) and C ($p = 0.0001$) but not in Group A.

CONCLUSIONS: Intraoperative collection and reinfusion substantially decreased net perioperative blood loss in patients who had a revision of both components (Group C) and in those who had a revision of the acetabular component (Group B). The use of intraoperative blood collection and reinfusion appears to be a valuable method of preserving blood volume in the perioperative period.

KEYWORDS: Orthopaedic Surgery, Hip Surgery

Transfusion. 2003 Apr;43(4):459-69.

9 ORTHOPEDIC SURGERY TRANSFUSION HEMOGLOBIN EUROPEAN OVERVIEW (OSTHEO) STUDY: BLOOD MANAGEMENT IN ELECTIVE KNEE AND HIP ARTHROPLASTY IN EUROPE.

Rosencher N, Kerkkamp HE, Macheras G, Munuera LM, Menichella G, Barton DM, Cremers S, Abraham IL; OSTHEO Investigation.
Cochin Hospital, 27 rue du Fbg St. Jacques, 75014 Paris, France. nadia.rosencher@cch.ap-hop-paris.fr

ABSTRACT

BACKGROUND: The purpose of this study was to assess current practices in blood management in elective orthopedic surgery in Europe.

STUDY DESIGN AND METHODS: For this 225-center prospective survey, data were collected on 3996 patients. Actual perioperative blood loss was compared to preoperative estimates. Differences in Hb levels and other outcome variables for patients receiving allogeneic versus autologous transfusions were evaluated. The probability of allogeneic transfusion based on selected predictor variables was estimated.

RESULTS: A total of 2640 (67%) hip and 1305 (33%) knee arthroplasty patients were evaluated. Estimated blood loss (median, 750 mL) was significantly lower than computed blood loss (median, 1944 mL). A total of 2762 (69%) patients received transfusions, including 1393 (35%) autologous-only and 1024 (25%) allogeneic-only. The probability of allogeneic transfusion decreased with increasing baseline Hb, but differentially so for men and women. Transfusion triggers were Hb levels of 8.93 \pm 1.83 g per dL for allogeneic transfusions, and 21 percent of these occurred when the Hb level was greater than 10 g per dL. Autologous blood transfusion was associated with a significantly lower rate (1%) of wound infections than allogeneic blood transfusion (4.2%).

CONCLUSION: Accurate assessment of preoperative Hb levels, better estimation of perioperative blood loss, efficient use of autologous blood, adherence to transfusion guidelines, and pharmacologic alternatives contribute to effective and comprehensive blood and anemia management.

KEYWORDS: Orthopaedic Surgery, Hip Surgery, Knee Surgery

J Arthroplasty. 2002 Apr;17(3):298-303.

10 PERIOPERATIVE BLOOD SALVAGE AS AN ALTERNATIVE TO PREDONATING BLOOD FOR PRIMARY TOTAL KNEE AND HIP ARTHROPLASTY.

Friederichs MG, Mariani EM, Bourne MH.
Department of Orthopedics, University of Utah, Salt Lake City, Utah, USA.

ABSTRACT

A total of 200 consecutive patients who underwent primary total knee or hip arthroplasty were reviewed to assess the efficacy of perioperative blood salvage and retransfusion. Five of 132 (3.8%) patients undergoing total knee arthroplasty and 3 of 68 (4.4%) patients undergoing total hip arthroplasty required allogeneic transfusion in addition to retransfusion of salvaged autologous blood. The risk of receiving allogeneic transfusion in addition to retransfusion of salvaged blood was 1.2% (2 of 173) in patients with a preoperative hematocrit of $\geq 37\%$. The risk of requiring allogeneic transfusion was 22% (6 of 27) in patients with a preoperative hematocrit of $< 37\%$ ($P < .01$). Perioperative blood salvage is safe and cost-effective and makes it possible to discontinue the practice of predonating blood for primary total knee arthroplasty and total hip arthroplasty in patients with a preoperative hematocrit $\geq 37\%$.

KEYWORDS: Orthopaedic Surgery, Hip Surgery, Knee Surgery

Eur J Anaesthesiol. 2000 Jul;17(7):411-7.

11 INCIDENCE AND RISK FACTORS FOR ALLOGENIC BLOOD TRANSFUSION DURING MAJOR JOINT REPLACEMENT USING AN INTEGRATED AUTOTRANSFUSION REGIMEN. THE RIZZOLI STUDY GROUP ON ORTHOPAEDIC ANAESTHESIA.

Borghi B, Casati A.

Department of Anaesthesiology, IRCCS Rizzoli Orthopaedic Institute, Bologna and Department of Anaesthesiology, IRCCS H San Raffaele, Via Olgettina 60-20132 Milan, Italy.

ABSTRACT

The efficacy of an integrated autotransfusion regimen, including pre-donation and perioperative salvage of autologous blood, was prospectively evaluated in 2884 patients undergoing total hip (n = 2016) or knee arthroplasty (n = 480), and hip revision (n = 388) with either balanced general, regional, or integrated epidural/general anaesthesia. Allogenic concentrated red blood cells were transfused in the presence of symptomatic anaemia or when haemoglobin concentration was < 6 g dL⁻¹ (10 g dL⁻¹ in patients affected by cerebrovascular or coronary artery disease) after all salvaged and pre-donated autologous blood had been transfused. A total of 278 patients (9.6%) received allogenic blood. Risk factors for allogenic blood transfusion were: preoperative haemoglobin concentration < 10 g dL⁻¹ (after autologous blood pre-donations) (Odds ratio: 8.7; 95% CI: 6.5-16.8; P = 0.004), hip revision versus hip or knee arthroplasty (Odds ratio: 5.8; 95% CI: 3.9-8.5; P = 0.0001) and inability in obtaining the number of pre-donations required by the Maximum Surgery Blood Order on Schedule (Odds ratio: 3.4; 95% CI: 2.7-4.1; P = 0.0001). The incidence of perioperative complications, including wound infection and haematoma, as well as myocardial ischaemia, respiratory failure and thromboembolic complications, was higher in those patients requiring allogenic blood transfusion (29.8%) than that observed in patients receiving only autologous blood (6.6%) (P = 0.0005); while the mean time duration from surgical procedure to patient discharge from the orthopaedic ward was shorter in those patients not receiving allogenic blood transfusion (12 days; 25-75th percentiles: 8-14 days) than in those patients who required perioperative transfusion with allogenic blood (15 days; 25-75th percentiles: 10-17 days) (P = 0.0005). In conclusion, this prospective study highlighted the clinical relevance of applying an extensive and integrated autotransfusion regimen in order to reduce allogenic blood transfusion and associated complications in patients undergoing major joint replacement.

KEYWORDS: Orthopaedic Surgery, Hip Surgery, Knee Surgery

Sangre (Barc). 1999 Dec;44(6):443-50.

Bull Hosp Jt Dis. 1999;58(4):184-7.

12 THE RESULTS OF INTRAOPERATIVE AUTOTRANSFUSION IN ORTHOPAEDIC SURGERY.

Benli IT, Akalin S, Duman E, Citak M, Kis M.

1st Department of Orthopaedics and Traumatology, Ankara Social Security Hospital, Turkey.

ABSTRACT

Perioperative hemorrhage associated with major orthopaedic surgery can become life threatening. Homologous bank blood transfusion can replace the volume of blood lost but it has serious disadvantages such as the transmission of viral agents, it has an insufficient platelet count, and transfusion reactions are possible. Hypotensive anesthesia, predeposited autologous blood transfusion and intraoperative autotransfusion are used to reduce these disadvantages. This study evaluates the results of 700 patients who underwent major orthopaedic intervention in our clinic between June 1991 and April 1998. Ninety-nine patients had hip surgery while 601 patients had spinal surgery. The autotransfusion unit saved an average of 858.9 +/- 136.8 cc of blood and an average of 1.9 +/- 1.2 units of saved blood was transfused. None of these patients needed homologous blood transfusion. One hundred patients who had spinal surgery during the same period were used as a control group. The control group required an average of 3.2 +/- 2.1 units of bank blood. Preoperative and postoperative hematocrit values revealed a statistically significant difference between the autotransfusion group and the homologous transfusion group (p < 0.05). The results of this study suggest that intraoperative autotransfusion prevents the decrease in hematocrit values while reducing the need for bank blood transfusion and hence avoiding the risk of transmission of viral infections.

KEYWORDS: Orthopaedic Surgery

Anesth Analg. 1999 Oct;89(4):861-9.

13 A META-ANALYSIS OF THE EFFECTIVENESS OF CELL SALVAGE TO MINIMIZE PERIOPERATIVE ALLOGENEIC BLOOD TRANSFUSION IN CARDIAC AND ORTHOPEDIC SURGERY. INTERNATIONAL STUDY OF PERIOPERATIVE TRANSFUSION (ISPOT) INVESTIGATORS.

Huët C, Salmi LR, Fergusson D, Koopman-van Gemert AW, Rubens F, Laupacis A.
INSERM U-330, Université Victor Segalen Bordeaux, France.

ABSTRACT

Concern about risks of allogeneic transfusion has led to an interest in methods for decreasing perioperative transfusion. To determine whether cell salvage reduces patient exposure to allogeneic blood, we performed meta-analyses of randomized trials, evaluating the effectiveness and safety of cell salvage in cardiac or orthopedic elective surgery. The primary outcome was the proportion of patients who received at least one perioperative allogeneic red cell transfusion. Twenty-seven studies were included in the meta-analyses. Cell salvage devices that do not wash salvaged blood were marginally effective in cardiac surgery patients when used postoperatively (relative risk [RR] = 0.85, 95% confidence interval [CI] = 0.79-0.92). Devices that wash or do not wash salvaged blood considerably decreased the proportion of orthopedic surgery patients who received allogeneic transfusion (RR = 0.39, 95% CI = 0.30-0.51 and RR = 0.35, 95% CI 0.26-0.46, respectively). No studies of cell savers that wash salvaged blood during cardiac surgery were included. Cell salvage did not appear to increase the frequency of adverse events. We conclude that cell salvage in orthopedic surgery decreases the risk of patients' exposure to allogeneic blood transfusion perioperatively. Postoperative cell salvage in cardiac surgery, with devices that do not wash the salvaged blood, is only marginally effective. IMPLICATIONS: This meta-analysis of all published randomized trials provides the best current estimate of the effectiveness of cell salvage and is useful in guiding clinical practice. We conclude that cell salvage in orthopedic surgery decreases the proportion of patients requiring allogeneic blood transfusion perioperatively, but postoperative cell salvage is only marginally effective in cardiac surgery.

KEYWORDS: Orthopaedic Surgery

J Spinal Disord. 1998 Dec;11(6):532-4.

14 THE EFFECTS OF PERIOPERATIVE BLOOD SALVAGE AND AUTOLOGOUS BLOOD DONATION ON TRANSFUSION REQUIREMENTS IN SCOLIOSIS SURGERY.

Anand N, Idio FG Jr, Remer S, Hoppenfeld S.
Department of Orthopedics, Albert Einstein College of Medicine Orthopedic Program at The Bronx-Lebanon Hospital Center, Bronx, NY 10457, USA.

ABSTRACT

Fifty consecutive cases of surgical instrumentation and fusion for adolescent idiopathic scoliosis were prospectively studied to test the hypothesis that the use of predonated autologous blood combined with judicious perioperative blood salvage could decrease the amount of homologous blood needed. All cases had posterior instrumentation and fusion. Nineteen patients had their rib prominence resected with an average of 4.8 ribs per patient. Our protocol called for perioperative blood salvage with the cell saver and reinfusion of postoperative drained blood if more than 300 ml were drained in 4 hours. Two units of predonated autologous blood was made available. Hypotensive anesthesia and meticulous hemostasis kept the blood loss to a minimum. The average total blood loss was 1,055 ml. Blood loss per segment was 91 ml with an average of 11 segments fused per patient. Patients with rib resection had a blood loss of 1,105 ml, while those without had a blood loss of 955 ml. The cell saver blood returned per case was 391 ml with the hematocrit of the product averaging 46%. Twelve patients were reinfused an average of 300 ml of the postoperative drained blood. The predonated autologous blood was used as part of the intraoperative fluid management. In no patient was homologous blood needed. The average starting hematocrit was 35.6%, with the hematocrit at discharge (seventh day) being 32.4%. There were no complications or blood transfusion reactions. Our results suggest that judicious perioperative blood management may decrease the need for homologous blood transfusion in selected posterior idiopathic scoliosis surgery.

KEYWORDS: Orthopaedic Surgery, Spinal Surgery, Scoliosis Surgery

Transfus Med. 1997 Dec;7(4):277-80.

15 CELL SALVAGE AUTO TRANSFUSION IN TOTAL KNEE REPLACEMENT SURGERY.

Shenolikar A, Wareham K, Newington D, Thomas D, Hughes J, Downes M.
Department of Anaesthesia, Morriston Hospital, Swansea, UK.

ABSTRACT

We conducted a prospective, randomized study to assess the impact of cell salvage, auto transfusion on the requirements for allogeneic blood for patients undergoing a total knee replacement (TKR). One hundred consecutive TKR patients were randomly allocated to receive either autologous blood (using cell salvage) or an allogeneic blood transfusion as necessary. Patients allocated to the autologous group were rescued with allogeneic blood if the postoperative haemoglobin fell below 9 g dL⁻¹. Forty-two (84%) of 50 patients in the autologous group required no supplementary blood transfusion. Forty (80%) of 50 patients allocated to receive allogeneic blood required transfusion. There were no detrimental effects of autologous blood transfusion. We conclude that autologous blood transfusion, using the cell saver system, is a safe and effective method of reducing the need for allogeneic blood transfusion and, in doing so, reduces the risk of transmission of infections associated with allogeneic blood transfusion, whilst decreasing demand on precious allogeneic blood reserves.

KEYWORDS: Orthopaedic Surgery, Knee Surgery

Br J Anaesth. 1997 Nov;79(5):662-4.

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16 AUTOTRANSFUSION IN MAJOR ORTHOPAEDIC SURGERY: EXPERIENCE WITH 1785 PATIENTS.

Borghi B, Pignotti E, Montebugnoli M, Bassi A, Corbascio M, de Simone N, Elmar K, Righi U, Laguardia AM, Bugamelli S, Cataldi F, Ranocchi R, Feoli MA, Bombardini T, Gargioni G, Franchini AG, Caroli GC.
1st Service of Anaesthesia and Intensive Care, IRCCS, Rizzoli Orthopaedic Institute, Bologna, Italy.

ABSTRACT

Using a prospective audit, we have evaluated the efficacy of an integrated autotransfusion regimen which comprised predepositing and intra- and postoperative blood salvage in major orthopaedic surgery. We examined prospectively the records of 1785 patients (1198 females, 5867 males, mean age 62 (range 16-90) yr, preoperative haemoglobin concentration 13.4 (SD 1.4) g dL⁻¹) undergoing total hip arthroplasty (THA, 1229 patients), THA after removal of internal fixation devices (RFD + THA, 18 patients), total knee arthroplasty (TKA, 263 patients), revision surgery of the hip (HR cup + stem revision, 197 patients; cup revision, 53 patients; stem revision, 16 patients) and total knee revision (TKR, nine patients). We estimated that the number of predonations (MSBOS = maximum surgery blood order schedule) was 2 u. for THA, TKA and TKR, and 3 u. for partial or total hip revision and total hip arthroplasty with fixation removal. We found that it was possible to obtain the MSBOS in 1597 patients (89.5%). Homologous red blood cell (HRBC) transfusions were carried out in 131 patients (7.3%). We found that the need to use HRBC was significantly associated with failure to meet the number of MSBOS, female sex, lower preoperative haemoglobin concentration, use of calcium heparin for antithrombosis prophylaxis, more extensive surgery, higher ASA rating and co-existing diseases such as coronary artery disease.

KEYWORDS: Orthopaedic Surgery, Hip Surgery, Knee Surgery, Sorin Group Compact Advanced

Chir Organi Mov. 1997 Jul-Sep;82(3):249-61.

17 AUTOTRANSFUSION WITH INTRA- AND POSTOPERATIVE BLOOD RECOVERY IN PROSTHETIC HIP SURGERY. A STUDY CONDUCTED ON 1368 CEMENTLESS PROSTHESES.

Magrini Pasquinelli F, Binazzi R, Borghi B, Gargioni G.
Il Clinica Ortopedica dell'Università di Bologna, Istituto Ortopedico Rizzoli.

