Clinical Excellence

Transfusion Reduction Initiative

“Identifying avoidable clinical variation that, when addressed, improves quality, decreases cost, expands margins, and enhances our ability to provide our community with the best care in the world.”

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“There’s overwhelming evidence to suggest that blood transfusion is a dual edged sword” V. Ferraris U. Kentucky. “Some people need it and it saves their lives, other people are harmed by it.”

Insurance plans are discouraging transfusions. Blood is expensive, Purchase price $225.00, then Type/Cross Type Screen, Antibody check, tubing, nursing time, disposal = $1,000.00 per unit
Developing Storage Lesion

Day 1  Day 21  Day 35

Scanning electron micrographs of red blood cells isolated from stored blood on Day 1, Day 21, and Day 35. During storage, the shape of RBCs changed gradually from normal discoid to echinocytes (dented or shriveled red cells).

Circulating Red Cells
Circulating Red Cells – Transfused 21 Days
PBM has been recognized by the World Health Organization (Res A63.R12) as a means to "promote the availability of transfusion alternatives".
Study Outcomes

1. International Consensus Conference on Transfusion Outcomes - 60% of RBC transfusion rated as inappropriate

2. Topic Trial Transfusion of Fresh Frozen Plasma - 50% of FFP administered to stable non-bleeding ICU patients

3. Platelet Transfusions in Hematology Patients; Are we using them Appropriately? 34% inappropriate. Considerable potential for decreased use.

More appropriate use of these will improved use and reduce cost.
RBC’s @ $1,000 per unit  FFP @ $375.00  Platelet pheresis @ $950.00

2. Trials 2011 Dec 23; (1): 266 MC Muller
3. Von Sang 2012 July 9 Ahead of print
“For every transfusion of packed red blood cells received by a patient undergoing coronary artery bypass graft (CABG) surgery, the risk of infection increases by 27%,” researchers reported at the 48th Annual Meeting of the Society of Thoracic Surgeons (STS)...

Possible reason: “immunomodulation caused by the RBC’s and presence of circulating non-transferrin bound iron which can promote growth of infection”

Transfusion 2011 Dec. 21
Negative Effects of Blood Transfusion

• Transfusion significantly associated tumor recurrence in Ovarian CA ≥ 59% Clinical Anesthesiology May 2011 Vol 37:5
• Increased mortality 18% - 10% with ≤ RBC’s JAMA 2014
• Lung resection CA recurrence ≥ 64% Luan BMC 2014 14:34
• Colorectal resection, recurrence ≥ 74% Cata Cochrane Sys Rev 2006
• Radical Cystectomy 17% ≥ CA recurrence per RBC unit Eur J Urol 2014 5811 # 9
• “There are now dozens of studies that demonstrate superior patient outcomes with restrictive transfusion practices” Mark Ereth, MD, Mayo Clinic
• Many Studies stressing Transfusion Free Approach
LAS PALMAS DEL SOL HEALTHCARE
Physician Order for Blood/Blood Component Transfusion (Adult)

PRBCs: # of units to transfuse: ________________ (each unit is ~300mL)
*For special patient populations only. Check if applicable:
☐ Irradiated*
☐ CMV negative*
☐ Washed*

Note: One unit of PRBC’s will increase Hgb by 1g/dL; Hct by 3-4%
Most recent Hgb ____________ g/dL  Hct __________ %

Indication: CHECK ALL THAT APPLY
☐ Hgb <7 g/dL
☐ Acute blood loss >20% estimated blood volume
☐ Hgb 8-9 g/dL WITH hematologic or oncologic diagnosis
☐ Hgb 8-10 g/dL WITH underlying disease that could cause tissue hypoxia (Acute MI, angina CVA, CHF, or COPD)
☐ Other reason for transfusion (please specify): ________________

CRYO: # of units to transfuse: ________________ (each unit ~15 mL per unit)

Note: Each unit of Cryo will increase fibrinogen by 5-10 mg/dL
Most recent coagulation studies:
INR __________ PT __________ PTT __________ Fibrinogen __________

Indication: CHECK ALL THAT APPLY:
☐ Fibrinogen <100 mg/dl AND actively bleeding
☐ Dysfibrinogenemia
☐ Factor VIII deficiency
☐ Von Willebrand’s disease when concentrate is not available from pharmacy
☐ DIC if volume overload is an issue
☐ Other reason for transfusion (please specify): ________________

PLTs: # of single donor apheresis unit to transfuse: ________________
(each unit is ~ 200-400 mL per unit)
*For special patient populations only. Check if applicable:
☐ Irradiated*
☐ CMV negative*
☐ VOL Reduced Plts (for Neonates only)*

Note: A single donor plt apheresis unit will increase the plt count by 30,000- 60,000/uL
Most recent platelet count ____________ /uL

