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# Best practice in blood transfusion management in cardiac surgery

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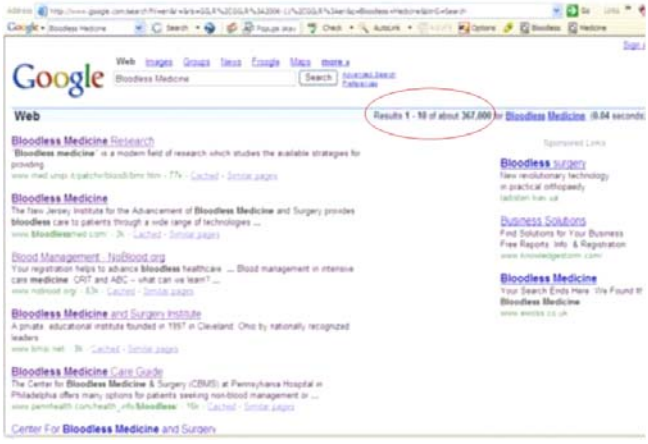
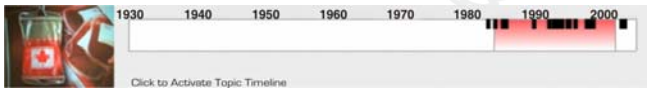
## OBJECTIVES

- To describe the paradigm shift in blood management
- To present the perioperative multimodalities strategies in reducing or eliminating allogeneic blood transfusion in cardiac surgery



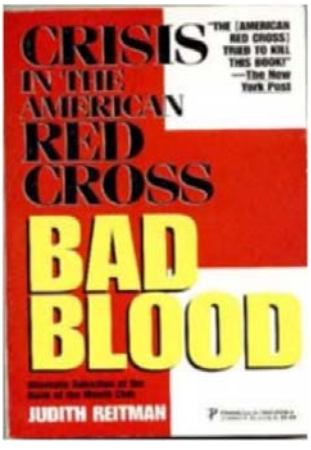

The Krever Report: Canada's Tainted Blood Disaster



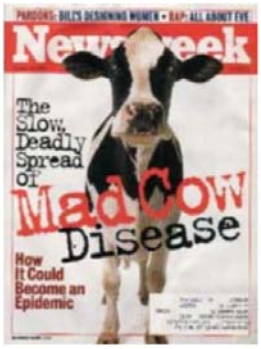

A new disease was threatening the Canadian blood supply in the early 1980's: AIDS, But the Canadian Red Cross was slow to introduce donor screening methods and even slower to test the blood. With the Krever Commission, those infected by the AIDS virus and hepatitis C found a compassionate ear and the answers they sought about who was to blame for this public health scandal.

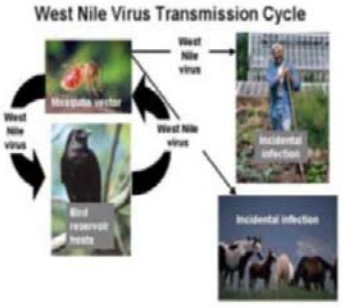
Canadian Broadcasting Corporation Archives
http://archives.cbc.ca

## RISKS OF BLOOD TRANSFUSION

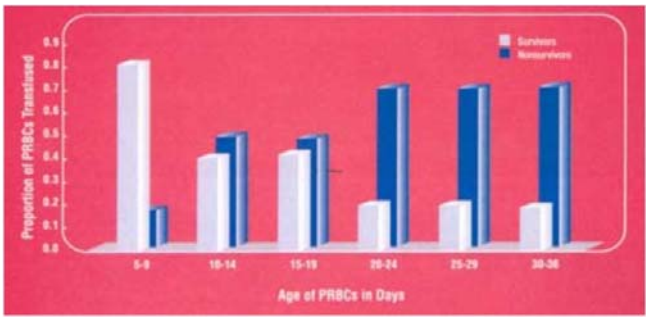



## RISKS OF BLOOD TRANSFUSION INFECTIOUS COMPLICATIONS




## AGE OF PRBC UNITS TRANSFUSED IS ASSOCIATED WITH MORTALITY




Purdy FR, et al. Can J Anaesth 1997;44:1256-61.