ABSTRACT

With regard to increasing reservations as to homologous transfusions and the objective risks that they involve, since 1984 we have been using an autotransfusion technique in total hip arthroplasty constituting blood predeposit for hemodilution, and intra- and postoperative blood recovery. When this method was used postoperative complications were not very significant even when patients were high-risk (cardiopathic); furthermore, the use of homologous transfusions was required in 2.2% of the patients in 1994 as compared to 90% in 1985. The use of our orthopaedic protocol allows for rapid recovery of movement in the patient thus reducing time bed-ridden and related risks (DVT and/or PTE); the transfusion protocol allows for a return to normal of hemodynamic conditions a few days after surgery. Finally, the reduced incidence of complications caused by homologous transfusions (hepatitis, AIDS...) constitutes a financial saving for the government.

KEYWORDS: Orthopaedic Surgery, Hip Surgery

J Am Coll Surg. 1995 May;180(5):561-7.

18 EFFECT OF PREOPERATIVE AUTOLOGOUS BLOOD DONATION AND INTRAOPERATIVE AND POSTOPERATIVE BLOOD RECOVERY ON HOMOLOGOUS BLOOD TRANSFUSION REQUIREMENT IN CEMENTLESS TOTAL HIP REPLACEMENT OPERATION.

Huo MH, Paly WL, Keggi KJ.
Department of Orthopaedic Surgery, Johns Hopkins School of Medicine, Baltimore, MD, USA.

ABSTRACT

BACKGROUND: Blood transfusion is often necessary in operations for total hip replacement (THR). This study was done to investigate the efficacy of three different methods of autologous blood conservation and transfusion in patients undergoing primary THR without cement.

STUDY DESIGN: One hundred fifty-five patients with osteoarthritis underwent unilateral cementless THR using normotensive general anesthesia performed by a single surgeon. The patients were divided into four groups depending on which conservation method was used. Ten different demographic and hematologic parameters were recorded and analyzed by using analysis of the variance and multiple regression methods.

RESULTS: All three methods were effective in reducing the need for homologous blood transfusions. The greatest benefit was realized when both preoperative autologous blood donation and intraoperative salvage using the Cell Saver were combined. The addition of postoperative salvage and retransfusion of wound drainage blood using the Solcotrans System did not significantly reduce further the chance of homologous blood transfusions.

CONCLUSIONS: The data from this study were similar to previously published reports. Regression analysis confirmed the correlation among the different variables studied. We currently offer preoperative donation and intraoperative salvage with the Cell Saver to patients undergoing cementless total hip replacement.

KEYWORDS: Orthopaedic Surgery, Hip Surgery

Transfus Sci. 1994 Dec;15(4):463-70.

19 AUTOLOGOUS BLOOD PRE-DEPOSIT AND CELL SALVAGE IN ORTHOPEDIC SURGERY.

Mercuriali F, Inghilleri G, Biffi E, Vinci A, Colotti MT, Scalamogna R.
Centro trasfusionale e di Immunoematologia, Istituto Ortopedico Gaetano Pini Università di Milano, Italy.

ABSTRACT

A successful autologous blood program should enrol all appropriate patients, conserve homologous blood and minimize the exposure to the risks of donor blood. A program of autotransfusion and proper use of blood has been implemented since 1980 with the objectives of including all eligible patients and to transfuse autologous blood only. The following strategies were adopted: critical review of transfusion indications; control of over-transfusion; avoidance of waste; systematic and integrated use of all autotransfusion techniques currently available. Results in 1992 in elective surgery: 98% enrolment, 75% blood conservation. Exposure to homologous blood was completely avoided in 53% of the cases.

KEYWORDS: Orthopaedic Surgery

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J Bone Joint Surg Am. 1989 Jan;71(1):8-14.

20 INTRAOPERATIVE AUTOLOGOUS TRANSFUSION IN REVISION TOTAL HIP ARTHROPLASTY.

Wilson WJ.
Swedish Hospital Medical Center, Seattle.

ABSTRACT

The records of ninety-eight patients (100 hips) who had revision total hip arthroplasty were reviewed to evaluate the efficacy of intraoperative autologous transfusion in reducing homologous blood-transfusion requirements. In the fifty hips in the study group, a mean of 685 milliliters of autologous blood, or 47 per cent of the estimated loss of blood, was transfused intraoperatively. During the entire course of hospitalization, the mean of the total homologous blood-transfusion requirements was 795 milliliters in thirty-nine study-group patients, compared with 1160 milliliters in forty-six control-group patients who did not have autologous transfusion. This difference was statistically significant (p less than 0.029). Eleven patients in the study group and four patients in the control group did not receive homologous blood. Overall, the use of intraoperative autologous transfusion was directly responsible for a 42 per cent reduction in the total amount of homologous blood that was transfused.

KEYWORDS: Orthopaedic Surgery, Hip Surgery

Orthopedics. 1986 Oct;9(10):1403-7.

21 THE EFFICACY OF INTRAOPERATIVE AUTOLOGOUS TRANSFUSION IN MAJOR ORTHOPEDIC SURGERY: A REGRESSION ANALYSIS.

Bovill DF, Moulton CW, Jackson WS, Jensen JK, Barcellos RW.

ABSTRACT

Perioperative blood loss associated with 89 cases of major orthopedic surgery was compared with that of a control group of 89 to determine the effectiveness of intraoperative autologous transfusion. Volume of banked blood transfused and hematocrit change were used to determine total blood loss. The orthopedic cases consisted of cemented "virgin" total hip replacement, cemented virgin tricompartmental knee replacement, and spine fusion. Use of an autotransfusion device (Cell Saver) intraoperatively was associated with significantly smaller volumes of transfused banked blood and significantly smaller hematocrit drops in the groups of patients who underwent total hip replacement or spine fusion, but not in the group of patients who underwent total knee replacement. One potential source of bias in the study stems from the fact that four days were allotted for equilibrium from perioperative blood loss in the hip and knee replacement groups, while, for reasons of data availability, equilibrium time in the spine fusion groups was two days.

KEYWORDS: Orthopaedic Surgery, Hip Surgery, Knee Surgery, Spinal Surgery



OBSTETRIC SURGERY



REFERENCES OVERVIEW

- Autotransfusion in obstetric surgery:

1 3 4 5 7 8 9

- Use of a leukocyte depletion filter when autotransfusing in obstetric surgery:

2 3 6

Int J Obstet Anesth. 2008 Jan;17(1):37-45.

1 CELL SALVAGE IN OBSTETRICS.

Allam J, Cox M, Yentis SM.

Magill Department of Anaesthesia, Intensive Care and Pain Management, Chelsea and Westminster Hospital, London, UK. docjoeya@yahoo.com

ABSTRACT

The safety of cell salvage in obstetrics has been questioned because of the presumed risk of precipitating amniotic fluid embolism and, to a lesser extent, maternal alloimmunisation. For these reasons, experience in this field is limited and has lagged far behind that in other surgical specialties. There has, however, been renewed interest in its use over recent years, mainly as a result of problems associated with allogeneic blood transfusion. Our aim was to review the medical literature to ascertain the principles of cell salvage, the ability of the process to remove contaminants, and its safety profile in the obstetric setting. The search engines PubMed and Google Scholar were used and relevant articles and websites hand searched for further references. Existing cell salvage systems differ in their ability to clear contaminants and all require the addition of a leucocyte depletion filter. Although large prospective trials of cell salvage with autotransfusion in obstetrics are lacking, to date, no single serious complication leading to poor maternal outcome has been directly attributed to its use. Cell salvage in obstetrics has been endorsed by several bodies based on current evidence. Current evidence supports the use of cell salvage in obstetrics, which is likely to become increasingly commonplace, but more data are required concerning its clinical use.

KEYWORDS: Obstetric Surgery

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Br J Anaesth. 2008 Aug;101(2):225-9. Epub 2008 May 30.

2 CONTAMINATION OF SALVAGED MATERNAL BLOOD BY AMNIOTIC FLUID AND FETAL RED CELLS DURING ELECTIVE CAESAREAN SECTION.

Sullivan I, Faulds J, Ralph C.

Department of Haematology, Royal Cornwall Hospital Trust, Royal Cornwall Hospital, Truro, Cornwall TR13LJ, UK. ian.sullivan@rcht.cornwall.nhs.uk

ABSTRACT

BACKGROUND: Cell salvage in obstetrics is still a controversial subject and has yet to be fully embraced. The aim of this exploratory study was to measure amniotic fluid (AF), heparin, and fetal red cell contamination of washed filtered salvaged maternal blood and to investigate differences based on the number of suction devices used.

METHODS: Patients undergoing elective Caesarean section were assigned alternately to one of two groups. In Group 1, all blood and AF was collected with one suction. In Group 2, AF was aspirated to waste with a second separate suction device before collection of any blood.

RESULTS: In both groups, alpha-fetoprotein (AFP), squames cells, and heparin were significantly reduced ($P < 0.001$) by the washing and filtering process. Mean AFP levels post-filtration were 2.58 IU ml⁻¹ in Group 1 and 3.53 IU ml⁻¹ in Group 2. Squames cells were completely removed in all but two cases. Fetal red blood cells were still present in the final product, range 0.13-4.35%. In Group 1, haemoglobin and haematocrit were higher than in Group 2, with lower white blood cell, AFP, and fetal red cell counts.

CONCLUSIONS: This study adds to the growing body of evidence that there is little or no possibility for AF contamination to enter the re-infusion system when used in conjunction with a leucodepletion filter.

KEYWORDS: Obstetric Surgery, Caesarean Section, Leucocyte Depletion Filter

Int J Obstet Anesth. 2007 Jul;16(3):241-9. Epub 2007 May 16.

3 BLOOD CONSERVATION TECHNIQUES IN OBSTETRICS: A UK PERSPECTIVE.

Catling S.

Department Anaesthesia, Singleton Hospital, Swansea, Wales, UK. sue.catling@btopenworld.com

ABSTRACT

In the UK, maternal mortality due to haemorrhage appears to be rising, with obstetric haemorrhage accounting for 3–4% of the red cells transfused. Allogeneic blood transfusion carries risks such as administration errors, transmitted infections and immunological reactions. The supply of blood is decreasing, partly due to the exclusion of donors who have themselves received a blood transfusion since 1980, in order to stop transmission of variant-Creutzfeldt-Jakob disease. The cost of blood is significantly increasing, partly because it is now leucocyte-depleted to minimize viral transmission. Various blood conservation techniques can reduce exposure to allogeneic blood thereby reducing risk and conserving the blood supply. These include preoperative autologous donation, acute normovolaemic haemodilution and intra-operative cell salvage. Preoperative autologous donation may produce anaemia, does not eliminate transfusion risk, cannot be used in an emergency and is not acceptable to Jehovah's Witnesses. It should be reserved for exceptional circumstances (rare blood type or unusual antibodies). Acute normovolaemic haemodilution may induce anaemia and cardiac failure and cannot be used in an emergency. It may have a limited role in combination with other techniques. Intra-operative cell salvage is more effective and useful in obstetrics than the other techniques, overcomes their shortcomings and is endorsed by CEMACH, OAA/AAGBI Guidelines, the National Blood Service and NICE.

KEYWORDS: Obstetric Surgery, Costs

Int J Gynaecol Obstet. 2002 Apr;77(1):77-8.

4 ACOG COMMITTEE OPINION. PLACENTA ACCRETA. NUMBER 266, JANUARY 2002. AMERICAN COLLEGE OF OBSTETRICIANS AND GYNCOLOGISTS.

Committee on Obstetric Practice.

ABSTRACT

The incidence of placenta accreta has increased 10-fold in the past 50 years and now occurs with a frequency of 1 per 2,500 deliveries. Women who have had two or more cesarean deliveries with anterior or central placenta previa have nearly a 40% risk of developing placenta accreta. If the diagnosis or strong suspicion of placenta accreta is formed before delivery, the patient should be counseled about the likelihood of hysterectomy and blood transfusion. Blood products and clotting factors should be available. Cell saver technology should be considered if available as well as the appropriate location and timing for delivery to allow access to adequate surgical personnel and equipment. A preoperative anesthesia assessment should be obtained.

KEYWORDS: Obstetric Surgery, Caesarean Section

Anesthesiology. 2000 Jun;92(6):1531-6.

5 AMNIOTIC FLUID REMOVAL DURING CELL SALVAGE IN THE CESAREAN SECTION PATIENT.

Waters JH, Biscotti C, Potter PS, Phillipson E.

Departments of General Anesthesiology, Obstetrics and Gynecology, and Anatomic Pathology, Cleveland Clinic Foundation, Cleveland, Ohio 44195, USA.

ABSTRACT

BACKGROUND: Cell salvage has been used in obstetrics to a limited degree because of a fear of amniotic fluid embolism. In this study, cell salvage was combined with blood filtration using a leukocyte depletion filter. A comparison of this washed, filtered product was then made with maternal central venous blood.

METHODS: The squamous cell concentration, lamellar body count, quantitative bacterial colonization, potassium level, and fetal hemoglobin concentration were measured in four sequential blood samples collected from 15 women undergoing elective cesarean section. The blood samples collected included (1) unwashed blood from the surgical field (prewash), (2) washed blood (postwash), (3) washed and filtered blood (postfiltration), and (4) maternal central venous blood drawn from a femoral catheter at the time of placental separation.

RESULTS: Significant reductions in the following parameters were seen when the postfiltration samples were compared to the prewash samples (median [25th-75th percentile]): squamous cell concentration (0.0 [0.0-0.1 counts/high-powered field (HPF)] vs. 8.3 counts/HPF [4.0-10.5 counts/HPF], $P < 0.05$); bacterial contamination (0.1 [0.0-0.2] vs. 3.0 [0.6-7.7] colony-forming units (CFU)/ml, $P < 0.01$); and lamellar body concentration (0.0 [0.0-1.0] vs. 22.0 [18.5-29.5] thousands/microl, $P < 0.01$). No significant differences existed between the postfiltration and maternal samples for each of these parameters. Fetal hemoglobin was in higher concentrations in the postfiltration sample when compared with maternal blood (1.9 [1.1-2.5] vs. 0.5% [0.3-0.7]). Potassium levels were significantly less in the postfiltration sample when compared with maternal (1.4 [1.0-1.5] vs. 3.8 mEq/l [3.7-4.0]).

CONCLUSIONS: Leukocyte depletion filtering of cell-salvaged blood obtained from cesarean section significantly reduces particulate contaminants to a concentration equivalent to maternal venous blood.

KEYWORDS: Obstetric Surgery, Caesarean Section, Leucocyte Depletion Filter

Obstet Gynecol. 1999 Jun;93(6):968-72.

6 CLEARANCE OF FETAL PRODUCTS AND SUBSEQUENT IMMUNOREACTIVITY OF BLOOD SALVAGED AT CESAREAN DELIVERY.

Fong J, Gurewitsch ED, Kump L, Klein R.

Department of Anesthesiology, New York Presbyterian Hospital-Weill Medical College of Cornell University, New York, New York 10021, USA.

ABSTRACT

OBJECTIVE: To determine if fetal products can be detected after postplacental, intraoperative blood salvage, and if the product is immunoreactive with maternal serum.

METHODS: We suctioned the shed blood of 27 term gravidas with intact membranes who had cesareans, beginning 4 minutes after placenta removal, into a COBE BRAT-2 salvage system (COBE Cardiovascular, Arvada, CO). Preoperative maternal and fetal cord blood samples were collected. Preprocessing and postprocessing salvaged blood was analyzed for alpha-fetoprotein (AFP), hemoglobin, hematocrit, and plasma-free hemoglobin. Papanicolaou smears and immunodiffusion using Ouchterlony methods for detection of protein-protein interactions were run on maternal serum. Postprocess salvaged blood was subjected to Kleihauer-Bethke tests, typed, and crossmatched with maternal serum, including mixed fields. No women were transfused.

RESULTS: Ten of 27 women shed enough postprocess salvaged blood for analysis. Alpha-fetoprotein was cleared, but Kleihauer-Bethke analyses were positive in all postprocessing specimens. Anucleate squamous cells were detected by Papanicolaou smears in four of ten preprocessed specimens, with one cleared by processing. No antigen-antibody reaction between maternal and preprocessed or postprocessed salvaged blood was found by the Ouchterlony method. Crossmatching of the final product with maternal serum was successful, with negative mixed fields in all cases.