Indication: CHECK ALL THAT APPLY
☐ Plt <10,000 without bleeding
☐ Plt <50,000 WITH active bleeding / surgery/ invasive procedure
☐ Plt <100,000 WITH CNS bleed
☐ Plt <100,000 WITH massive transfusion
☐ DIC regardless of plt count
☐ Qualitative plt defect regardless of plt count
☐ Post-op bleeding/ prior to surgery in patient with history of anti-plt drug therapy regardless of plt count
☐ Other reason for transfusion (please specify): ________________

FFP or THAWED PLASMA: # of units to transfuse: ________________ (each unit is ~ 200-275 mL)

Note: FFP is not indicated when INR values are normal. FFP should NOT be used as a volume expander. A dose of 10-15 mL/kg is usually adequate to correct a coagulopathy.
Note: Lower levels of factor V (decreased 60%) and factor VIII (decreased up to 40%). When FFP expires it converts to thawed plasma and can be kept for 5 days.

Most recent coagulation studies:
INR __________ PT __________ PTT __________ Fibrinogen __________

Indication: CHECK ALL THAT APPLY
☐ INR >2.0 AND actively bleeding or scheduled for surgery / invasive procedure
☐ Emergent reversal of Coumadin for active bleeding/ procedure/ surgery
☐ After massive transfusion
☐ Therapeutic Plasma Exchange
☐ DIC
☐ ATIII, Protein C or Protein S deficiencies
☐ Coagulation factor replacement (II, V, VII, IX, X, XI) when specific factor therapy is NOT available
☐ Other reason for transfusion (please specify): ________________
In 42 of 45 clinical studies, RBC transfusions were associated with unfavorable outcome. This analysis demonstrated that there is sparse evidence that routine RBC transfusion in non-bleeding patients with hemoglobin concentration of 7g/dL leads to improved outcome, which justifies transfusion triggers above 8g/dL only in patients with restricted cardiac output.
Marik’s Forrest Plot

Figure 2. Association between blood transfusion and the risk of death (odds ratio [OR] and 95% confidence interval [CI]). ACS, abdominal compartment syndrome; ICU, intensive care unit.

Figure 3. Association between blood transfusion and the risk of infectious complications (odds ratio [OR] and 95% confidence interval [CI]). ICU, intensive care unit.
1. Meta Analysis of 10 observational trials 203,665 patients w/ ACS. Tx vs No Tx. Increase all cause mortality 300% with absolute increase of death 12% w/ Tx.

2. Tx associated w/ higher risk independent of baseline hemoglobin, nadir hemoglobin levels.

3. Tx was associated w/ 200% increased risk in MI. These conclusions are counter to presumption that Tx reduce both MI & mortality in ACS patients.
Red blood cell transfusion after PCI was associated with increased mortality, MI, and stroke

Clinical impact ratings: ★★★★★☆☆☆ ★★★★★☆☆☆

Question
Is red blood cell transfusion after percutaneous coronary intervention (PCI) associated with in-hospital adverse events?

Methods
Design: Retrospective cohort study using data from the CathPCI registry.

Setting: 1431 hospitals in the USA.

Patients: 2 258 711 patient visits (1 967 218 patients) that involved a first PCI or cardiac catheterization during each hospital stay from July 2009 to March 2013. During 48 430 patient visits (mean age 71 y, 56% women), patients received a red blood cell transfusion after PCI. 2 210 281 control patient visits (mean age 65 y, 67% men) did not include a transfusion. Exclusion criteria were coronary artery bypass graft surgery during the same hospital stay or missing data on bleeding events, complications, or discharge status.

Risk factors: Red blood cell transfusion (receipt of packed red blood cells or whole blood) during hospital stay.

Outcomes: Outcomes included in-hospital mortality, myocardial infarction (MI), and stroke.

Source of funding: American College of Cardiology Foundation’s National Cardiovascular Data Registry.

For correspondence: Dr. M.W. Sherwood, Duke Clinical Research Institute, Durham, NC, USA. E-mail matthew.sherwood@dm.duke.edu.

Commentary
The study by Sherwood and colleagues describes broad variation in transfusion practice after PCI across different hospitals.