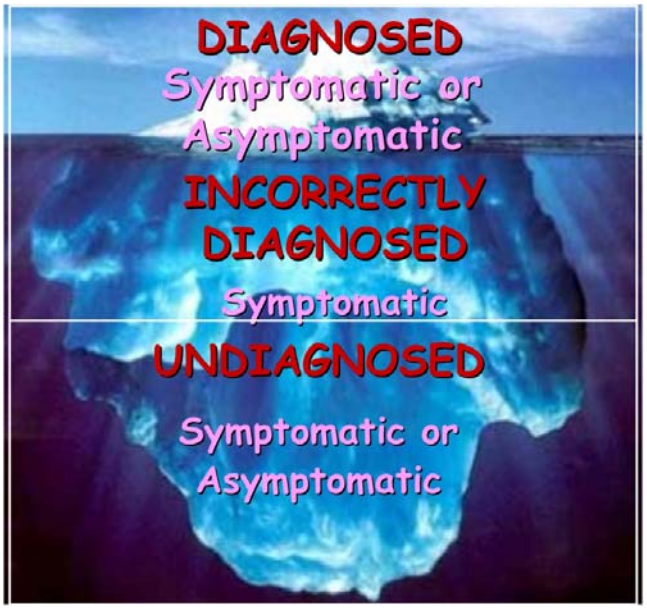
## RISKS: ALLOGENEIC TRANSFUSION

Transfusion risks Post-transfusion reaction

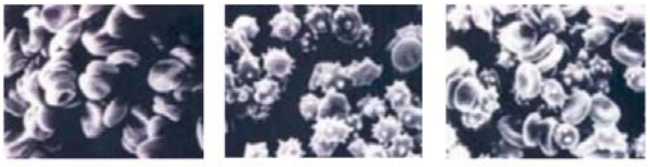
| | | | |
|---|---|---|---|
| HIV | < 1:1,900,000 | Hemolysis | 1:700,000 |
| HCV | 1:1,800,000 | Bacterial | 1:300,000 |
| HBV | 1:250,000 | TRALI (deaths) | 1:500,000 |
| HTLV-I&II | 1:2,000,000 | Nonbac infection | 1:600,000 |
| West Nile Virus | 1:1,200 to 1:30,000 | GvHD | 1:800,000 |
| CMV | 1:7,500 | Mistransfusion | 1:19,000 |
| Malaria | 1:5,000,000 | TRALI (incidences) | 1:5,000 |
| Babesiosis | 1:5,000,000 | Febrile reaction | 1:200 |
| Chagas | 1:300,000 | Post-transfusion purpura | |
| 1:200,000 | | | |
| Bacteria RBC | 1:1.6 x 105 | | |
| Bacteria Platelet | 1:12,000 to 1:60,000 | | |

Physician's guide 2001: Informed consent for blood and blood products
British Columbia Provincial blood coordinating office

## TRANSFUSION HAZARDS




## RBCS CHANGE SHAPE DURING STORAGE




- Scanning electron micrographs of RBCs 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 (RBCs with multiple regular spiny projections)[2]

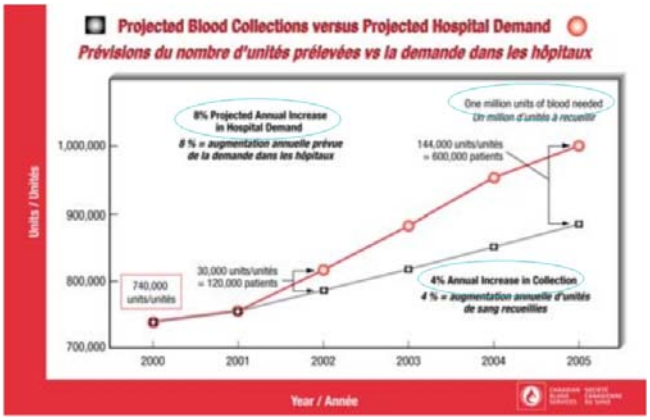
## CURRENT BLOOD SUPPLY IS THE SAFEST EVER IN TRANSFUSION HISTORY

There will NEVER be zero risk

## PROJECTED BLOOD COLLECTIONS *VERSUS* PROJECTED HOSPITAL DEMAND

Prévisions du nombre d'unités prélevées *vs* la demande dans le höpitaux

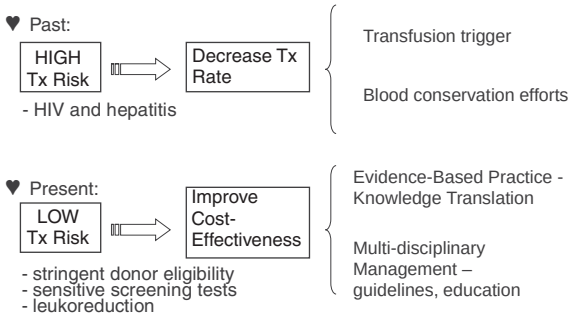
1. Hovav T, Yedgar S, Manny N, Barshtein G. Transfusion. 1999;39:277-281.
2. Taber's Cyclopedic Medical Dictionary, 18th Edition