CONCLUSION: Fetal debris was present in blood salvaged 4 minutes after removal of placenta. Despite clearance of humoral material, fetal blood cells were detectable in all postprocess salvaged blood. The product was compatible with maternal blood by crossmatching and its supernate did not immunoreact with maternal serum.

KEYWORDS: Obstetric Surgery, Caesarean Section, Leucocyte Depletion Filter, Sorin Group Brat2

7 BLOOD SALVAGE DURING CAESAREAN SECTION.

Rainaldi MP, Tazzari PL, Scagliarini G, Borghi B, Conte R.
Anaesthesia and Intensive Care Maternity Unit, Policlinico S. Orsola, Bologna, Italy.

ABSTRACT

The aim of this study was to assess blood salvage during Caesarean section. In 15 Caesarean sections, red cells lost were collected and washed with a Dideco machine and tested for the presence of fetoplacental material, bacterial contamination, free haemoglobin and fetal blood cells. Successive patients were allocated randomly to one of two groups. In group 1 (n = 34), intraoperative blood was salvaged, while group 2 served as a control. The mean amount of blood salvaged in group 1 was 363 (SD 153) ml. Blood was salvaged following these guidelines: identification of blood group of the mother and fetus; avoidance of aspirating blood from the umbilical cord; commencement of salvage after removing the fetoplacental unit; completely filling the centrifugation bowl with red cells; washing the cells using at least 1000 ml of physiological solution per bowl; and mixing the contents of the bowl, completely eliminating the buffy coat where fetal cells are located. In group 1, the use of homologous blood transfusions was significantly lower (one of 34 (2.9%) patients compared with eight of 34 (23.5%); $P = 0.01$), haemoglobin concentrations during the first 4 days after operation were significantly higher and postoperative hospital stay was significantly shorter. Duration of hospital stay was significantly shorter in group 1 (5.3 (1.9) vs 7.3 (4) days; $P = 0.003$). Mean base haemoglobin concentrations were significantly lower in group 1 (10.7 (1.4) vs 11.7 (1.5) g dl⁻¹; $P > 0.0001$), while after surgery mean haemoglobin concentrations were significantly higher approximately 3 h after operation compared with the control group (10.2 (1.5) vs 8.6 (1.2) g dl⁻¹; $P < 0.0001$). On the first day, haemoglobin concentrations were 9.8 (1.5) vs 8 (1.4) g dl⁻¹ ($P < 0.0001$), on the second day 9.8 (1.4) vs 7.7 (1.4) g dl⁻¹ ($P < 0.0001$), on the third day 10.1 (1.5) vs 7.5 (1.3) g dl⁻¹ ($P < 0.0001$) and on the fourth day 10.4 (1.5) vs 8.1 (1.4) g dl⁻¹ ($P < 0.0001$).

KEYWORDS: Obstetric Surgery, Caesarean Section, Sorin Group Electa

Am J Obstet Gynecol. 1998 Sep;179(3 Pt 1):715-20.

8 THE SAFETY OF INTRAOPERATIVE AUTOLOGOUS BLOOD COLLECTION AND AUTOTRANSFUSION DURING CESAREAN SECTION.

Rebarber A, Lonser R, Jackson S, Copel JA, Sipes S.
Department of Obstetrics and Gynecology, Yale University School of Medicine, New Haven, Connecticut, USA.

ABSTRACT

OBJECTIVE: We evaluated the safety of intraoperative autologous blood collection and autotransfusion during cesarean section.

STUDY DESIGN: A multicenter historical cohort study identified 139 patients in whom autologous blood collection autotransfusion during cesarean section was performed. We also identified 87 control patients who underwent similar surgical procedures at the same centers without autotransfusion. The outcome variables we compared were acute respiratory distress syndrome, amniotic fluid embolism, disseminated intravascular coagulation, need for ventilatory support, infectious morbidity, and the length of postpartum hospitalization.

RESULTS: Demographic and obstetric characteristics were similar in both groups. The ranges of autotransfused volumes were 200 to 11,250 mL at Yale, 225 to 1160 mL at Good Samaritan, and 125 to 4750 mL at Hinsdale. No statistically significant differences existed between the two groups in any of the outcome variables analyzed. No case of acute respiratory distress syndrome or amniotic fluid embolism was identified in either group.

CONCLUSIONS: Our multicenter experience reveals no demonstrably increased risk of complications in patients receiving autologous blood collection autotransfusion during cesarean section.

KEYWORDS: Obstetric Surgery, Caesarean Section

9 THE ABILITY OF THE HAEMONETICS 4 CELL SAVER SYSTEM TO REMOVE TISSUE FACTOR FROM BLOOD CONTAMINATED WITH AMNIOTIC FLUID.

Bernstein HH, Rosenblatt MA, Gettes M, Lockwood C.
Department of Anesthesiology, Mount Sinai Medical Center, New York, NY 10029-6574, USA.

ABSTRACT

The purpose of this study was to determine whether functionally active tissue factor could be removed from blood contaminated with amniotic fluid (AF) after processing through a Haemonetics 4 Cell Saver System (Haemonetics Corporation, Braintree, MA). In Phase I, AF was collected from 29 women undergoing cesarean section. Nine experiments were performed. Forty-milliliter aliquots of pooled AF were mixed with 125 mL of packed red blood cells and processed in the Cell Saver. In Phase II, all the blood and AF lost at cesarean section was collected and processed through the Cell Saver. Pre- and postwash specimens were collected and analyzed for total tissue factor concentration and the concentration of functionally active tissue factor. In Phase I, total tissue factor concentration was reduced by 89%, and the concentration of active tissue factor was reduced to 0 after processing. In Phase II, no tissue factor was detected after processing through the Cell Saver. We have demonstrated the ability of the Haemonetics 4 Cell Saver System to remove tissue factor activity from blood contaminated with AF. Implications: Hemorrhage after childbirth may require massive transfusion. If the patient's own blood can be collected and given back to the patient, this may avoid the use of regular banked blood. Amniotic fluid, which may mix with blood lost after delivery, contains tissue factor, a substance that may activate the coagulation system and cause further bleeding. The authors found that the Haemonetics 4 Cell Saver System (Haemonetics Corporation, Braintree, MA), which collects and washes blood, can remove tissue factor from blood contaminated with amniotic fluid.

KEYWORDS: Obstetric Surgery, Caesarean Section, Haemonetics Cell Saver





VASCULAR SURGERY



REFERENCES OVERVIEW

- Autotransfusion in aortic aneurysm repair surgery:



Vascular. 2009 Mar-Apr;17(2):83-92.

1 INTRAOPERATIVE CELL SALVAGE VERSUS ALLOGENEIC TRANSFUSION DURING ABDOMINAL AORTIC SURGERY: CLINICAL AND FINANCIAL OUTCOMES.

Marković M, Davidović L, Savić N, Sindjelić R, Ille T, Dragas M.

Clinic for Vascular Surgery, Institute for Cardiovascular Diseases, Clinical Centre of Serbia, Belgrade, Serbia. drmirosavlav@gmail.com

ABSTRACT

The objective of this study was to assess the clinical and financial outcomes of intraoperative cell salvage (ICS) during abdominal aortic surgery. In this study, 90 patients were operated on with the use of ICS (group 1, prospective) and 90 patients without ICS (group 2, historical control). According to the type of operation, the patients were subdivided into three consecutive 30-patient subgroups (1, aortoiliac occlusive disease [AOD]; 2, elective abdominal aortic aneurysm [AAA]; or 3, ruptured abdominal aortic aneurysm [RAAA]). Transfusion requirements and postoperative complications were recorded. The total amounts of perioperatively transfused allogeneic blood were higher in all patient subgroups that underwent surgery without ICS ($p = .0032$). In the ICS group, 50% of AOD patients and 60% of elective AAA patients received no allogeneic transfusions. There were no significant differences in the incidence of postoperative complications in any group examined. ICS significantly reduced the necessity for allogeneic transfusions during abdominal aortic surgery. ICS use was most valuable in urgent situations with high blood losses, such as RAAA, for which only small amounts of allogeneic blood were initially available. In patients with more than 3 units of autologous blood reinfused, this method was cost effective.

KEYWORDS: Vascular Surgery, Abdominal Aortic Aneurysm Repair, Costs

Ir J Med Sci. 2007 Mar;176(1):33-6.

2 TRANSFUSION REQUIREMENTS AND OUTCOMES IN PATIENTS UNDERGOING ABDOMINAL AORTIC SURGERY USING INTRA-OPERATIVE CELL SALVAGE.

Healy CF, Doyle M, Egan B, Hendrick B, O'Malley MK, O'Donohoe MK.

Department of Vascular Surgery, Mater Misericordiae University Hospital, Eccles Street, Dublin 7, Ireland. healyciarlan@eircom.net

ABSTRACT

BACKGROUND: Intraoperative cell salvage (ICS) is the recovery, anticoagulation, filtration and reinfusion of blood lost during surgery. The aim of this study is to determine the safety and efficacy of ICS in emergency and elective abdominal aortic surgery.

METHODS: This study reviews volumes of blood loss, blood salvaged with ICS, allogenic blood requirements, and clinical outcomes in patients undergoing abdominal aortic surgery using ICS.

RESULTS: Seventy-nine patients undergoing abdominal aortic surgery are included. Supplemental allogenic blood was not required in 45/79 (57%) of all patients. Transfusion with allogenic blood was not necessary in 41/63 (66%) of elective abdominal aortic aneurysm repairs. ICS was associated with no major complications.

CONCLUSION: ICS is a safe procedure and substantially reduces the need for blood transfusion in patients undergoing abdominal aortic surgery. It may substantially alleviate shortages of allogenic blood and should be part of the armamentarium of vascular units.

KEYWORDS: Vascular Surgery, Abdominal Aortic Aneurysm Repair

Arch Surg. 2007 Nov;142(11):1098-101.

3 INTRAOPERATIVE AUTOTRANSFUSION IN ABDOMINAL AORTIC ANEURYSM SURGERY: META-ANALYSIS OF RANDOMIZED CONTROLLED TRIALS.

Takagi H, Sekino S, Kato T, Matsuno Y, Umemoto T.

Department of Cardiovascular Surgery, Shizuoka Medical Center, Sunto-gun, Shizuoka, Japan. kfgth973@ybb.ne.jp

ABSTRACT**OBJECTIVE:** To determine whether intraoperative autotransfusion reduces the percentage of patients undergoing allogeneic blood transfusion.**DATA SOURCES AND STUDY SELECTION:** Using a public domain database (MEDLINE) and a Web-based search engine (PubMed), all intraoperative autotransfusion vs control prospective randomized controlled trials that enrolled patients undergoing elective infrarenal abdominal aortic aneurysm surgery, published between January 1, 1966, and November 30, 2005, were searched. Relevant studies were identified through a manual search of secondary sources including references of initially identified articles.**DATA EXTRACTION:** Data on detailed inclusion criteria, autotransfusion system type, and incidence of allogeneic blood transfusion were abstracted from each study. Sensitivity analyses were performed by excluding individual trials one at a time and recalculating the pooled risk ratio estimates for the remaining studies.**DATA SYNTHESIS:** Our search identified 4 randomized controlled trials including data for 292 patients. Pooled analysis demonstrated a statistically significant 37% reduction in risk of allogeneic blood transfusion with intraoperative autotransfusion compared with control (risk ratio, 0.63; 95% confidence interval, 0.41-0.95; $P = .03$) in a random-effects model. There was statistically significant trial heterogeneity of results ($P = .02$) but no evidence of statistically significant publication bias ($P = .497$). Two of 4 sensitivity analyses demonstrated statistically nonsignificant results favoring intraoperative autotransfusion.**CONCLUSION:** Based on a meta-analysis of available randomized controlled trials, intraoperative autotransfusion reduces risk of allogeneic blood transfusion in elective infrarenal abdominal aortic aneurysm surgery.**KEYWORDS:** Vascular Surgery, Abdominal Aortic Aneurysm Repair

Vox Sang. 2005 May;88(4):244-8.

4 DOES WASHING SWABS INCREASE THE EFFICIENCY OF RED CELL RECOVERY BY CELL SALVAGE IN AORTIC SURGERY?

Haynes SL, Bennett JR, Torella F, McCollum CN.

Academic Surgery Unit, South Manchester University Hospital Trust, Manchester, UK. s_haynes@fs1.with.man.ac.uk

ABSTRACT**BACKGROUND AND OBJECTIVES:** We investigated the contribution of swab washing to the efficiency of red cell recovery by intraoperative cell salvage (ICS) in 10 patients undergoing elective aortic aneurysm repair.**MATERIALS AND METHODS:** Volumes and haemoglobin (Hb) concentrations were recorded in the blood recovered by direct suction and from washed swabs, both before and after processing with a Haemonetics Cell Saver 5.**RESULTS:** The mean \pm standard deviation (SD) estimated blood loss was 991 \pm 403 ml, resulting in a mean \pm SD salvaged RBC volume of 380 \pm 124 ml. The median [interquartile (IQR) range] Hb collected from suction was 84.9 (61.8-131.4) g, of which 50.1 (45-71.5) g was returned to the patient after processing, a median yield of 68 (49-77)%. The swab wash produced a median (IQR) Hb of 39.4 (28.4-64.9) g, of which 26.2 (16.8-31) g was reinfused, a 67 (33-98)% yield. Swab wash thus contributed with a median (IQR) of 31 (24-39)% of the total RBC recovery.**CONCLUSIONS:** Washing swabs improves the efficiency of red cell recovery by ICS.**KEYWORDS:** Vascular Surgery, Abdominal Aortic Aneurysm Repair, Haemonetics Cell Saver, Swab Wash

Anaesth Intensive Care. 2000 Dec;28(6):646-9.

5 RELATIVE COST OF AUTOLOGOUS RED CELL SALVAGE VERSUS ALLOGENEIC RED CELL TRANSFUSION DURING ABDOMINAL AORTIC ANEURYSM REPAIR.

Gardner A, Gibbs N, Evans C, Bell R.

Departments of Anaesthesia and Vascular Surgery, Sir Charles Gairdner Hospital, Perth, Western Australia.

ABSTRACT

The costs of washed autologous red cell concentrate obtained by intraoperative red cell salvage were compared to the costs of allogeneic packed red cell transfusion during 110 consecutive abdominal aortic aneurysm repairs. The mean volume of scavenged blood during elective procedures was 1350 ml (range 350 to 6675 ml, n = 90) and emergency procedures 2750 ml (range 750 to 9400 ml, n = 20). The mean volume of processed (washed) blood returned during elective repairs was 759 ml (range 150 to 2900 ml, n = 51) and emergency repairs 1117 ml (range 0 to 4100 ml, n = 20). During elective repairs, the cost of routine autologous red cell salvage (\$151 per 285 ml unit) was only slightly greater than the estimated cost of cross-matched, leucocyte-reduced, allogeneic blood (\$143 per 285 ml unit). During emergency repairs, washed autologous red cells (\$83 per 285 ml unit) were less expensive than allogeneic packed red cells. These findings indicate that, compared with the use of allogeneic packed red cells, red cell salvage during emergency abdominal aortic aneurysm repair can be justified on an economic basis alone, and that routine red cell salvage during elective repair can achieve the benefits of autologous blood at little extra cost to the community.

KEYWORDS: Vascular Surgery, Abdominal Aortic Aneurysm Repair, Costs

J Vasc Surg. 1996 Aug;24(2):213-8.

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6 INTRAOPERATIVE SALVAGE IN PATIENTS UNDERGOING ELECTIVE ABDOMINAL AORTIC ANEURYSM REPAIR: AN ANALYSIS OF COST AND BENEFIT.

Goodnough LT, Monk TG, Sicard G, Satterfield SA, Allen B, Anderson CB, Thompson RW, Flye W, Martin K. Washington University School of Medicine, Division of Laboratory Medicine, St. Louis, MO 63110, USA.

ABSTRACT

PURPOSE: Although autologous blood procurement has become a standard of care in elective surgery, recent studies have questioned its cost-effectiveness. We therefore reviewed our 3-year experience with intraoperative cell salvage in patients who underwent elective abdominal aortic aneurysm repair.

METHODS: A 3-year retrospective chart review of elective abdominal aortic aneurysm (infrarenal and suprarenal) repair was performed. Transthoracic repairs were excluded.