Association between red blood cell transfusion after percutaneous coronary intervention (PCI) and in-hospital adverse events*

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Event rates</th>
<th>Adjusted odds ratio (95% CI)†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composite of mortality, myocardial infarction, or stroke</td>
<td>17%</td>
<td>3.1%</td>
</tr>
<tr>
<td>In-hospital mortality</td>
<td>13%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>4.5%</td>
<td>1.8%</td>
</tr>
<tr>
<td>Stroke</td>
<td>2.0%</td>
<td>0.2%</td>
</tr>
</tbody>
</table>

* CI defined in Glossary.
† Adjusted for age, sex, race, body mass index, prior MI, prior coronary artery bypass graft or vascular surgery, cardiogenic shock, cardiac arrest, use of intracoronary balloon pump, prior congestive heart failure, peripheral vascular disease, cerebrovascular disease, tobacco use, chronic lung disease, diabetes, hyperlipidemia, family history, dialysis, glomerular filtration rate, New York Heart Association class IV congestive heart failure, location of lesion, PCI indication, PCI status, and hospital characteristics.
8 Rights of Transfusion Administration

1. Right Product (Is the appropriate product being utilized for the clinical presentation?)
2. Right Patient (2 patient identifiers)
3. Right Dose (Are 2 units ordered when 1 will do?)
4. Right Time (Completed within 4 hours of issue?)
5. Right Reason (What clinical sign in addition to a lab value supports the transfusion?)
6. Right Site (Patent IV and only Normal Saline given through the IV)
7. Right Documentation (MD documentation of appropriate indication/Consent/2 person verification/Vital Signs/Start/End Times)
8. Right Response (Based on the indication, did the transfusion have the desired clinical effect?)

Burns, C The Bloody Truth Blog May 2011
Analysis states “Most important study of 2013”

**Transfusion Strategies for Acute Upper Gastrointestinal Bleeding**

Candid Villanueva, M.D., Alan Colomo, M.D., Alba Bosch, M.D., Mar Concepcion, M.D., Virginia Hernandez-Gea, M.D., Carles Aracil, M.D., Isabel Graupera, M.D., Maria Poca, M.D., Cristina Alvarez-Urturi, M.D., Jordi Gordillo, M.D., Carlos Guarner-Argete, M.D., Miquel Santaló, M.D., Eduardo Muñiz, M.D., and Carlos Guarner, M.D.

**BACKGROUND**
The hemoglobin threshold for transfusion of red cells in patients with acute gastrointestinal bleeding is controversial. We compared the efficacy and safety of a restrictive transfusion strategy with those of a liberal transfusion strategy.

**METHODS**
We enrolled 921 patients with severe acute upper gastrointestinal bleeding and randomly assigned 461 of them to a restrictive strategy (transfusion when the hemoglobin level fell below 7 g per deciliter) and 460 to a liberal strategy (transfusion when the hemoglobin fell below 9 g per deciliter). Randomization was stratified according to the presence or absence of liver cirrhosis.

**RESULTS**
A total of 225 patients assigned to the restrictive strategy and 65 assigned to the liberal strategy (15% vs. 11%). The probability of survival at 6 weeks was 82% in the liberal-strategy group (95% vs. 85% confidence interval, 0.55; 95% confidence interval, 0.70; 95% CI, 0.26 to 1.25) and was significantly higher with the restrictive strategy in a subgroup of patients who had bleeding time 0.85, but not in those with cirrhosis at 1.04 (95% CI, 0.45 to 2.37). Within the first week increased significantly in patients assigned to the restrictive strategy.

**CONCLUSIONS**
As compared with a liberal transfusion strategy, a restrictive strategy significantly improved outcomes in patients with acute upper gastrointestinal bleeding. (Funded by the Fonds de la Recherche en Santé du Quebec.)

- **60% reduction** in Transfusion Exposure
- **45% reductions** in morality (4% absolute reduction)
- **40% reduction** in rate of re-bleeding
- **67% reduction** in emergent surgeries
- **17% reduction** in LOS (2 day absolute Reduction)
4 randomized trials failed to demonstrate significant differences in bleeding risks comparing prophylactic platelet transfusion triggers of 10,000 vs 20,000/uL. Consequently a platelet count of 10,000/uL is now recommended as a trigger for prophylactic platelet transfusions in patients w/ thrombocytopenia due to bone marrow disorders, chemotherapy or hematopoietic progenitor cell transplantation.
The degree of anticoagulation is expressed in multiples of the International Normalized Ratio (INR), with the usual therapeutic range defined as an INR of 2.0 to 3.0. The potential for hemorrhagic complications increases with warfarin therapy, especially with an INR ≥ 4.5.
• Substantial proportion of FFP transfused in non-bleeding patients, not supported by literature.
• Most common reason is an attempt to normalize an elevated Pre-Procedural INR.
• Multiple studies have noted an INABILITY of FFP to correct INR values ranging from 1.1 – 1.85
In the lab, we began using Yellow Top tubes for cultures & Gold Top minimal draw tubes for Chemistries. These can be stored for several hours and used for additional tests should they be ordered by another physician.

Reduces iatrogenic blood loss. Some hospitals draw up to 200-250mL per day!!

For hospitals using a Sysmex Analyzer, are you gathering MCV (80-100) Ret He (29.0-35.5pg) IRF (2.3 – 13.4%) IPF (1.1 – 7.1%) MCV (Mean Corpuscular Volume) – Ret He (Reticulocyte Hemoglobin) – IRF (Immature Reticulocyte Fraction) - IPF (Immature Platelet Fraction)
Tranexamic Acid (TA) is listed in the class of Recommendation as Level of Evidence 1A. Their highest rating. The impact of administration of TA in reducing the use of red blood cells and other blood products in cardiac surgery was 34%.

BMC Anesthesia 2006
Tranexamic Acid in Trauma

SPECIAL COMMENTARY

Should antifibrinolytics be given in all patients with trauma?

Marcel Levi

Purpose of review
Hemorrhage is the second most important cause of death in patients with trauma, contributing to approximately 30% of trauma-related mortality. Pharmacological prohemostatic agents may be useful adjunctive treatment options in patients with severe blood loss.

Recent findings
Transamin acid was evaluated in a large international randomized controlled study in patients with trauma and severe blood loss. The drug was shown to reduce death due to bleeding, provided the treatment was given within 3 h after injury. Tranexamic acid treatment did not result in serious adverse events nor thrombotic complications.

Summary
In view of this efficacy and safety of this relatively cheap and simple drug, it may be recommended to put tranexamic acid in the first (maybe even prehospital) line of management of patients with severe traumatic hemorrhage.

Keywords
antifibrinolytics, hemorrhage, prohemostatic drugs, tranexamic acid, trauma.

INTRODUCTION

Bleeding is a frequently occurring clinical problem. A substantial number of hospital admissions in medical wards is related to bleeding and perioperative bleeding is one of the most frequent complications of surgery [1]. Bleeding is of particular importance in trauma and is the second most important cause of death in trauma patients, contributing to approximately 30% of trauma-related mortality [2]. Trauma-related coagulopathy proceeds via a myriad of mechanisms, including loss of factors and platelets due to massive bleeding, acidosis and hypothermia further compromising the coagulation system, dysregulation of mediatory pathways, such as the activated protein C system and fibrinolysis, and systemic activation of thrombin generation [3].

Management of bleeding consists of local control measures to retain adequate circulation, and proper transfusion procedures [4]. In addition to these strategies, prohemostatic treatment may, in some cases, support the treatment of (severe) bleeding. Pharmacological agents that are capable of promoting hemostasis or fibrin formation, or can block fibrinolytic activity, may interfere in the balance between activation of coagulation and physiological anticoagulation. This strategy may be useful in the prevention and treatment of bleeding in patients with coagulation defects but also in patients with an unipolar normal coagulation system, who experience severe (postoperative) bleeding or are to undergo procedures known to be associated with major blood loss [5].

The safety of prohemostatic therapy also deserves some consideration. Interfering in the balance between coagulant and anticoagulant mechanisms can indeed result in undesirable adverse effects. The best illustration may be the higher risk of bleeding in patients receiving anticoagulant therapy. Conversely, prohemostatic agents may, at least theoretically, predispose for thrombotic complications. The occurrence of such complications are fortunately relatively rare. Obviously, the expected benefit of the application of prohemostatic agents

Crash 2 study involving over 20,000 patients indicated that the use of TA reduces probability of death by 34%. Received Crash 2 highest endorsement.

Lancet Vol. 376 July 2010 p.23-32

Additional 95 studies, including 7,838 patients, TA reduced probability of receiving a blood transfusion by 38%.

Curr Opin Anesthesiol 2012 25: 385-388
Other Tranexamic Acid Usage

129 trials, 10,488 patients, carried out from 1972-2011. TA reduced probability of receiving blood transfusion by 34%. Fewer deaths in TA group.

Brit Med Jour May 2012 344 e3054

Adequately Blinded Trials (69 trials – 5,968 patients) 37 % Transfusion Reduction
36 Orthopedic Trials
5 Gynecologic Trials
1 Vascular Trial

7 Cranial & Head /Neck trials
2 Hepatic & Urologic Trials

Crit Care 2011 15 (2) R 117

Conclusions Strong evidence that tranexamic acid reduces blood transfusion in surgery has been available for many years. Further trials on the effect of tranexamic acid on blood transfusion are unlikely to add useful new information. However, the effect of tranexamic acid on thromboembolic events and mortality remains uncertain. Surgical patients should be made aware of this evidence so that they can make an informed choice.
Our experience with thromboelastometry has reduced blood utilization significantly. Useful in trauma, cardiac and interventional radiology. Allows surgeons to determine clotting function prior to surgery. Blue top determines clotting profile up to 90% in 10 minutes. Saved $10K on first day of use.