RESULTS: Estimated blood lost was 1748 +/- 1236 ml, or 35% of baseline blood volume (5012 +/- 689 ml). Overall, 164 (89%) received red blood cell (RBC) transfusions (3.5 +/- 2.0 U/patient). The cost per patient for cell salvage was \$315 +/- \$97, representing 31% of all RBC costs and 24% of total blood component costs. Mean salvage volume infused was 578 +/- 600 ml; at a mean hematocrit level of 55.7% the RBC volume infused from salvage during surgery was 313 +/- 328 ml (representing 27% of total RBC volume lost during the hospital stay). This mean RBC volume salvaged represented the equivalent of 1.6 blood bank RBC units. The mean blood bank costs saved by using cell salvage was \$248, or 79% of the \$315 actually spent for salvage. We found no decrease in percentage of patients undergoing transfusion until salvage volumes that were infused exceeded 750 ml, or the equivalent of two blood bank units; all of these patients who benefitted had estimated blood lost > or = 1000 ml.

CONCLUSIONS: We conclude that use of intraoperative cell salvage was most beneficial for patients who had estimated blood loss greater than or equal to 1000 ml and cell salvage volumes infused greater than or equal to 750 ml. Patients who are estimated to lose less than 1000 ml receive little benefit yet incur substantial costs from intraoperative cell salvage.

KEYWORDS: Vascular Surgery, Abdominal Aortic Aneurysm Repair, Costs





TRANSPLANT SURGERY



REFERENCES OVERVIEW

- Autotransfusion in liver transplant surgery:



1 EVALUATION OF CELL SALVAGE AUTOTRANSFUSION UTILITY DURING LIVER TRANSPLANTATION.

Massicotte L, Thibeault L, Beaulieu D, Roy JD, Roy A.
Department of Anesthesiology, Hepatobiliary Service of Centre hospitalier de l'Université de Montréal (CHUM), Hôpital St-Luc, Montréal, Québec, Canada. luc.massicotte@umontreal.ca

ABSTRACT

BACKGROUND: Orthotopic liver transplantation (OLT) may be associated with massive blood loss and the need for allogenic blood product transfusions. Cell salvage autotransfusion (CS) is an attractive alternative to allogenic red blood cell (RBC) transfusion. However, controversy surrounds its usefulness during OLT; some studies stated that CS decreased transfusions of allogenic blood products and others stated that blood loss was increased. The aim of this study was to evaluate the efficiency of the CS during OLT.

PATIENTS AND METHODS: After approval by the institutional ethics committee, a prospective survey was undertaken. A total of 150 consecutive OLTs were included in the study. Two groups of patients were formed. Period 1 included patients 1-75 with no CS use. Period 2 comprised patients 76-150 with systematic CS use.

RESULTS: Patients from both periods were comparable. CS was used in all cases in period 2, and there was enough salvaged blood to retransfuse 65% of these OLTs. The mean volume of retransfused blood was 338 \pm 339 ml. The transfusion rate did not change from period 1 to period 2. The mean number of RBC units transfused per patient was 0.4 \pm 0.9 vs 0.4 \pm 1.2 with 78.7% vs 81.3% of cases not receiving transfusion of any blood product. The threshold for RBC transfusions was the same. The length of surgery and blood loss were greater in period 2 than in period 1 (associated with the arrival of two junior surgeons), but the hemoglobin (Hb) value was also higher at the end of surgery (93.8 \pm 19.3 g/L vs 85.2 \pm 17.8 g/L, p <0.0001).

CONCLUSION: Despite increased blood loss in period 2, CS saved 21 g/L of Hb per patient or two RBC unit transfusions. As long as we cannot predict with accuracy which patients will bleed, we will continue to use the CS for all OLTs.

KEYWORDS: Transplant Surgery, Liver Transplant

2 IMPACT OF BLOOD SALVAGE DURING LIVER TRANSPLANTATION ON REDUCTION IN TRANSFUSION REQUIREMENTS.

Sankarankutty AK, Teixeira AC, Souza FF, Mente ED, Oliveira GR, Almeida RC, Andrade CM, Origuella EA, Silva Ode C.
Division of Gastroenterology, Department of Surgery and Anatomy, FMRP, USP, Brazil.

ABSTRACT

PURPOSE: The aim of this study was to analyse the changes in transfusion requirements, in patients submitted to orthotopic liver transplantation from cadaveric donors, with the use of intraoperative red blood cell salvage (Cell Saver).

METHODS: Data from 41 transplants were analysed. Intraoperative blood loss was calculated from the cell salvage, suction and the swabs. The autologous and heterologous transfusions were recorded. The red blood salvage was performed using the Cell Saver 5 System (Haemonetics). For analysis the patients were divided in two groups: one that used the Cell Saver and another that didn't.

RESULTS: The median age of the patients was 50 years and the main indication for liver transplantation was cirrhosis (35 cases-85.3%). The median blood loss was 8362 \pm 3994 ml (with the Cell Saver) and 10824 \pm 7002 ml (without the Cell Saver) and the median transfusion of heterologous packed red blood cells was 9.6 \pm 8 units (with the Cell Saver) compared to 22.3 \pm 21 units (without the Cell Saver).

CONCLUSIONS: The Cells Saver has the potential to reduce the need for heterologous blood transfusion reducing the risks of transmissible diseases.

KEYWORDS: Transplant Surgery, Liver Transplant, Haemonetics Cell saver

Transplantation. 2006 Feb 27;81(4):536-40.

3 A PROSPECTIVE STUDY INVESTIGATING THE COST EFFECTIVENESS OF INTRAOPERATIVE BLOOD SALVAGE DURING LIVER TRANSPLANTATION.

Phillips SD, Maguire D, Deshpande R, Muiesan P, Bowles MJ, Rela M, Heaton ND.
Liver Transplantation Unit, Kings College Hospital, London, United Kingdom.

ABSTRACT

BACKGROUND: Adult orthotopic liver transplantation is associated with significant use of allogenic blood products, which places considerable demands on finite resources. This could be reduced by autologous red cell salvage use, and we evaluated its cost effectiveness in this prospective study.

METHODS: Intraoperative autotransfusion was used in 660 adult liver transplant patients between January 1997 and July 2002. These included 134 with acute liver failure, 62 retransplants, 90 alcohol-related, 183 viral, 98 cholestatic chronic liver diseases, and 93 with other etiologies.

RESULTS: The total volume of red blood cells transfused was 3641 \pm 315 ml, 2805 \pm 234 ml, 2603 \pm 443 ml, and 2785 \pm 337 ml for alcohol-related, viral, cholestatic, and others, respectively. Low preoperative hemoglobin was significantly associated with higher intraoperative transfusion requirements. Blood volumes transfused at retransplantation were significantly higher (7077 \pm 1110 ml vs. 2864 \pm 138 ml; $P<0.001$) than for acute liver failure and chronic liver disease. Autologous blood volumes transfused were similar in all diagnostic groups, but were significantly greater in retransplantation (2754 \pm 541 ml vs. 1524 \pm 77 ml; $P<0.01$). Venovenous bypass was significantly associated with higher transfusion requirements. Total savings per case were similar for all diagnostic groups but were greater in cases of retransplantation (864 \pm 222 pounds (1235 \pm 317 US dollars) vs. 238 \pm 24 pounds (340 \pm 34 US dollars; $P<0.001$). With the use of autologous transfusion over the study period, a cost saving of 131,901 pounds (188,618 US dollars) was achieved.

CONCLUSIONS: Intraoperative red blood cell salvage and autologous transfusion is cost effective in adult liver transplantation. Currently, where optimum resource utilization and fiscal constraint are paramount in healthcare delivery, autologous transfusion is an important adjunct in liver transplantation.

KEYWORDS: Transplant Surgery, Liver Transplant, Costs

Masui. 2000 Jul;49(7):788-91.

4 INTRAOPERATIVE AUTOLOGOUS BLOOD TRANSFUSION WAS EFFECTIVE IN A MASSIVE BLOOD LOSS DURING LIVING-RELATED DONOR LIVER TRANSPLANTATION.

Okazaki S, Adachi T, Segawa H, Furutani H, Fukuda K.
Department of Anesthesia, Kyoto University Hospital.

ABSTRACT

We have experienced massive blood loss (> 80,000 g) during living-related donor liver transplantation (LRDLT) of a 14-year old girl with biliary atresia. As available homologous blood was not sufficient, we transfused autologous blood (13,400 ml) during operation. Although immunosuppressant was administered to the patient, severe infection did not occur for 10 days after the operation. Cold ischemia time of the graft liver was about 16 hr, but her postoperative liver function was well-maintained. The case suggests that intraoperative autologous blood transfusion is effective if homologous blood is insufficient during LRDLT.

KEYWORDS: Transplant Surgery, Liver Transplant

Am Surg. 1985 Nov;51(11):623-6.

5 AUTOTRANSFUSION IN HEPATIC TRANSPLANTATION.

Van Voorst SJ, Peters TG, Williams JW, Vera SR, Britt LG.

ABSTRACT

Hepatic transplantation is often accompanied by a large volume of intraoperative blood loss which may place extraordinary transfusion demands on a community blood bank. In an effort to conserve blood bank resources, intraoperative autotransfusion has recently been used in our adult patients undergoing orthotopic hepatic transplantation. A group of seven patients receiving autotransfusion was studied and compared to another group of five patients who did not receive autotransfusion. In spite of receiving more blood during the transplant procedure, the autotransfusion group required a mean of 7.9 units less banked blood. Post-transplant transfusion requirements and bleeding complications were similar in both groups. Hematocrit and total bilirubin were not adversely affected, while transient elevation of BUN and serum creatinine appeared to be unrelated to the salvage process. This procedure was found to be safe and cost-effective, while conserving blood bank resources.

KEYWORDS: Transplant Surgery, Liver Transplant



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TUMOR SURGERY



REFERENCES OVERVIEW

- Autotransfusion in liver cancer surgery:

1 4 6 8 11 12 14

- Autotransfusion in prostate cancer surgery:

2 5 7 13 16 19 25

- Autotransfusion in lung cancer surgery:

23

- Autotransfusion in urinary bladder cancer surgery:

2 10 25

- Autotransfusion in gynecologic cancer surgery:

9

- Autotransfusion in esophageal cancer surgery:

18 20

- Use of a leukocyte depletion filter when autotransfusing in tumor surgery:

3 4 7 8 9 15 19

- Use of blood irradiation when autotransfusing in tumor surgery:

7 15 17 21 22 24

Eur Surg Res. 2011;47(3):182-7. Epub 2011 Oct 4.

1 LIVER TRANSPLANTATION FOR HEPATOCELLULAR CARCINOMA - IS THERE A RISK OF RECURRENCE CAUSED BY INTRAOPERATIVE BLOOD SALVAGE AUTOTRANSFUSION?

Foltys D, Zimmermann T, Heise M, Kathes M, Lautem A, Wisser G, Weiler N, Hoppe-Lotichius M, Hansen T, Otto G. Departments of Transplantation and Hepatobiliary Surgery, University Medical Centre, Johannes Gutenberg University, Mainz, Germany.

ABSTRACT

BACKGROUND/AIMS: The use of intraoperative blood salvage autotransfusion (IBSA) during surgical approaches may contribute to tumour cell dissemination. Therefore, IBSA should be avoided in cases of malignancy. However, the risks of IBSA might be acceptable in liver transplantation (LT) for selected small hepatocellular carcinoma (HCC).

METHODS: In total, 136 recipients of LT with histologically proven HCC in the explanted liver were included in this analysis. With regard to tumour recurrence, 40 patients receiving IBSA despite HCC (IBSA group) were compared to 96 patients without IBSA (non-IBSA group).

RESULTS: Milan criteria as assessed in the explanted liver were fulfilled in 24 of 40 IBSA patients and 58 of 96 non-IBSA patients ($p = 0.85$). Five of 40 patients in the IBSA group and 18 of 96 patients in the non-IBSA group experienced tumour recurrence ($p = 0.29$). In spite the theoretical risk of tumour cell dissemination, the recurrence rate was not increased in the IBSA group.

CONCLUSION: Our results indicate that IBSA does not modify the risk of HCC recurrence. Therefore, in highly selected HCC patients undergoing LT, the use of IBSA appears to be justified.

KEYWORDS: Tumor Surgery, Liver Transplant, Hepatocellular Cancer

Br J Hosp Med (Lond). 2010 Jan;71(1):57.

2 SHOULD CELL SALVAGE BE USED IN ONCOLOGICAL SURGERY?

Bouras I, Mingo O. University College London Hospital, London NW1 2BU.

ABSTRACT

Cell salvage, the process whereby blood is suctioned from the surgical site then filtered, centrifuged and washed before being transfused, was first developed in 1974. Since then it has become a widely used technique which reduces the need for allogenic blood transfusion. Cell salvage was initially considered to be contraindicated in obstetrics, because of the risk of amniotic fluid emboli, in potentially 'dirty' surgical sites and in oncological surgery because of concerns about re-transfusion of malignant cells. However, cell salvage is now routinely used in obstetrics, particularly in massive haemorrhage, and in elective bowel resection. The potential use of cell salvage in oncological surgery has been highlighted following the National Institute for Health and Clinical Excellence (NICE, 2008) guidance sanctioning (although not specifically recommending) cell salvage during radical prostatectomy and cystectomy. This leads to the question of whether cell salvage is safe to use in these and other types of oncological surgery.

KEYWORDS: Tumor Surgery, Obstetric Surgery, Prostatectomy, Cystectomy

Br J Anaesth. 2010 Oct;105(4):401-16. Epub 2010 Aug 28.

3 CELL SALVAGE AS PART OF A BLOOD CONSERVATION STRATEGY IN ANAESTHESIA.

Ashworth A, Klein AA.

Department of Anaesthesia and Critical Care, Papworth Hospital, Papworth Everard, Cambridge CB23 3RE, UK.

ABSTRACT

The use of intraoperative cell salvage and autologous blood transfusion has become an important method of blood conservation. The main aim of autologous transfusion is to reduce the need for allogeneic blood transfusion and its associated complications. Allogeneic blood transfusion has been associated with increased risk of tumour recurrence, postoperative infection, acute lung injury, perioperative myocardial infarction, postoperative low-output cardiac failure, and increased mortality. We have reviewed the current evidence for cell salvage in modern surgical practice and examined the controversial issues, such as the use of cell salvage in obstetrics, and in patients with malignancy, or intra-abdominal or systemic sepsis. Cell salvage has been demonstrated to be safe and effective at reducing allogeneic blood transfusion requirements in adult elective surgery, with stronger evidence in cardiac and orthopaedic surgery. Prolonged use of cell salvage with large-volume autotransfusion may be associated with dilution of clotting factors and thrombocytopenia, and regular laboratory or near-patient monitoring is required, along with appropriate blood product use. Cell salvage should be considered in all cases where significant blood loss (>1000 ml) is expected or possible, where patients refuse allogeneic blood products or they are anaemic. The use of cell salvage in combination with a leucocyte depletion filter appears to be safe in obstetrics and cases of malignancy; however, further trials are required before definitive guidance may be provided. The only absolute contraindication to the use of cell salvage and autologous blood transfusion is patient refusal.

KEYWORDS: Tumor Surgery, Obstetric Surgery, Leucocyte Depletion Filter

Clin Transplant. 2010 Mar 1;24(2):265-72. Epub 2009 Sep 24.

4 INTRAOPERATIVE BLOOD SALVAGE AND LEUKOCYTE DEPLETION DURING LIVER TRANSPLANTATION WITH BACTERIAL CONTAMINATION.

Liang TB, Li JJ, Li DL, Liang L, Bai XL, Zheng SS.

Department of Hepatobiliary and Pancreatic Surgery, Key Laboratory of Multi-organ Transplantation of Ministry of Public Health, Key Laboratory of Organ Transplantation of Zhejiang Province, First Affiliated Hospital, School of Medicine, Zhejiang University, Hangzhou, China.

ABSTRACT

BACKGROUND: Bacterial contamination is considered to be a contraindication for intraoperative blood salvage (IBS) during OLT. The aims of this study were to evaluate the efficiency of the autotransfusion device with an additional leukocyte depletion filter (LDF) for eliminating bacterial contaminations, and its clinical outcomes in terms of post-operative infections during OLT.