Do not just purchase an instrument and pray it will be accepted. Be pro-active in making it an important decision making tool.
# Thromboelastrometry Outcomes in Cardiac Surgery

<table>
<thead>
<tr>
<th>Surgeon 1-</th>
<th>2011  39 cases, 38 Transfused 97.44%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2012  45 cases, 33 Transfused 73.33%</td>
</tr>
<tr>
<td></td>
<td>2013  49 cases, 10 Transfused 19.50%</td>
</tr>
<tr>
<td>Surgeon 2-</td>
<td>2011  40 cases, 29 Transfused 72.50%</td>
</tr>
<tr>
<td></td>
<td>2012  39 cases, 23 Transfused 58.97%</td>
</tr>
<tr>
<td></td>
<td>2013  36 cases, 12 Transfused 33.33%</td>
</tr>
<tr>
<td>Surgeon 3-</td>
<td>2011  25 cases, 25 Transfused 100%</td>
</tr>
<tr>
<td></td>
<td>2012  16 cases, 10 transfused 62.50%</td>
</tr>
<tr>
<td></td>
<td>2013  20 cases,  5 transfused  20%</td>
</tr>
</tbody>
</table>
ROTEM® Thromboelastometry System
A Basic Guide to Assays and Clinical Interpretation

ROTEM® Parameters

Normal TEMograms

ROTEM® Results in Clinically Significant Bleeding
Consider the effects on ROTEM® parameters: (CT, A10 (MCF) and ML):
- CT<sub>pr</sub> Prolonged
  - Suggests Heparin influence or intrinsic pathway factor deficiency
- CT<sub>Ex</sub> Prolonged
  - Suggests extrinsic pathway factor deficiency
- A10<sub>NLX</sub> Reduced
  - Suggests inadequate clot firmness as a result of decreased platelets, fibrinogen and/or FXIII
- MCF<sub>NLX</sub> Reduced
  - Suggests inadequate clot firmness as a result of decreased platelets, fibrinogen and/or FXIII
- MCF<sub>NB</sub> Reduced
  - Suggests inadequate fibrin contribution to clot firmness
- ML<sub>NLX</sub> > 15%
  - Suggests hyperfibrinolysis

Abnormal TEMograms (Demonstrating Coagulopathies)

U.S. Reference Ranges<sup>1</sup>

<table>
<thead>
<tr>
<th>Parameters</th>
<th>CT&lt;sub&gt;pr&lt;/sub&gt;</th>
<th>CFT</th>
<th>A&lt;sub&gt;10&lt;/sub&gt;</th>
<th>A&lt;sub&gt;20&lt;/sub&gt;</th>
<th>MCF&lt;sub&gt;NLX&lt;/sub&gt;</th>
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<tbody>
<tr>
<td>INTEM</td>
<td>122-208</td>
<td>45-110</td>
<td>60-80</td>
<td>51-72</td>
<td>57-72</td>
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<td>EXTEN</td>
<td>43-82</td>
<td>48-127</td>
<td>65-80</td>
<td>50-70</td>
<td>52-70</td>
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<td>PRTEM</td>
<td>7.2-4</td>
<td>Compare to INTEM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>APTEN</td>
<td>Compare to EXTEN</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Assays
INTEM – Intrinsic Pathway activation (F II, V, VIII, IX, X, XI, XII, Heparin)
EXTEN – Extrinsic Pathway activation (F II, V, VIII, X)
FIITEM – Fibrin activity/contribution to clot firmness (extrinsic activation, platelet neutralization)
HEPTEM – Confirms heparin effect (intrinsic activation, heparin neutralization)
APTEM – Confirmation of hyperfibrinolysis (extrinsic activation with antifibrinolytic agent)

Clinical Interpretation of ROTEM® Parameters<sup>3-5</sup>

Interpretation Note: This table is based on clinical practice. However, other clinicians may have different recommendations and interpretations. "MCF" stands for an erroneous product.
BADGE CARD - ROTEM ALGORITHM

- EXTEM A10 ≤ 48mm & FIBTEM A10 ≥ 10mm & MCF (Mean Clot Firmness)
- Fibtem A10 ≤ 10mm
- INTEM CT ≥ 240 Seconds and/or EXTEM CT ≥ 100 Seconds (Clotting Time)
- ML EXTEM ≥ 15%

- and/or Plt ≤ 100 x 10^9/L
- and/or Fibrinogen ≤ 1.5g/L
- PT/aPTT ≥ 1.5 x Normal
- FFP and/or PCC Profil 9 (Prothrombin Complex Concentrate)

- PLATELETS
- Cryoprecipitate

- TRANEXAMIC ACID (TXA)
22 yr old female, 25 weeks pregnant, Placental Abruption in DIC
67 yr old male, Hypercoagulable

**FIBTEM**

<table>
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<tr>
<th>RT: 01:00:19</th>
<th>ST: 2013-06-14T08:49:37</th>
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<tbody>
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<td>CT</td>
<td>59 s</td>
</tr>
<tr>
<td>CFT</td>
<td>52 s</td>
</tr>
<tr>
<td>α</td>
<td>80 mm</td>
</tr>
<tr>
<td>A10</td>
<td>43 mm</td>
</tr>
<tr>
<td>A20</td>
<td>47 mm [7 - 24]</td>
</tr>
<tr>
<td>MCF</td>
<td>49 mm [7 - 24]</td>
</tr>
<tr>
<td>ML</td>
<td>2 %</td>
</tr>
<tr>
<td>LI30</td>
<td>100 %</td>
</tr>
<tr>
<td>LI60</td>
<td>%</td>
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</table>

**EXTEM**

<table>
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<tbody>
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<td>59 s [43 - 82]</td>
</tr>
<tr>
<td>CFT</td>
<td>43 s [48 - 127]</td>
</tr>
<tr>
<td>α</td>
<td>82 mm [65 - 80]</td>
</tr>
<tr>
<td>A10</td>
<td>74 mm</td>
</tr>
<tr>
<td>A20</td>
<td>76 mm [50 - 70]</td>
</tr>
<tr>
<td>MCF</td>
<td>77 mm [52 - 70]</td>
</tr>
<tr>
<td>ML</td>
<td>2 %</td>
</tr>
<tr>
<td>LI30</td>
<td>99 %</td>
</tr>
<tr>
<td>LI60</td>
<td>%</td>
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**INTEM**

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<tbody>
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<tr>
<td>CFT</td>
<td>37 s [45 - 110]</td>
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<tr>
<td>α</td>
<td>83 mm [70 - 81]</td>
</tr>
<tr>
<td>A10</td>
<td>74 mm</td>
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<tr>
<td>A20</td>
<td>78 mm [51 - 72]</td>
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<td>ML</td>
<td>0 %</td>
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<tr>
<td>LI30</td>
<td>100 %</td>
</tr>
<tr>
<td>LI60</td>
<td>%</td>
</tr>
</tbody>
</table>
Recalled cardiac catheter causing massive bleeding
ROTEM showing full DIC
Massive Transfusion w/ ROTEM

With ROTEM, patient received fewer blood products than a 1:1:1 ratio.
Masimo Radical 7
Non Invasive Hemoglobin Monitoring

SpHb Monitoring Impact on Frequency of RBC Units Transfusions in Lower Blood Loss Surgery

- **Retrospective Cohort**: 4.6%
- **Standard Care Group**: 4.5%
- **SpHb Group**: 0.6%

*87% Relative Reduction*

Randomized controlled trial in 327 orthopedic surgery pts, 157-Standard Care & 170-SpHb

Ehrenfeld JM et al. ASA. 2010. LB05 (abstract). *p=0.03 vs. Standard Care Group;*
Non Invasive Hemoglobin Monitoring

SpHb Monitoring Impact on Frequency of ≥3 RBC Unit Transfusions in High Blood Loss Surgery

Prospective cohort study in 106 neurosurgery surgery pts, 61 Standard Care & 45 SpHb

*\( p < 0.01 \) vs. Standard Care Group

Awada W et al. STA. 2013 (abstract).
Del Sol Protocol for Masimo

Non - Invasive Hemoglobin Monitoring

Masimo

PURPOSE:
To define specific clinical situations or patients in which the use of Masimo Rainbow parameters are medically justified and clinically indicated. The non invasive characteristics of pulse oximetry, coupled with the addition of SpHb or SpMetHb, is of great clinical value because it eliminates the wait time involved with traditional invasive blood tests that are conducted by a central laboratory and reduces some of the unnecessary blood loss that patients endure due to diagnostic testing. Masimo technology is essential for Patient Blood Management in reducing unnecessary RBC transfusions and assisting clinical staff with earlier identification of bleeding.

POLICY:
The use of the Rainbow sensor will be limited to use in departments and clinical areas as defined in the policy. Rainbow sensors should only be used when indications defined in this policy and procedures are present. For patient’s on High Dose Pressors, Non Invasive Hemoglobin sensors will probably not be reliable. Please use Sp02 sensors on these patient’s.

EQUIPMENT:
Masimo Radical 7 Pulse CoOximeter and Masimo Rainbow Sensor

INDICATIONS FOR USE:
• GI Bleeding
• Trauma – MTA and Level 1 (Fluid resuscitation with hemoglobin of 8 or less)
• First 48 hours post cardiac surgery
• Antepartum/Postpartum Hemorrhage
• Patients requiring resuscitation with Hgb of 8 or less
• First 48 hours of Septic patient’s in the ICU
• Anemia with 7 grams of hemoglobin or less
• Perioperative based Anesthesia/Surgeon recommendation
471 Hemoglobin Measurements from 62 ICU Surgical Patients Changes in 3 Hb Methods vs changes in reference Hb (Central Lab Hematology Analyzer Sysmex XT 2000i)

Cell salvage as part of a blood conservation strategy in anaesthesia

A. Ashworth and A. A. Klein*
Department of Anaesthesia and Critical Care, Papworth Hospital, Papworth Everard, Cambridge CB23 3RE, UK
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Key points
- Cell salvage reduces the requirement for allogenic blood transfusion.
- It should be considered for surgery with an anticipated blood loss of >1000 ml.
- It can be used in cancer surgery, but a leucocyte depletion filter is recommended.
- Evidence from cardiac and orthopaedic surgery is reasonable but is limited for other surgery.
- There is still a need for large prospective randomized controlled trials.