METHODS: Forty-five patients with end-stage liver disease and cirrhotic ascites were enrolled in this study. The blood from the surgical field was collected and processed by an autotransfusion device (Cell Saver 5) and a LDF for bacteriological analysis. Among them, 12 patients with chronic severe hepatitis B received autologous transfusion for analysis of the effect on post-operative infections.

RESULTS: Spontaneous bacterial peritonitis (SBP) ($p < 0.05$, OR = 20.1) and a long duration of operation ($p < 0.01$, OR = 8.3) were found to be critical risk factors for contamination. Autotransfusion devices with an additional LDF significantly eliminated bacterial contaminants from shed blood ($p < 0.05$). About 33% (4/12) of the patients who received autologous transfusion with salvaged and filtered erythrocytes got post-operative bacterial infection.

CONCLUSIONS: Autotransfusion devices with an additional LDF could significantly eliminate bacterial contaminants of shed blood during OLT. The new mode of IBS might be a good option in reducing post-operative infections, and deserves a large-scale clinical trial.

KEYWORDS: Tumor Surgery, Liver Transplant, Hepatocellular Cancer, Leucocyte Depletion Filter, Haemonetics Cell Saver

Transfusion. 2009 Jul;49(7):1431-4. Epub 2009 Mar 20.

5 IMPACT OF INTRAOPERATIVE RED BLOOD CELL SALVAGE ON TRANSFUSION REQUIREMENTS AND OUTCOMES IN RADICAL PROSTATECTOMY.

MacIvor D, Nelson J, Triulzi D.

Department of Pathology and Laboratory Medicine, University of Kentucky Medical Center, 800 Rose Street, Lexington, KY 40536, USA. dma223@email.uky.edu

ABSTRACT

BACKGROUND: Preoperative autologous blood donation lowers preoperative hemoglobin (Hb) levels, and the collected blood is frequently wasted. Intraoperative red blood cell (RBC) salvage provides fresher autologous blood in proportion to surgical blood loss, making cell salvage (CS) in radical prostatectomy (RP) feasible for study.

STUDY DESIGN AND METHODS: This retrospective study compared two strategies to reduce allogeneic RBC transfusion requirements in RP: preoperative autologous donation (PAD) versus CS. Patients underwent RP by one surgeon at one institution during two comparable time periods in 2005 (PAD-Group 1) and 2006 (CS-Group 2).

RESULTS: Group 1 patients (n = 40) underwent PAD, collecting 63 autologous RBC units; 36 units (57.1%) were reinfused and 27 (42.9%) were wasted. No Group 1 patient received allogeneic blood. Group 2 patients (n = 63) underwent intraoperative CS and received a mean of 287 mL of salvaged blood. In Group 2, two patients (3.2%) with preoperative Hb levels too low to permit autologous donation each received 2 units of allogeneic RBCs. Group 1 patients had significantly lower preoperative (-1.4 g/dL) and postoperative (-0.8 g/dL) Hb values compared to the CS group. There were no significant differences between groups in procedure times, length of stay, or numbers of cancer recurrences over the 24- to 36-month follow-up period.

CONCLUSION: Perioperative CS can effectively replace PAD for RP patients, offering similar avoidance of allogeneic transfusion, with greater convenience and superior postoperative Hb levels.

KEYWORDS: Tumor Surgery, Prostatectomy

Hepatogastroenterology. 2009 May-Jun;56(91-92):808-12.

6 THE INFLUENCE OF INTRAOPERATIVE HOMOLOGOUS BLOOD TRANSFUSION ON PROGNOSIS AFTER LIVER TRANSPLANTATION FOR HEPATOCELLULAR CARCINOMA.

Kaido T, Takada Y, Egawa H, Uemoto S.

Department of Hepato-Biliary-Pancreatic and Transplant Surgery, Kyoto University Graduate School of Medicine, Kyoto, Japan. kaido@kuhp.kyoto-u.ac.jp

ABSTRACT

BACKGROUND/AIMS: We investigated the influence of intraoperative homologous blood transfusion on prognosis after liver transplantation for hepatocellular carcinoma.

METHODOLOGY: Between February 1999 and December 2006, 153 patients with hepatocellular carcinoma underwent living donor liver transplantation at our center. Recurrence-free and overall survival was compared between patients with blood transfusion and those without transfusion in red blood cells, fresh frozen plasma, or platelet concentrate.

RESULTS: Recurrence-free survival was significantly higher in the platelet concentrate transfused group than in the group without platelet concentrate transfusion (P=0.003), although there were no significant differences between the three transfused groups and the non-transfused groups in overall survival. The platelet concentrate transfused group had more patients within the preoperative Milan criteria (P=0.014) and more patients with Child-Pugh C classification (P<0.001).

CONCLUSIONS: Recurrence-free survival after liver transplantation for hepatocellular carcinoma was significantly higher in the platelet concentrate transfused group than the group without platelet concentrate transfusion.

KEYWORDS: Tumor Surgery, Liver Transplant, Hepatocellular Cancer

Vox Sang. 2008 Nov;95(4):308-12.

7 INTRAOPERATIVE AUTOLOGOUS BLOOD RECOVERY IN PROSTATE CANCER SURGERY: IN VIVO VALIDATION USING A TUMOUR MARKER.

Poli M, Camargo A, Villa L, Moura R, Colella R, Deheinzeln D.
Banco de Sangue de São Paulo, São Paulo, Brazil. mccpoli@bssp.com.br

ABSTRACT

BACKGROUND AND OBJECTIVE: Intraoperative autologous blood recovery during radical retro pubic prostatectomy has the potential of contamination with tumour cells. Its safety is proved by similar survival rates between allogeneic and autologous transfusion to oncology patients without standardization. Silencing of the gene encoding pi class of glutathione-S transferase is a specific and sensitive molecular marker for prostate cancer, because it is present in more than 90% of prostate tumours. Using such tumour marker, we aimed to demonstrate that viable tumour cells could be eliminated using leucodepletion filters followed by irradiation.

MATERIALS AND METHODS: Fifty patients with pi class of glutathione-S transferase promoter hypermethylation in their primary prostate tumours were included in the analysis. Peripheral blood samples were collected during anaesthetic induction and recovered blood was collected throughout the surgery and then submitted to washing, leucoreduction and irradiation. Samples were analysed stepwise for the presence of promoter hypermethylation using real-time methylation-specific polymerase chain reaction.

RESULTS: Positive hypermethylation was found in recovered blood (two samples), recovered and washed blood (three samples), and recovered washed and filtered blood (two samples). After filtration and irradiation of the recovered blood, this marker could not be detected in any of the cases analysed, suggesting the absence of viable tumour cells.

CONCLUSION: Even though the risk of disseminating tumour cells in prostate cancer surgery by intraoperative autologous blood recovery is not yet fully established, no tumour-specific gene amplification was found after the association of blood filtration and irradiation, suggesting a significant reduction of such risk.

KEYWORDS: Tumor Surgery, Prostatectomy, Leukocyte Depletion Filter, Blood Irradiation

Transplantation. 2008 Mar 27;85(6):863-9.

8 INTRAOPERATIVE BLOOD SALVAGE DURING LIVER TRANSPLANTATION IN PATIENTS WITH HEPATOCELLULAR CARCINOMA: EFFICIENCY OF LEUKOCYTE DEPLETION FILTERS IN THE REMOVAL OF TUMOR CELLS.

Liang TB, Li DL, Liang L, Li JJ, Bai XL, Yu W, Wang WL, Shen Y, Zhang M, Zheng SS.
Department of General Surgery, Key Laboratory of Multi-organ Transplantation of Ministry of Public Health, the First Affiliated Hospital, School of Medicine, Zhejiang University, Hangzhou, P.R. China.

ABSTRACT

BACKGROUND: Intraoperative blood salvage (IBS) reduces homologous transfusion in orthotopic liver transplantation (OLT), but may carry with it the risk of reinfusing tumor cells in patients with hepatocellular carcinoma (HCC). The use of leukocyte depletion filters (LDFs) for the removal of tumor cells is rarely reported in clinical OLT. The aims of this study were to evaluate the frequency of tumor cell contamination in surgical field during OLT for HCC recipients and to investigate the efficiency of additional LDFs for eliminating tumor cells from IBS.

METHODS: Thirty-two HCC patients with preoperatively elevated serum alpha-fetoprotein (AFP) underwent OLT. The blood from the surgical field was collected and processed by an autotransfusion device (Cell Saver 5), followed by 2 consecutive LDF filtrations. The HCC cells in IBS samples and filtered samples were determined using a nested RT-PCR technique to detect the AFP mRNA.

RESULTS: The shed blood samples from 20 (62.5%) of the 32 HCC patients were contaminated with HCC cells and 15 of them remained positive after Cell Saver processing. Patients within the Milan or UCSF criteria were less likely to have HCC cell contamination and the contaminated HCC cells were more likely to be removed by the Cell Saver in these patients as compared to other patients ($P < 0.01$). After filtration through an additional LDF, most cases (13/15) became negative except for those with ruptured tumors ($P < 0.05$).

CONCLUSIONS: Our results suggest that blood filtration with the LDF can efficiently remove tumor cells and the use of an additional LDF after use of the Cell Saver could markedly reduce the risk of tumor cell reintroduction during the OLT in HCC recipients with nonruptured tumors.

KEYWORDS: Tumor Surgery, Liver Transplant, Hepatocellular Cancer, Leukocyte Depletion Filter

Anaesthesia. 2008 Dec;63(12):1332-8.

9 USE OF A LEUCOCYTE FILTER TO REMOVE TUMOUR CELLS FROM INTRA-OPERATIVE CELL SALVAGE BLOOD.

Catling S, Williams S, Freitas O, Rees M, Davies C, Hopkins L.
Singleton Hospital, Swansea, UK. sue.catling@btopenworld.com

ABSTRACT

SUMMARY: The intra-operative blood loss of 50 consecutive gynae-oncology patients undergoing surgery for endometrial, cervical or ovarian cancer was cell salvaged and filtered. In each case blood samples were taken from the effluent tumour vein, a central venous line, the cell saver reservoir, the cell salvage re-transfusion bag after processing but before filtration and from the cell salvage re-transfusion bag after processing and filtration. Samples were examined using immunohistochemical monoclonal antibody markers for epithelial cell lines. Viable, nucleated malignant cells were detected in 2/50 central venous samples, 34/50 reservoir samples and 31/50 unfiltered cell salvaged samples. After passage through a Pall RS leucocyte depletion filter no remaining viable, nucleated malignant cells were detected in any sample. The clinical risks of cell salvage in these circumstances should be reviewed in the light of the risks of allogeneic blood transfusion.

KEYWORDS: Tumor Surgery, Gynecological Surgery, Leukocyte Depletion Filter

Urology. 2007 May;69(5):881-4.

10 INTRAOPERATIVE CELL SALVAGE DURING RADICAL CYSTECTOMY DOES NOT AFFECT LONG-TERM SURVIVAL.

Nieder AM, Manoharan M, Yang Y, Soloway MS.
Department of Urology, University of Miami Miller School of Medicine, Miami, Florida 33140, USA. anieder1@med.miami.edu

ABSTRACT

OBJECTIVES: To evaluate the risk of long-term recurrence for patients who received cell-salvaged blood during radical cystectomy (RC).

METHODS: We retrospectively analyzed an RC database and compared those who did and did not receive cell-salvaged blood according to baseline parameters, pathologic outcomes, and recurrence.

RESULTS: A total of 378 patients underwent RC between 1992 and 2005 by one surgeon. Of these, 65 (17.2%) received cell-salvaged blood and 313 (82.8%) did not. The two groups had similar baseline characteristics. There were no differences between the two groups when compared by pathologic stage. The median follow-up for patients who did and did not receive cell-salvaged blood was 19.1 and 20.7 months, respectively ($P = 0.464$). The 3-year disease-specific survival rate for the two groups was 72.2% and 73.0%, respectively ($P = 0.90$).

CONCLUSIONS: Intraoperative cell salvage is a safe blood management strategy for patients undergoing RC. There is no increased risk of metastatic disease or death for those who receive cell-salvaged blood. Concerns about spreading tumors cells by IOCS during RC would seem unwarranted. However, only a prospective, multicenter, randomized trial would provide the most valid assessment of the safety of IOCS.

KEYWORDS: Tumor Surgery, Cystectomy

nn Thorac Cardiovasc Surg. 2005 Oct;11(5):293-300.

11 EFFECT OF SUBSTITUTING ALLOGENIC BLOOD TRANSFUSION WITH AUTOLOGOUS BLOOD TRANSFUSION ON OUTCOMES AFTER RADICAL OESOPHAGECTOMY FOR CANCER.

Takemura M, Osugi H, Higashino M, Takada N, Lee S, Kinoshita H.
Department of Gastroenterological Surgery, Osaka City University Graduate School of Medicine, Osaka, Japan.

ABSTRACT

BACKGROUND: The oncologic benefit of avoiding allogenic blood transfusion in oesophageal cancer resection has not been studied.

METHODS: The medical records of 68 patients (Auto group) who underwent a potentially curative oesophageal cancer resection without allogenic blood transfusion from 1996 to 1999 receiving 800 g of autologous blood donated preoperatively, and 97 patients (Allo group) who underwent the same operation with allogenic blood transfusion from 1990 to 1995 were compared.

RESULTS: There were no differences in age, gender, stage of disease, number of retrieved nodes, or perioperative hemoglobin concentration between the two groups. The survival of the 45 patients with nodal involvement in the Auto group was better than that of the 59 patients in the Allo group ($p=0.0435$), and the survival of the 35 patients with T3 or T4 lesions in the Auto group was better than that of the 61 patients in the Allo group ($p=0.0408$). According to logistic regression analysis, allogenic blood transfusion correlated with tumour recurrence in patients with either nodal involvement or a T3-4 lesion. The natural killer cell activity remained higher in the Auto group than in the Allo group ($p<0.05$).

CONCLUSION: Avoidance of allogenic blood transfusion favorably effected the survival of patients with oesophageal cancer at risk for recurrence.

KEYWORDS: Tumor Surgery, Liver Transplant, Hepatocellular Cancer

Transpl Int. 2005 Nov;18(11):1236-9.

12 BLOOD SALVAGE AUTOTRANSFUSION DURING TRANSPLANTATION FOR HEPATOCARCINOMA: DOES IT INCREASE THE RISK OF NEOPLASTIC RECURRENCE?

Muscari F, Suc B, Vigouroux D, Duffas JP, Miguieres I, Mathieu A, Lavayssiere L, Rostaing L, Fourtanier G.
Digestive Surgery Department, University Hospital, Rangueil, Toulouse, France.

ABSTRACT

Impact of intraoperative blood salvage autotransfusion (IBSA) on neoplastic recurrence during liver transplantations for hepatocellular carcinoma (LT-HCC). Between January 1989 and February 2003, 16 patients received a LT-HCC without IBSA. This group was compared with 31 patients who received the same surgical procedure during the same period, but with IBSA. Data were prospectively collected. All patients had at least a 1-year postoperative follow up. Pairing was made according to the size of the largest nodule. The percentage of recurrence observed in the two groups was similar: 6.4% in the IBSA group vs. 6.3% in the group without IBSA. The median amount of transfused salvage blood was 1558 ml. The differences observed between the two groups concerned the Child score which was A in 58% patients of the IBSA group vs. 80% in the other group; the percentage of severe portal hypertension was 55% in the IBSA group vs. 31%; the median number of packed red blood cell units transfused intraoperatively was 7 in the IBSA group vs. 0, and the median number of frozen fresh plasma units transfused intraoperatively was 11 in the IBSA group vs. 4.5. It appears that IBSA, essentially used during the most haemorrhagic transplantations, could be used in the case of HCC because it does not modify the risk of neoplastic recurrence.

KEYWORDS: Tumor Surgery, Liver Transplant, Hepatocellular Cancer

Urology. 2005 Apr;65(4):730-4.

13 INTRAOPERATIVE CELL SALVAGE DURING RADICAL PROSTATECTOMY IS NOT ASSOCIATED WITH GREATER BIOCHEMICAL RECURRENCE RATE.

Nieder AM, Carmack AJ, Sved PD, Kim SS, Manoharan M, Soloway MS.
Department of Urology, University of Miami School of Medicine, Miami, Florida 33101, USA.

ABSTRACT

OBJECTIVES: To evaluate the risk of long-term biochemical recurrence for patients who receive cell-salvaged blood. Radical retropubic prostatectomy (RRP) is historically associated with the potential for significant blood loss. Different blood management strategies include blood donation, hemodilution, preoperative erythropoietin, and intraoperative cell salvage (IOCS). Oncologic surgeons have been reluctant to use IOCS because of the potential risk of tumor dissemination.

METHODS: We retrospectively analyzed an RRP database and compared those who did and did not receive cell-salvaged blood by baseline parameters, pathologic outcomes, and biochemical recurrence. We also stratified our patients according to the risk of recurrence.

RESULTS: A total of 1038 patients underwent RRP between 1992 and 2003. Of these, 265 (25.5%) received cell-salvaged blood and 773 (74.5%) did not. The two groups had similar baseline characteristics. No differences were found between the two groups when compared by risk of seminal vesicle invasion or positive surgical margins. Those who received cell-salvaged blood had a lower risk of extraprostatic extension. The median follow-up for all patients was 40.2 months. The overall risk of biochemical recurrence at 5 years for those who did and did not receive cell-salvaged blood was 15% and 18%, respectively ($P = 0.76$). No significant differences were found in the risk of biochemical recurrence when patients were stratified according to low, intermediate, and high risk.

CONCLUSIONS: IOCS is a safe and effective blood management strategy for patients undergoing RRP. The risk of biochemical recurrence was not increased for those who received cell-salvaged blood. Concerns about spreading tumor cells by way of IOCS would seem unwarranted.

KEYWORDS: Tumor Surgery, Prostatectomy

Surg Today. 2005;35(12):1042-6.

14 LONG-TERM SAFETY OF AUTOTRANSFUSION DURING HEPATECTOMY FOR HEPATOCELLULAR CARCINOMA.

Hirano T, Yamanaka J, Iimuro Y, Fujimoto J.
First Department of Surgery, Hyogo College of Medicine, 1-1 Mukogawacho, Nishinomiya 663-8501, Japan.

ABSTRACT

PURPOSE: To evaluate the long-term safety of autotransfusion (AT) in hepatectomy for hepatocellular carcinoma (HCC).

METHODS: Between 1988 and 1989, 46 patients with HCC underwent hepatectomy with AT (group 1). For a comparison, we matched 50 patients with HCC who underwent hepatectomy, and received homologous but not autologous blood (group 2). The 10-year cumulative survival curves and cancer-free curves of the two groups were examined, and the pattern of recurrence was compared.

RESULTS: Group 1 had a significantly higher cumulative 10-year survival rate than group 2, at 20% vs 8%, respectively ($P < 0.05$). Among the patients who underwent curative resection, those in group 1 had significantly better cumulative survival and cancer-free survival rates than those in group 2, at 27% vs 11% ($P < 0.05$) and 13% vs 0% ($P < 0.05$), respectively. Among the patients with stage I-II HCC, those in group 1 had significantly better cumulative survival and cancer-free survival rates than those in group 2, at 30% vs 5% ($P < 0.01$) and 20% vs 5% ($P < 0.05$), respectively. However, the rates were similar among patients with stage III-IV disease in both groups. The pattern of recurrence in the two groups was similar.

CONCLUSION: Autotransfusion promoted survival in patients undergoing hepatectomy for stage I or II HCC.

KEYWORDS: Tumor Surgery, Liver Transplant, Hepatocellular Cancer

Transfus Med. 2004 Apr;14(2):151-5.

15 MOLECULAR EVIDENCE OF TUMOUR CELL REMOVAL FROM SALVAGED BLOOD AFTER IRRADIATION AND LEUCOCYTE DEPLETION.

Poli MC, Villa LL, Colella R, Deheinzeln D.

Transfusion Medicine Department, Centro de Tratamento e Pesquisa Hospital do Câncer, Rua Professor Antonio Prudente, 211-CEP:01509-010, São Paulo, Brazil. mccpoli@hcancer.org.br

ABSTRACT

Intra-operative autologous blood recovery offers many advantages. However, blood salvage during cancer surgery is of limited use due to the potential presence of circulating tumour cells. It was the aim of this study to show that intra-operative salvage blood can be freed of cells and cellular DNA after leucoreduction by filtration and irradiation of washed blood. Known amounts of tissue culture derived from carcinoma, melanoma and osteosarcoma were added to whole blood bags. This mixture was then submitted to washing, leucoreduction and irradiation. Samples were studied stepwise in relation to the integrity and size of DNA by the polymerase chain reaction (PCR). After filtration and irradiation, PCR targeting the beta-globin gene (268 bp amplicon) was negative. Our results were corroborated by studying plasma samples added with tumoural cells. Using PCR methodology, we showed the absence of DNA from cells in experimentally contaminated blood and plasma bags after filtration and irradiation. This experimental study is an effort to ensure the safety of intra-operative autologous transfusion.

KEYWORDS: Tumor Surgery, Leukocyte Depletion Filter, Blood Irradiation

BJU Int. 2003 Apr;91(6):474-6.

16 THE USE OF CELL SALVAGE DURING RADICAL RETROPUBIC PROSTATECTOMY: DOES IT INFLUENCE CANCER RECURRENCE?

Davis M, Sofer M, Gomez-Marin O, Bruck D, Soloway MS.

Department of Urology, University of Miami, School of Medicine, Miami, Florida, USA.

ABSTRACT

OBJECTIVE: To assess whether there is a difference in the biochemical recurrence rate in patients who had radical retropubic prostatectomy (RRP) with or without cell salvage transfusion.

PATIENTS AND METHODS: The records of 769 consecutive patients undergoing RRP between 1992 and 1998 were retrospectively reviewed. Patients having adjuvant hormonal treatment, postoperative external beam radiotherapy, or a follow-up of < 1 year were excluded from the analysis. The remaining 408 patients were categorized into three groups: 87 who received cell-salvaged blood using a commercial cell saver; 264 receiving only autologous transfusion; and 57 with no transfusion. Disease recurrence was defined as a prostate-specific antigen (PSA) level of > 0.2 ng/mL. Bivariate and multivariate logistic regression analyses were used to assess and compare the risk of cancer recurrence in the three groups. Covariates used in the multivariate analyses included Gleason score, preoperative PSA level, seminal vesicle involvement and surgical margins.

RESULTS: The mean (range) follow-up was 40.2 (12-104) months; there were no significant differences among the groups in initial PSA level and Gleason score. In the multivariate logistic regression analysis, the initial PSA, Gleason score, seminal vesicle involvement and surgical margins, but not transfusion group, were independent predictors of recurrence.

CONCLUSION: Cell salvage during RRP does not influence the recurrence of prostate cancer. Cell salvage is a safe method of transfusion during RRP.

KEYWORDS: Tumor Surgery, Prostatectomy

Transfus Apher Sci. 2002 Oct;27(2):153-7.

17 INTRAOPERATIVE BLOOD SALVAGE IN CANCER SURGERY: SAFE AND EFFECTIVE?

Hansen E, Bechmann V, Altmeyen J.

Department of Anesthesiologie, University of Regensburg, Germany. ernil.hansen@klinik.uni-regensburg.de

ABSTRACT

To support blood supply in the growing field of cancer surgery and to avoid transfusion induced immunomodulation caused by the allogeneic barrier and by blood storage lesions we use intraoperative blood salvage with blood irradiation. This method is safe as it provides efficient elimination of contaminating cancer cells, and as it does not compromise the quality of RBC. According to our experience with more than 700 procedures the combination of blood salvage with blood irradiation also is very effective in saving blood resources. With this autologous, fresh, washed RBC a blood product of excellent quality is available for optimal chemotherapy in cancer patients.

KEYWORDS: Tumor Surgery, Blood Irradiation

Cancer. 2001 Oct 1;92(7):1913-8.

18 SIGNIFICANCE OF ALLOGENIC BLOOD TRANSFUSION ON DECREASED SURVIVAL IN PATIENTS WITH ESOPHAGEAL CARCINOMA.

Nozoe T, Miyazaki M, Saeki H, Ohga T, Sugimachi K.

Department of Surgery and Science, Graduate School of Medical Sciences, Kyushu University, Maidashi 3-1-1, Higashi Ward, Fukuoka, 812-8582, Japan. nozoet@surg2.med.kyushu-u.ac.jp

ABSTRACT

BACKGROUND: To the authors' knowledge, the significance of allogenic blood transfusion in the prognosis of patients with esophageal carcinoma remains controversial. The objective of the current study was to elucidate the correlation, if any, between intraoperative allogenic blood transfusion and prognosis in patients with esophageal carcinoma.

METHODS: Two hundred fifty-nine patients with esophageal carcinoma who had undergone esophagectomy and reconstruction were studied. The clinicopathologic data and survival were compared between the 87 patients (33.6%) who received an intraoperative allogenic blood transfusion and the 172 patients (66.4%) who did not.

RESULTS: Multivariate analysis demonstrated that the factors that appeared to independently determine prognosis in patients with esophageal carcinoma were the depth of the tumor ($P = 0.0001$), lymph node metastasis ($P < 0.0001$), lymphatic invasion ($P = 0.0002$), venous invasion ($P = 0.0008$), and the occurrence of postoperative complications ($P = 0.034$). Intraoperative allogenic blood transfusion was not found to be an independent prognostic indicator.

CONCLUSIONS: In the current study, an advanced stage of disease at the time of surgery, which resulted in the need for blood transfusion and the occurrence of postoperative complications, appeared to worsen the prognosis in patients with esophageal carcinoma.

KEYWORDS: Tumor Surgery, Esophageal Cancer

Urology. 2001 Nov;58(5):740-5.

19 INTRAOPERATIVE CELL SALVAGE IN RADICAL RETROPUBIC PROSTATECTOMY.

Gray CL, Amling CL, Polston GR, Powell CR, Kane CJ.
Department of Urology, Naval Medical Center, San Diego, California, USA.

ABSTRACT

OBJECTIVES: To investigate the efficacy and safety of intraoperative cell salvage with autotransfusion using leukocyte reduction filters in patients undergoing radical retropubic prostatectomy (RRP).

METHODS: Between September 1996 and March 1999, 62 patients (age range 48 to 70 years) with clinically localized prostate cancer underwent RRP with intraoperative cell salvage as the sole blood management technique. Salvaged blood was passed through a leukocyte reduction filter before autotransfusion. The 62 cell salvage patients were compared with a cohort who predonated 1 to 3 U autologous blood (n = 101). The estimated blood loss, preoperative and postoperative hematocrit, need for homologous transfusion, and biochemical recurrence rates were compared between the two groups. The progression-free survival rates were compared using the Kaplan-Meier method.

RESULTS: No difference was found in preoperative prostate-specific antigen level, pathologic stage, or estimated blood loss between the cell salvage and autologous predonation groups. The preoperative and postoperative hematocrit levels were higher in the cell salvage group (42.7% versus 39.6% and 31.3% versus 27.9%, respectively; $P < 0.001$ for each). The homologous transfusion rates were lower in the cell salvage group (3% versus 14%, $P = 0.04$). The incidence of progression-free survival (prostate-specific antigen level 0.4 ng/mL or greater) was no different between the groups ($P = 0.41$).

CONCLUSIONS: Intraoperative cell salvage with autotransfusion using leukocyte reduction filters in RRP results in higher perioperative hematocrit levels and low homologous transfusion rates and eliminates the need for autologous predonation. Cell salvage does not appear to be associated with an increased risk of early biochemical progression after RRP.

KEYWORDS: Tumor Surgery, Prostatectomy, Leukocyte Depletion Filter

Surgery. 2000 Feb;127(2):185-92.

20 USEFULNESS OF AUTOLOGOUS BLOOD TRANSFUSION FOR AVOIDING ALLOGENIC TRANSFUSION AND INFECTIOUS COMPLICATIONS AFTER ESOPHAGEAL CANCER RESECTION.

Kinoshita Y, Udagawa H, Tsutsumi K, Ueno M, Nakamura T, Akiyama H, Takahashi K, Kajiyama Y, Tsurumaru M.
Department of Surgery, Toranomon Hospital, Tokyo, Japan.

ABSTRACT

BACKGROUND: A retrospective investigation was conducted to determine whether autologous blood collection could reduce allogenic transfusion after resection of esophageal cancer and whether allogenic transfusion influenced postoperative infection.

METHODS: Patients (n = 100) who met the criteria for hemoglobin, age, body weight, and serum protein donated 800 mL of autologous blood from May 1994 to December 1997. The control group (n = 248) was selected from patients who met the same criteria and did not donate autologous blood over the 10 years before the start of autologous blood collection.

RESULTS: Only three patients (3%) from the autologous group required allogenic transfusion versus 84 patients (33.7%) from the control group. Sixteen of the 26 patients who received more than 4 units of allogenic blood contracted postoperative infections compared with 25 of 165 patients who did not ($P < .0001$). Autologous blood transfusion significantly increased the probability of avoiding allogenic transfusion (odds ratio, 27.58), and allogenic transfusion was significantly related to postoperative infection (odds ratio, 1.19), according to logistic regression analysis.

CONCLUSIONS: Autologous blood collection reduces the need for allogenic transfusion in patients undergoing resection of esophageal cancer, and avoidance of allogenic transfusion may reduce the risk of postoperative infection.

KEYWORDS: Tumor Surgery, Esophageal Cancer

Transfus Sci. 1999 Oct;21(2):129-39.

21 AUTOAPHERESIS AND INTRAOPERATIVE BLOOD SALVAGE IN ONCOLOGIC SURGERY.

Valbonesi M, Bruni R, Lercari G, Florio G, Carlier P, Morelli F.
Immunohematology Services, San Martino University Hospital, Genova, Italy.

ABSTRACT

Transfusion of predeposit or salvaged autologous blood has continued to grow since the 1980s. Issues such as the indications for use and cost effectiveness as well as the safety of autologous blood salvaged during cancer surgery have emerged and should be addressed. The concern for possible contamination of autologous RBC with cancer cells responsible for metastasis has limited the use of autologous salvaged blood in cancer patients. Nevertheless, clinical experience has been gained on the use of salvaged blood in patients with colorectal, gastric, renal, hepatic, breast, bladder and lung cancer. No evidence has been reported showing an increase in metastasis or a decrease in patient survival, in spite of the obvious demonstration that salvaged blood is contaminated with viable tumor cells which are not washed out of the RBC layer during intraoperative blood salvage (IOBS). However, a number of limitations have hampered the widespread use of IOBS in these patients and the technique is not well established. Increasing knowledge of the deleterious effects of allogeneic blood transfusion both in terms of the increased number of viral or bacterial infections and the down-regulation of the patient's immune system have recalled attention to IOBS and to the techniques such as filtration, which might reduce the risk of reinfusion of cancer cells, or totally eliminate the risks such as irradiation has been proposed by Hansen's group. This paper reviews the topic with some emphasis on our personal experience with gamma and X-ray irradiation of salvaged blood in a large reference hospital, where IOBS and filtration of salvaged blood were established for use in cancer patients in 1993 and 1996.

KEYWORDS: Tumor Surgery, Blood Irradiation

Transfusion. 1999 Jun;39(6):608-15.

22 BLOOD IRRADIATION FOR INTRAOPERATIVE AUTOTRANSFUSION IN CANCER SURGERY: DEMONSTRATION OF EFFICIENT ELIMINATION OF CONTAMINATING TUMOR CELLS.

Hansen E, Knuechel R, Altmeppen J, Taeger K.
Department of Anesthesiology, University of Regensburg, Germany. ernil.hansen@klinik.uni-regensburg.de

ABSTRACT

BACKGROUND: Intraoperative blood salvage is contraindicated in cancer surgery because of contaminating tumor cells and the risk of systemic dissemination. On the basis of the radiosensitivity of cancer cells, irradiation of salvaged blood with 50 Gy is proposed as a way to allow return of salvaged blood.

STUDY DESIGN AND METHODS: Elimination of tumor cells by blood irradiation was studied in vitro with cells from 10 cell lines and from 14 tumor preparations after their addition to red cells in high numbers, or with blood shed during cancer surgery. Before and after gamma radiation, tumor cells were isolated by density gradient centrifugation and tested for their proliferative capacity in a cell colony assay. DNA metabolism was analyzed by incorporation of 5' bromodesoxyuridine.

RESULTS: Survival curves of cells from various tumors confirmed D0 (the dose required to reduce the fraction of surviving cells to 37 percent of the original value) values in the range of 1.2 to 2.2 Gy. After irradiation of tumor cell-contaminated blood with 50 Gy, no cell colony formation was observed, which indicates a reduction rate exceeding 10 log. Irradiated cancer cells showed viability, but no residual DNA metabolism.