Summary. 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: blood transfusion; care, intraoperative; surgery
Intraoperative Blood Salvage in Penetrating Abdominal Trauma: a Randomised, Controlled Trial

Douglas M. Bowley, Philip Barker, Kenneth D. Boffard

Abstract

Background: Blood is a scarce and costly resource. Transfusion is often required after major trauma but blood may not be readily available, and concerns remain over the potential adverse consequences of allogeneic blood transfusion. Intraoperative blood salvage (IBS) is used

Transfusions reduced from 11.17 units for the control arm to 6.47 in the cell salvage group. Patients were no more likely to become septic in the cell salvage than were those in the control group. Cell salvage significantly reduced allogeneic blood usage with no discernible effect on rates of postoperative infection or mortality.
Las Palmas Del Sol Medical Center
Adult Inpatient Anemia Management Guidelines

IRON DEFICIENCY ANEMIA

- Obtain Comprehensive Retic Order Set (MCV, Ret He, IRF)** Iron, Ferritin, TIBC, Creatinine, B-12 Level, % Saturation
- Hgb less than 8 g/dL, TSat less than 20% (or Ret He less than 28 pg)
- Venofer 200mg IV every 48 hours x 5 doses. Mix in 50mL Sodium Chloride 0.9% (infuse over 30 minutes)
  - Recommended for Ferritin less than 100-400ng/mL AND Ret He (Retic Hemoglobin) equal to or less than 28pg & IRF (Immature Retic Fraction) greater than 2.3%
- Hgb 8-9g/dL, Tsat less than 20% (or Ret He less than 28 pg)
- Venofer 200mg IV every 48 hours x 3 doses. Mix in 50mL Sodium Chloride 0.9% (infuse over 30 minutes)
  - Recommended for Ferritin less than 100ng/mL AND Ret He (Retic Hemoglobin) equal to or less than 28pg & IRF (Immature Retic Fraction) greater than 2.3%
- Hgb 9.1-10g/dL, Tsat less than 15% (or Ret He less than 26 pg)
- Venofer 200mg every 48 hours x 2 Doses. Mix in 50mL Sodium Chloride 0.9% (infuse over 30 minutes)
  - Recommended for Ferritin less than 100-400ng/mL AND Ret He (Retic Hemoglobin) equal to or less than 28pg & IRF (Immature Retic Fraction) greater than 2.3%

***Total dose iron replacement is not an inpatient therapy. Consider outpatient treatment for a Hgb greater than 10g/dL or if iron replacement is not completed.

Cyanocobalamin (vitamin B-12) 1mg IM daily x 7 Doses [ ] Vitamin B-12 1mg PO Daily x 7 doses (B-12 levels less than 200pg/mL)

- Hgb target = 11g/dL. No reimbursement above 12g d/L
- Pharmacy protocol to call MD if goal reached and Procrit not discontinued
- Previous treatment with oral or IV iron, ESA [ ] NO / [ ] YES
- Does the patient refuse transfusions? [ ] NO / [ ] YES
  - [ ] YES Patient is a Jehovah’s Witness

- Erythropoietin PROCRIT 40,000 Units SQ for one dose (Hemoglobin between 9-10)
  - (Refer to the Outpatient Anemia Center for continued treatment)
Options for those refusing transfusion for religious/personal reasons
NIH has recognized anemia as a national crisis. Many who present for surgery and/or medical treatment are, by WHO guidelines (H&H 13-39), anemic. Examples:

- Orthopedic 30-60%
- Pregnant/Post Partum 20-60%
- Bariatric 25-50%
- Irritable Bowel Syndrome 25-45%
- Congestive Heart Failure & Heart Failure 45-75%

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Center for Anemia Management - Benefits

• Patients treated in the outpatient setting
• Increased patient satisfaction
• Reduces transfusion exposure
• Reduces re-admissions
• Insurance re-imbursement
• Pays for itself

• (Exclusion; Oncology patients)
Hemodilution Protocol

**Work Sheet**

*For Surgical cases with EBL ≥ 1,000 OR For those refusing transfusion*

- **HEMODILUTION START TIME** __________
- **Previous Surgery;** ______________________
- **Weight;** __________
- **Previous Injury;** ______________________
- **Hematocrit;** __________
- **Creatine;** ______________________
- **Renal failure;** __________
- **Hypertension;** __________
- **Diabetes;** __________
- **Plavix** On ___ DC when? ______
- **Coumidin** On ___ DC when? ______
- **Reapro** On ___ DC when? ______
- **Integrilin** On ___ DC when? ______