CONCLUSION: The level of inactivation by a 50-Gy dose far exceeds that needed to inactivate the number of proliferating tumor cells observed or expected in wound blood. These results provide the experimental basis for the clinical application of blood irradiation for intraoperative blood salvage in cancer surgery.

KEYWORDS: Tumor Surgery, Blood Irradiation

Vox Sang. 1997;72(4):221-4.

23 EFFECTIVENESS OF LEUKOCYTE FILTERS IN REDUCING TUMOR CELL CONTAMINATION AFTER INTRAOPERATIVE BLOOD SALVAGE IN LUNG CANCER PATIENTS.

Perseghin P, Viganò M, Rocco G, Della Pona C, Buscemi A, Rizzi A.
Servizio Trasfusionale, Azienda Ospedaliera Ospedale E. Morelli, Sondalo, Italia.

ABSTRACT

OBJECTIVES: In an effort to reduce allogeneic blood transfusions in patients undergoing elective surgery for lung cancer, we investigated the effectiveness of a method of processing shed blood with an automated device for intra operative blood salvage (IOBS) and filtration with a 3rd-generation polyester filter to remove tumor cells.

METHODS: Sixteen patients were operated on for different types of lung cancer. We searched for malignant cells in pre- and postprocessed shed blood employing density gradient centrifugation, staining of cytopins with hematoxylin-eosin, and antibodies to human cytokeratins.

RESULTS: In 9 out of 16 cases (56%), neoplastic cells were detected in prefiltration samples, but none were found in postfiltration cytopins.

CONCLUSION: IOBS combined with appropriate filtration could be a very useful and safe tool in reducing allogeneic blood transfusion in cancer patients.

KEYWORDS: Tumor Surgery, Lung Cancer

Infusionsther Transfusionsmed. 1994 Oct;21(5):337-48.

24 AUTOLOGOUS BLOOD TRANSFUSION IN TUMOR OPERATIONS.

Hansen E, Hofstädter F, Taeger K.
Klinik für Anästhesiologie, Universität Regensburg, BRD.

ABSTRACT

OBJECTIVE: The potential and limits of autologous transfusion in tumor patients are discussed according to the literature. New aspects are derived from own recent studies.

DATA SOURCES AND SELECTION CRITERIA: The critical review of the German and English literature is based on a Medline and DIMDI backsearch covering the last 20 years. Own data not yet published are presented.

RESULTS: Predeposit autologous blood represents an important and practical alternative to homologous transfusion also for tumor patients. Predeposit programs are limited by tumor anemia, the urgent time schedule for surgery, and the variable need for transfusions. Intraoperative autotransfusion is contraindicated in these patients. Our own studies on the presence of tumor cells in the blood shed from the surgical field during oncologic surgery confirm the concerns about a systemic spread of tumor cells after retransfusion. Further efforts aim to an elimination of contaminating tumor cells. In contrast to the literature filters for white blood cell depletion were found to fail to completely remove tumor cells. A 3 log₁₀ retention was measured. Proliferative activity of tumor cells was completely abolished by irradiation of the blood.

CONCLUSIONS: Irradiation with 50 Gy allows safe retransfusion of blood salvaged during tumor surgery. This promising possibility is now to be tested in clinical studies.

KEYWORDS: Tumor Surgery, Blood Irradiation

Arch Surg. 1986 Nov;121(11):1326-9.

25 INTRAOPERATIVE AUTOTRANSFUSION IN UROLOGIC ONCOLOGY.

Klimberg I, Sirois R, Wajsman Z, Baker J.

ABSTRACT

The value of autotransfusion is widely recognized in the surgical community and may be of increasing importance in prevention of acquired immunodeficiency syndrome and hepatitis. The concern of potential contamination of the blood with viable tumor cells has resulted in limited use of autotransfusion in cancer surgery. The objective of this study was to examine the benefits and safety of autotransfusion in patients undergoing major surgery of genitourinary tumors. Autotransfusion was used in 49 consecutive patients. Twenty-four patients had radical cystectomy, ten had radical prostatectomy, 13 had radical nephrectomy, and two had other types of operations. An autotransfusion machine (Haemonetics Cell Saver) was used. The follow-up included physical examination, chest roentgenogram every three months, and bone scan and computed tomographic scan if clinically indicated. Liver and renal profiles were routinely performed every three months. Five of 49 patients developed metastases during follow-up examination from 12 to 23 months. The low incidence of metastatic spread and the pattern of spread fall to implicate autotransfusion as a cause of tumor dissemination. Autotransfusion and predeposited blood banking may result in elimination of or significant reduction in homologous transfusions.

KEYWORDS: Tumor Surgery, Cystectomy, Prostatectomy, Nephrectomy, Haemonetics Cell Saver





PREOPERATIVE SEQUESTRATION



REFERENCES OVERVIEW

- Preoperative sequestration in cardiac surgery:

2 3 4 5 6 7 8 9

- Preoperative sequestration in vascular surgery:

1

J Clin Anesth. 2002 Feb;14(1):10-4.

1 INTRAOPERATIVE USE OF PLATELET-PLASMAPHERESIS IN VASCULAR SURGERY

Safwat AM, Bush R, Prevec W, Reitan JA.

Department of Anesthesiology and Pain Medicine, University of California, Davis School of Medicine, Davis, CA, USA.

ABSTRACT

STUDY OBJECTIVE: To determine, in a pilot study, whether pheresis of plasma and platelets before surgical blood loss, with reinfusion of the autologous plasma and platelets after completion of the aortic reconstruction, will result in decreased bleeding and decreased transfusion of allogeneic blood components in patients undergoing elective aortic reconstruction.

DESIGN: Randomized study.

SETTING: University medical center.

INTERVENTIONS: Patients were randomized to perioperative (acute) platelet plasmapheresis (APP group) versus conventional blood component therapy (control group). In the APP group, blood was withdrawn after induction of anesthesia, to sequester approximately 300 mL of platelet rich plasma (PRP); platelet poor plasma (PPP) and red blood cells (RBC) were sequestered as well. An autotransfusion device was used to collect and re-infuse autologous RBC during the course of the operation in both groups. After completion of the aortic reconstruction, autologous PRP and PPP were re-infused in the APP group. Blood loss, volume of blood component transfusions, and preoperative and postoperative hemoglobin (Hb), hematocrit (Hct), platelet, international normalized ratio (INR), and activated partial thromboplastin time (aPTT) were recorded.

MEASUREMENTS AND MAIN RESULTS: There was no difference between groups in demographics, preoperative laboratory values, or surgical procedures, although more patients were treated for aneurysms (73% vs. 60%) and fewer for occlusive disease (20% vs. 40%) in the control versus APP group. Also, there were no differences between the control and APP groups in duration of operation, blood loss, volume of colloid infused, or volume of allogeneic RBC and plasma transfused. Patients in the APP group received a greater volume of crystalloid solution (9.1 +/- 3.4 L vs. 6.8 +/- 3.0 L; $p = 0.002$), but fewer units of allogeneic platelets than the control group (0.7 +/- 1.0 units vs. 0.2 +/- 0.4 units; $p < 0.04$). There were no differences in postoperative Hb, Hct, INR, aPTT, or fibrinogen. The platelet count was lower in the APP group than in the control group (123 +/- 40 x 10³/mm³ vs. 182 +/- 51 x 10³/mm³; $p = 0.004$).

CONCLUSIONS: Perioperative platelet plasmapheresis led to fewer allogeneic platelet transfusions in patients undergoing elective aortic reconstruction. However, there was no decrease in blood loss and no reduction in transfusion of allogeneic RBC or plasma. Perioperative platelet plasmapheresis is not recommended for routine use in elective aortic reconstruction.

KEYWORDS: Preoperative Sequestration, Vascular Surgery

Anesth Analg. 2000 Mar;90(3):509-16

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2 PLATELET-RICH PLASMA SEQUESTRATION, WITH THERAPEUTIC PLATELET YIELDS, REDUCES ALLOGENEIC TRANSFUSION IN COMPLEX CARDIAC SURGERY.

Stover EP, Siegel LC, Hood PA, O'Riordan GE, McKenna TR.

Department of Anesthesia, Stanford University School of Medicine, Stanford, California 94305, USA.

ABSTRACT

Platelet dysfunction is the most common cause of nonsurgical bleeding after cardiopulmonary bypass (CPB). We hypothesized that reinfusion of a therapeutic quantity of platelets sequestered before CPB would decrease the need for allogeneic platelet transfusion, as well as decrease bleeding and total allogeneic transfusion, in cardiac surgery patients at moderately high risk for bleeding. Fifty-five patients undergoing either reoperative coronary artery bypass (CABG) or combined CABG and valve replacement were randomized to control or platelet-rich plasma sequestration (pheresis) groups. All patients received intraoperative epsilon-aminocaproic acid infusions. There was no significant difference between groups with respect to preoperative characteristics, duration of CPB, or target postoperative hematocrit. Mean platelet yields were 6.2 +/- 2.1 units (3.1 x 10¹¹ platelets). Mean pheresis time was 44 min. Allogeneic platelets (range = 6-12 units) were transfused to 28% of control patients, compared with 0% of pheresis patients ($P < 0.01$). Allogeneic packed red blood cells were transfused to 45% of control patients (1.2 units per patient) versus 31% of pheresis patients (0.7 unit per patient) ($P = 0.35$). Total allogeneic units transfused were significantly reduced in the pheresis group ($P < 0.02$). Mediastinal chest tube drainage was not significantly decreased in the pheresis group. In this prospective, randomized study, therapeutic platelet yields were obtained before CPB. In contrast with recent studies with low platelet yields, these data support the conclusion that platelet-rich plasma sequestration is effective in reducing allogeneic platelet transfusions and total allogeneic units transfused in cardiac surgery patients at moderately high risk for post-CPB coagulopathy and bleeding.

IMPLICATIONS: Transfusion of allogeneic blood products, including platelets, is common during complex cardiac surgical procedures. In the present prospective, randomized study, a significant reduction in allogeneic platelet transfusion and total allogeneic units transfused was observed after the reinfusion of a therapeutic quantity of autologous platelets sequestered before cardiopulmonary bypass. Platelet dysfunction is the most common cause of nonsurgical bleeding after cardiopulmonary bypass (CPB). We hypothesized that reinfusion of a therapeutic quantity of platelets sequestered before CPB would decrease the need for allogeneic platelet transfusion, as well as decrease bleeding and total allogeneic transfusion, in cardiac surgery patients at moderately high risk for bleeding. Fifty-five patients undergoing either reoperative coronary artery bypass (CABG) or combined CABG and valve replacement were randomized to control or platelet-rich plasma sequestration (pheresis) groups. All patients received intraoperative epsilon-aminocaproic acid infusions. There was no significant difference between groups with respect to preoperative characteristics, duration of CPB, or target postoperative hematocrit. Mean platelet yields were 6.2 +/- 2.1 units (3.1 x 10¹¹ platelets). Mean pheresis time was 44 min. Allogeneic platelets (range = 6-12 units) were transfused to 28% of control patients, compared with 0% of pheresis patients ($P < 0.01$). Allogeneic packed red blood cells were transfused to 45% of control patients (1.2 units per patient) versus 31% of pheresis patients (0.7 unit per patient) ($P = 0.35$). Total allogeneic units transfused were significantly reduced in the pheresis group ($P < 0.02$). Mediastinal chest tube drainage was not significantly decreased in the pheresis group. In this prospective, randomized study, therapeutic platelet yields were obtained before CPB. In contrast with recent studies with low platelet yields, these data support the conclusion that platelet-rich plasma sequestration is effective in reducing allogeneic platelet transfusions and total allogeneic units transfused in cardiac surgery patients at moderately high risk for post-CPB coagulopathy and bleeding. **IMPLICATIONS:** Transfusion of allogeneic blood products, including platelets, is common during complex cardiac surgical procedures. In the present prospective, randomized study, a significant reduction in allogeneic platelet transfusion and total allogeneic units transfused was observed after the reinfusion of a therapeutic quantity of autologous platelets sequestered before cardiopulmonary bypass.

KEYWORDS: Preoperative Sequestration, Cardiac Surgery, Cardiopulmonary Bypass Surgery

Eur J Cardiothorac Surg. 1997 Mar;11(3):557-63.

3 THE INFLUENCE OF ACUTE PREOPERATIVE PLASMAPHERESIS ON COAGULATION TESTS, FIBRINOLYSIS, BLOOD LOSS AND TRANSFUSION REQUIREMENTS IN CARDIAC SURGERY.

Menges T, Welters I, Wagner RM, Boldt J, Dapper F, Hempelmann G.

Department of Anaesthesiology and Intensive Care Medicine, Justus-Liebig-University, Giessen, Germany.

ABSTRACT

OBJECTIVE: Withdrawal of autologous plasma and reinfusion after cardiopulmonary bypass (CPB) offers the opportunity of improving patients' haemostasis and reducing homologous blood consumption in cardiac surgery. The influence of acute, preoperative plasmapheresis (APP) on coagulation tests, fibrinolysis, blood loss and transfusion requirements was investigated in elective aortocoronary bypass patients.

METHODS: Forty patients were randomized to a control or pheresis group. The pheresis group had platelet-rich plasmapheresis (PRP-group, $n = 20$) performed before incision and the platelet-rich plasma (PRP) was returned after CPB. The control group ($n = 20$) was managed without pheresis. All patients had serial coagulation studies, including prothrombin split products (F1/F2), fibrinopeptide A (FPA), protein C (PC), thrombomodulin (TM), tissue-plasminogen-activator (t-PA), plasminogen-activator-inhibitor (PAI 1), fibrinopeptide B beta 15-42 (FPB beta 15-42), haemoglobin and platelet counts determined intra- and postoperatively. Chest tube drainage and transfusion requirements were recorded.

RESULTS: APP had no negative effects on the quality of PRP. The platelet count of the withdrawn autologous plasma was $239 \pm 33 \times 10^9/l$. From the end of the operation (after retransfusion of autologous plasma) until the first postoperative day platelet counts were significantly higher in the PRP-group ($P > 0.05$). Plasma concentrations of modified antithrombin III (ATM), F1/F2 and FPA increased (166-290% from baseline) and PC- and TM-antigen decreased (11-49% from baseline) to a different extent for both groups throughout CPB. t-PA-activity increased intraoperatively peaking at the end of CPB (PRP-group: 4.8 ± 0.8 IU/ml, control-group: 8.1 ± 2.3 IU/ml) ($P > 0.05$). With onset of CPB PAI-1 levels decreased and were further reduced after CPB in control patients in comparison to PRP-patients ($P < 0.05$). FPB beta 15-42 occurred in peak concentrations after neutralisation of heparin by protamine. Only PRP-patients showed baseline values of coagulation and fibrinolytic parameters on the next morning ($P < 0.05$). Total postoperative blood loss during the first 24 h was 503 ± 251 ml (PRP-group) and 937 ± 349 ml in the control-group ($P < 0.05$). None of the PRP-patients received allogeneic blood, whereas five control-patients received 11 units of packed red cells ($P < 0.05$).

CONCLUSIONS: The findings suggest that in elective cardiac surgery heparin cannot prevent generation of both thrombin and fibrin, born throughout CPB and postoperatively. The use of PRP withdrawn immediately preoperatively is an attractive technique to reduce allogeneic blood usage and preoperative blood loss, especially in patients in whom withdrawal of autologous whole blood cannot be performed.

KEYWORDS: Preoperative Sequestration, Cardiac Surgery, Cardiopulmonary Bypass Surgery

J Cardiothorac Vasc Anesth. 1997 Feb;11(1):13-7.

4 INTRAOPERATIVE PLASMAPHERESIS IN CARDIAC SURGERY.

Armellin G, Sorbara C, Bonato R, Pittarello D, Dal Cero P, Giron G.
Department of Anesthesiology and Critical Care, University of Padova, Italy.

ABSTRACT

OBJECTIVE: To determine the effects of intraoperative plasmapheresis on total transfusion requirements, mediastinal drainage, and coagulation.

DESIGN: The trial was prospective, randomized, and controlled.

SETTING: Inpatient cardiac surgery at a university medical center.

PARTICIPANTS: Two hundred ninety-three consecutive patients undergoing cardiac surgery requiring cardiopulmonary bypass.

INTERVENTIONS: Intraoperative plasmapheresis (IP) was performed in 147 patients before heparinization; platelet-rich plasma was reinfused immediately after heparin reversal.

MEASUREMENTS AND MAIN RESULTS: Mediastinal chest tube drainage during the first 12 postoperative hours was significantly less in the IP group ($p = 0.022$), but no difference was noted in total postoperative blood loss between the two groups. The amount of packed red cells and fresh frozen plasma transfused to the IP group in the intensive care unit was significantly lower ($p = 0.02$, $p = 0.002$, respectively); 51.4% of patients required no transfusion compared with the control group (34.5%) ($p = 0.006$). No differences were noted for data collected in the intensive care unit in terms of the mean duration of chest tube drainage, ventilator time, or any hematologic variables at baseline or at any subsequent time in the study.

CONCLUSIONS: After cardiac surgery, intraoperative plasma-pheresis reduces early postoperative bleeding and decreases the need for homologous transfusions.

KEYWORDS: Preoperative Sequestration, Cardiac Surgery, Cardiopulmonary Bypass Surgery

Ann Thorac Surg. 1991 Apr;51(4):541-4; discussion 545-6.

5 BENEFIT FROM COMBINING BLOOD CONSERVATION MEASURES IN CARDIAC OPERATIONS.

Jones JW, Rawitscher RE, McLean TR, Beall AC Jr, Thornby JI.
Cora and Webb Mading Department of Surgery, Baylor College of Medicine, Houston, Texas.

ABSTRACT

Conventional blood conservation techniques have been insufficient to decrease transfusion needs in increasingly complex cardiac operations. To evaluate combinations of conservation techniques, 300 patients were divided into three equal groups. Group 1 had intraoperative autotransfusion and return of mediastinal drainage for 4 hours postoperatively. Group 2 had these measures plus intraoperative plasmapheresis. These two groups were given a transfusion for a hematocrit of less than 0.21 on cardiopulmonary bypass. Group 3 was treated with the same measures as group 2 but did not receive transfusions while on pump unless the hematocrit decreased to less than 0.15. The percentage of patients in each group given transfusions in the operating room was 34% in group 1, 28% in group 2, and 7% in group 3 (p less than 0.05). The percentage of all patients receiving transfusions during hospitalization was 68% in group 1, 36% in group 2 (p less than 0.05), and 18% in group 3 (p less than 0.05). Average total units transfused were 2.16 \pm 0.25 in group 1, 0.7 \pm 0.15 in group 2 (p less than 0.05), and 0.37 \pm 0.07 in group 3 (p less than 0.05). The perioperative morbidity rates including myocardial infarctions and strokes were similar. There were no deaths in group 3. Combining complementary conservation measures is effective in reducing homologous blood transfusions, and the need for transfusion can be safely reduced by allowing profound hemodilution during bypass.

KEYWORDS: Preoperative Sequestration, Cardiac Surgery, Cardiopulmonary Bypass Surgery

Ann Thorac Surg. 1990 Apr;49(4):585-9; discussion 590.

6 EFFECTS OF INTRAOPERATIVE PLASMAPHERESIS ON BLOOD LOSS IN CARDIAC SURGERY.

Jones JW, McCoy TA, Rawitscher RE, Lindsley DA.
Ritter Heart Institute, Toledo Hospital, Ohio.

ABSTRACT

Intraoperative platelet-rich plasmapheresis allows autotransfusion of fresh, undamaged platelets and clotting factors at the completion of the operation. To evaluate this technology, we randomly assigned 100 consecutive patients who were to undergo an elective coronary bypass procedure and had normal clotting studies into the experimental (plasmapheresis) or the control group. Characteristics of both groups were similar, including average age (61.4 years versus 61.3 years [experimental versus control group]), sex (78% male versus 74% male), preoperative weight (80.9 kg versus 80.2 kg), preoperative red cell mass (1,989 mL versus 1,890 mL), perfusion time (102 minutes versus 106 minutes), and coagulation studies. Both internal mammary arteries were used in 68% of the patients. All patients had preoperative and postoperative blood volume determinations and complete clotting studies. Sixty-two variables related to bleeding were analyzed. Strict indications for transfusion were a hemoglobin level less than 7 g/100 mL in patients younger than 70 years and a hemoglobin level less than 8 g/100 mL in patients older than 70 years. The group receiving intraoperative plasmapheresis had a significant reduction in operative red cell mass loss (1,050 +/- 43 mL versus 1,226 +/- 61 mL; $p = 0.021$), a reduction in the average homologous transfusion (0.67 +/- 0.15 unit versus 1.8 +/- 0.25 units; $p = 0.0002$), and an increase in the percentage of patients not requiring blood transfusions (66% versus 32%; $p = 0.001$). This technique is useful in reducing postoperative blood loss and homologous transfusions.

KEYWORDS: Preoperative Sequestration, Cardiac Surgery, Cardiopulmonary Bypass Surgery

Ann Thorac Surg. 1989 Jun;47(6):897-902.

7 DETERMINANTS OF HOMOLOGOUS BLOOD USAGE UTILIZING AUTOLOGOUS PLATELET-RICH PLASMA IN CARDIAC OPERATIONS.

Giordano GF Sr, Giordano GF Jr, Rivers SL, Chung GK, Mammana RB, Marco JD, Raczkowski AR, Sabbagh A, Sanderson RG, Strug BS.
Southern Arizona Regional Red Cross Blood Program, Tucson 85719.

ABSTRACT

The present study evaluated (1) the influence of the collection of autologous platelet-rich plasma intraoperatively in addition to intraoperative autotransfusion on homologous blood usage and bleeding in cardiac operations; (2) the influence of age, sex, body surface area, type of operation, and reoperations on homologous blood usage and bleeding in cardiac operations utilizing intraoperative autotransfusion and autologous platelet-rich plasma collected intraoperatively; and (3) the influence of the preoperative administration of aspirin, Persantine (dipyridamole), heparin sodium, thrombolytic agents, Coumadin (crystalline warfarin sodium), and nonsteroid, antiinflammatory drugs on homologous blood usage and bleeding in cardiac operations utilizing intraoperative autotransfusion and autologous platelet-rich plasma collected intraoperatively. The results demonstrated a decrease in homologous blood use and bleeding when autologous platelet-rich plasma is collected in addition to the use of intraoperative autotransfusion. All of the patient and procedural variables influenced homologous blood usage and bleeding to some extent. Only the thrombolytic agents affected blood usage by increasing homologous plasma usage. All other drugs evaluated did not influence blood utilization or the amount of bleeding intraoperatively or postoperatively.

KEYWORDS: Preoperative Sequestration, Cardiac Surgery

Ann Thorac Surg. 1988 Oct;46(4):416-9.

8 AUTOLOGOUS PLATELET-RICH PLASMA IN CARDIAC SURGERY: EFFECT ON INTRAOPERATIVE AND POSTOPERATIVE TRANSFUSION REQUIREMENTS.

Giordano GF, Rivers SL, Chung GK, Mammana RB, Marco JD, Raczkowski AR, Sabbagh A, Sanderson RG, Strug BS.
Southern Arizona Regional Red Cross Blood Program, Tucson 85719.

ABSTRACT

The Southern Arizona Red Cross Blood program, in conjunction with participating hospitals and cardiac surgeons, evaluated the effect of a program to harvest autologous platelet-rich plasma (PRP) from patients immediately prior to undergoing cardiopulmonary bypass surgery. The PRP was transfused back to the patient after heparin neutralization was achieved at the completion of cardiopulmonary bypass. The effect of this autologous PRP product on homologous plasma and platelet usage was examined. The study demonstrates a significant decrease in homologous plasma and platelet usage when autologous PRP is used in cardiac surgery.

KEYWORDS: Preoperative Sequestration, Cardiac Surgery, Cardiopulmonary Bypass Surgery

Int J Artif Organs. 1987 Jan;10(1):47-50

9 A NEW TECHNIQUE FOR HEMODILUTION, PREPARATION OF AUTOLOGOUS PLATELET-RICH PLASMA AND INTRAOPERATIVE BLOOD SALVAGE IN CARDIAC SURGERY.

Ferrari M, Zia S, Valbonesi M, Henriquet F, Venere G, Spagnolo S, Grasso MA, Panzani I.

ABSTRACT

We have developed a new system for the production of autologous platelet-rich plasma and red blood cell concentrates to be used in autologous transfusion support of cardiac surgery patients. In 15 operations no homologous blood products were required. Costs were diminished since with the same harness it was possible to carry out the intraoperative blood salvage and concentrate the erythrocytes contained in the oxygenator and its lines. Indirect costs were also reduced since no infective complication was observed due to homologous blood products.

KEYWORDS: Preoperative Sequestration, Cardiac Surgery





MISCELLANEA



REFERENCES OVERVIEW

- Autotransfusion and suction-induced hemolysis:

1

- Autotransfusion and partial bowls:

2 4

- Autotransfusion and bacterial contamination

3

Anesth Analg. 2007 Mar;104(3):684-7.

1 MODIFICATION OF SUCTION-INDUCED HEMOLYSIS DURING CELL SALVAGE.

Waters JH, Williams B, Yazer MH, Kameneva MV.

Department of Anesthesiology, Magee Womens Hospital of University of Pittsburgh Medical Center, Pittsburgh, PA 15213, USA.

ABSTRACT

BACKGROUND: The efficiency of red blood cell collection during cell salvage is dictated by multiple variables, including suction pressure. In this study, we attempted to determine the influence of suction pressure on the efficiency of cell salvage and to identify methods for minimizing the impact of suction on salvaged blood.

METHODS: Whole blood was placed in 60-mL aliquots either in a beaker or on a flat surface and suctioned at 100 and 300 mm Hg. The amount of hemolysis was measured and compared under the varying conditions. The experiments were repeated with the blood diluted with normal saline solution in a 1:1 mix.

RESULTS: Hemolysis ranged from 0.21% to 2.29%. Hemolysis was greatest when whole blood was suctioned from a flat surface at 300 mm Hg. It was reduced when the blood was diluted with saline. Blood suctioned from a surgical field during cell salvage should be done with minimal suction pressures and with the goal of minimizing blood-air interfaces.

CONCLUSIONS: Significant reduction of blood damage can be obtained by diluting blood with normal saline while suctioning it from the surgical field. Although immediate hemolysis due to suctioning was not very high, the red blood cell damage from suctioning produced by a dynamic blood-air interface might adversely affect the efficiency of cell salvage.

KEYWORDS: Suction, Hemolysis

J Extra Corpor Technol. 2005 Jun;37(2):161-4.

2 PARTIAL BOWLS USING THE HAEMONETICS CELL SAVER 5: DOES IT PRODUCE A QUALITY PRODUCT?

Serrick CJ, Scholz M.

Trillium Health Centre, Mississauga, Ontario, Canada. cserrick@thc.on.ca

ABSTRACT

Controversy still exists on the validity of processing a partial bowl during the collection of shed blood lost through surgery during cell salvaging. The purpose of this study was to assess the quality of red blood cells produced from a partial bowl of autologous suctioned blood using the Haemonetics Cell Saver 5. Suctioned blood was collected from 17 patients undergoing cardiac surgery. A partially filled cell saver bowl was washed with 1500 mL of NaCl. Reservoir and processed blood samples were examined for potassium, leukocytes, hematocrit, platelets, and plasma-free hemoglobin and then compared with 22 previously studied full bowls. Results are summarized in the table below: In conclusion, the Haemonetics Cell Saver 5 can produce a quality product from washing a partial bowl with a better washout of white blood cells compared with a full bowl. However, there is a reduction in red blood cell recovery.

KEYWORDS: Cardiac Surgery, Partial Bowl, Haemonetics Cell Saver

Anesthesiology. 2003 Sep;99(3):652-5.

3 BACTERIAL REDUCTION BY CELL SALVAGE WASHING AND LEUKOCYTE DEPLETION FILTRATION.

Waters JH, Tuohy MJ, Hobson DF, Procop G.

Section of Anesthesia for Obstetrics & Gynecology, Department of General Anesthesiology, Cleveland Clinic Foundation, Ohio 44195, USA. watersj@ccl.org

ABSTRACT

BACKGROUND: Blood conservation techniques are being increasingly used because of the increased cost and lack of availability of allogeneic blood. Cell salvage offers great blood savings opportunities but is thought to be contraindicated in a number of areas (e.g., blood contaminated with bacteria). Several outcome studies have suggested the safety of this technique in trauma and colorectal surgery, but many practitioners are still hesitant to apply cell salvage in the face of frank bacterial contamination. This study was undertaken to assess the efficacy of bacterial removal when cell salvage was combined with leukocyte depletion filtration.

METHODS: Expired packed erythrocytes were obtained and inoculated with a fixed amount of a stock bacteria (Escherichia coli American Type Culture Collections [ATCC] 25922, Pseudomonas aeruginosa ATCC 27853, Staphylococcus aureus ATCC 29213, or Bacteroides fragilis ATCC 25285) in amounts ranging from 2,000 to 4,000 colony forming units/ml. The blood was processed via a cell salvage machine. The washed blood was then filtered using a leukocyte reduction filter. The results for blood taken during each step of processing were compared using a repeated-measures design.

RESULTS: Fifteen units of blood were contaminated with each of the stock bacteria. From the prewash sample to the postfiltration sample, 99.0%, 99.6%, 100%, and 97.6% of E. coli, S. aureus, P. aeruginosa, and B. fragilis were removed, respectively.

DISCUSSION: Significant but not complete removal of contaminating bacteria was seen. An increased level of patient safety may be added to cell salvage by including a leukocyte depletion filter when salvaging blood that might be grossly contaminated with bacteria.

KEYWORDS: Bacterial Removal, Leukocyte Depletion Filter

J Extra Corpor Technol. 2001 May;33(2):80-5.

4 EFFECT OF PARTIAL-FILLING AUTOTRANSFUSION BOWLS ON THE QUALITY OF REINFUSED PRODUCT.

Tremain KD, Stammers AH, Niimi KS, Glogowski KR, Muhle ML, Trowbridge CC, Yang T.

Division of Clinical Perfusion Education, School of Allied Health Professions, University of Nebraska Medical Center, Omaha, USA. kimtremain@excite.com

ABSTRACT

Intraoperative autotransfusion is used in a variety of surgical procedures with the quantity of blood loss dependent upon numerous factors. These procedures may or may not produce a full autotransfusion bowl. The inadequate removal of contaminants has been correlated to the incomplete filling of bowls, resulting in a condition called "Salvaged Blood Syndrome." The purpose of this study was to assess the quality of aspirated whole blood after processing with an autotransfusion system using various fill volumes and two wash volumes. An in vitro circuit was designed to mimic the mechanical effects of extracorporeal flow on blood. Twenty-four Baylor-style bowls were filled at 400 mL min⁻¹ and washed at 300 mL min⁻¹. Two wash volumes, 1000 and 2000 mL, and three bowl volumes: low, mid, and full, were used in this study. The bowl volumes were determined by using red cell quantities of 60, 100, and 135 mL for the low-fill, mid-fill, and full bowls, respectively. Samples were drawn pre-autotransfusion and post-autotransfusion and analyzed for plasma-free hemoglobin, IL-8, white blood cell count, platelet count, albumin, and total protein. All data were analyzed using one-way analysis of variance (ANOVA) with significance accepted at $p > \text{or} = .05$. Plasma-free hemoglobin levels and hematocrit were concentrated significantly ($p < .05$) as bowl volume increased. A significant difference in IL-8 levels was found in the wash volumes in the low-fill bowls ($p < .02$). Platelet count was significantly decreased between the full bowl with 1000 mL wash and the full bowl with 2000 mL wash ($p < .0004$). Total protein reduction was significantly less in the low-fill bowl with 1000 mL wash as compared to the other bowl treatments ($p < .05$). In conclusion, the quality of the washed product did not vary significantly between fill or wash volumes, with the exception of the low-fill bowl with 1000 mL wash.

KEYWORDS: Partial Bowl, Sorin Group Brat2

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SORIN GROUP ITALIA S.R.L.
VIA STATALE 12 NORD, 86
41037 MIRANDOLA MODENA ITALY
TEL +39 0535 29811
FAX +39 0535 24312
INFO.CP@SORIN.COM



SORIN'S GREEN LEAF PROGRAM

WWW.SORIN.COM