- **REPLACEMENT FLUID** _______________________ Amount _________ mL
- **Replacement Colloid if necessary** ___________ Amount _________ mL
- **Comments** ____________________________________________________________

**Calculation Sheet/Formula for Hemodilution**

\[
\text{Patient Weight (Kg)} \times 50 \text{ Female} = \text{Est. Blood Volume (EBV)}
\]

\[
\text{Starting HCT} \times \text{HCT % Sequestered} = \text{EBV} \div 450\text{mL} = \text{mL Blood withdrawn}
\]

\[
\text{EBV} \times \text{HCT Sequestered} \div \text{average Starting HCT- Target HCT} = \text{Units of blood withdrawn}
\]

Formula: Am J. Anesthesiology Jan/Feb 1996 p. 25
A Multimodal Approach for the Reduction of Allogeneic Blood Products Following Coronary Artery Bypass Grafting Utilizing Transcollation™ Technology

Shankha Biswas, MD; Bradford Ray, NRABT

Introduction
Exposure to allogeneic blood in cardiac surgery is a major concern. Despite advances in perioperative blood management, allogeneic blood transfusions continue to remain high. The risk of transfusion after coronary artery bypass grafting (CABG) varies between 10 to 70%, with a direct correlation between patient mortality after CABG and transfusions. It has been suggested that patients receiving transfusions are at a four times greater risk of death within 100 days of surgery. Transfusions have been linked to an increased prevalence of infection, which in turn increases the likelihood of pulmonary dysfunction and mortality.

Conventional intraoperative hemostatic techniques include electrocautery and topical sealants. In an effort to improve hemostasis and patient outcomes, Salient Surgical Technologies (Portsmouth, NH) has created Transcollation technology, which simultaneously integrates radiofrequency (RF) energy and saline allowing thermal energy to reach targeted tissues. The saline cools the energy delivered such that it mechanically seals vessels and tissue planes compared to conventional electrocautery, which create an eschar coagulum plug.

Salient Surgical Technologies (Portsmouth, NH) has developed surgical tools that employ Transcollation technology, a process that combines radiofrequency (RF) energy and saline to achieve hemostasis in soft tissue and bone. The saline couples the energy and maintains surface temperatures at or below 100°C to mechanically seal vessels and tissue planes, unlike conventional electrocautery which creates an eschar coagulum plug.

We hypothesized that a blood conservation program which incorporates retrograde autologous prime (RAP), modified ultrafiltration, and Transcollation technology could significantly reduce our patients’ exposure to allogeneic blood products following CABG.

Methods
A comprehensive multimodal blood conservation program was established. This included RAP, modified ultrafiltration, and Transcollation technology. The retrospective study design consisted of 69 consecutive patients divided into 34 control patients and 35 experimental patients. The experimental group included the use of Transcollation technology to paint the surface of the chest wall after IMA harvesting, as well as RAP and modified ultrafiltration.

Results
Analysis of demographic variables revealed similarity among the groups with the exception of distribution of gender, preoperative hemoglobin levels (Hgb) and ASA scores. We observed a 46% reduction in the prevalence of exposure to allogeneic blood products in the treatment group (p = 0.014) [Fig. 2] and a 47% reduction in the prevalence of allogeneic blood transfusions (p = 0.014). This translated to a 62% reduction in red blood cell (RBC) exposure (p = 0.005), an 88% reduction in platelet (Pit) exposure (p = 0.0001) and a 86% reduction in fresh frozen plasma (FFP) exposure (p = 0.0001). Overall there was a 76% reduction in the average number of units transfused (p = 0.0001) [Fig. 3]. Additionally, a 36% reduction in chest drainage was observed (p = 0.02). Of significant note, was the 48% reduction in intensive care unit (ICU) stay, which translated to an average of 2 less days (p = 0.0001) [Fig. 4].

Conclusions
The use of Transcollation technology coupled with RAP and modified ultrafiltration significantly reduces postoperative allogenic blood transfusion following CABG. This may improve patient outcomes and reduce costs associated with patients undergoing CABG.
IMPROVED PATIENT OUTCOMES

- Optimizing Coagulation
- Interdisciplinary Blood Conservation Modalities
- Patient-Centered Decision Making
- Managing Anemia

SABM©2013
Fiscal 2010
447,000 patient days
$12.99 per APD (Adjusted Patient Day)

Fiscal Year 2014
502,000 Patient Days
$6.99 APD

50% decrease in patient cost per day
55,000 additional patient days for 2014
Thank you for your time and attention!

Questions?