| Item | Price |
|---|---|
| Red blood cells | $ 400 |
| Autologous (whole) blood | $ 400 |
| Erythropoietin 40,000 IU/week for 4 weeks | $ 2,280† |
| Erythropoietin 1,000 Il | $ 14.25† |
| 5 units platelets | $ 500 |
| 4 units buffy coat derive platelets | $500 |
| 1 units single donor (apheresis) platelets | $500 |
| 1 unit HLA-matched single donor (apheresis) platelets | $1,250 |
| Apheresis fresh frozen plasma | $220 |
| 4 units frozen plasma | $700 |
| 8 units cryoprcipitate | $500 |
| Aprotinin 3 million units | $500 |
| Tranexamic add 6 g | $150 |
| IVIG per gram | $75 |
| Albumin 5% 500 ml | $100 |
| Pentaspan® per 500 m | $ 70 |
| Hexten® 500 ml | $60 |
| CMV anigen-negative, additional cost per unit | $20 |
| Irradiation per unit | $25 |
| Blood group (ABO, RhD) | $10 |
| Antibody screen | $25 |
| Crossmatch (no antibody) | $15 |
| Crossmatch (antibody positive patient) | $45 |

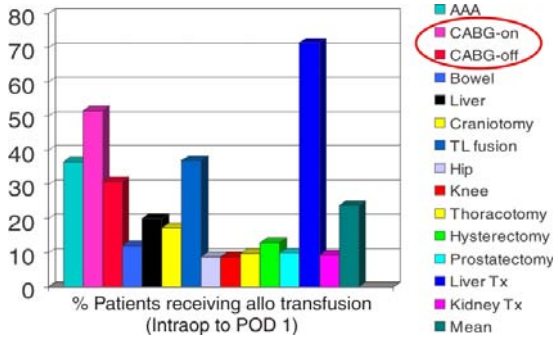
Callum JL, Pinkerton PH. Blood transfusions, blood alternatives & transfusion reactions. 2nd Ed. 2005
Sponsored by Ontario Ministry of Health, Health Canada, Canadian Blood Services

## PARADIGM SHIFT IN EVIDENCE-BASED BLOOD MANAGEMENT



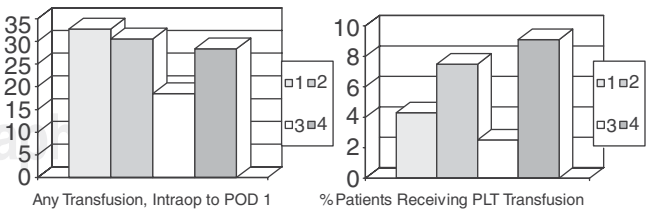


## CANADIAN UTILIZATION STUDY ALLOGENEIC RBC BY PROCEDURE



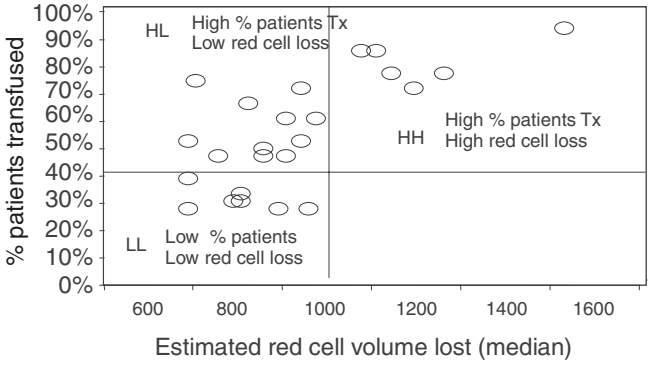

Cheng, Karkouti, Belisle, Giffin, Martin. CJA 2006

## CANADIAN UTILIZATION STUDY: % PATIENTS TX BY INSTITUTIONS




Cheng, Karkouti, Belisle, Giffin, Martin. CJA 2006

## IMPORTANCE OF INSTITUTIONAL PRACTICE AFFECTING THE INCIDENCE OF TRANSFUSION




Stover. Anesthesiology 1998;88:327-333

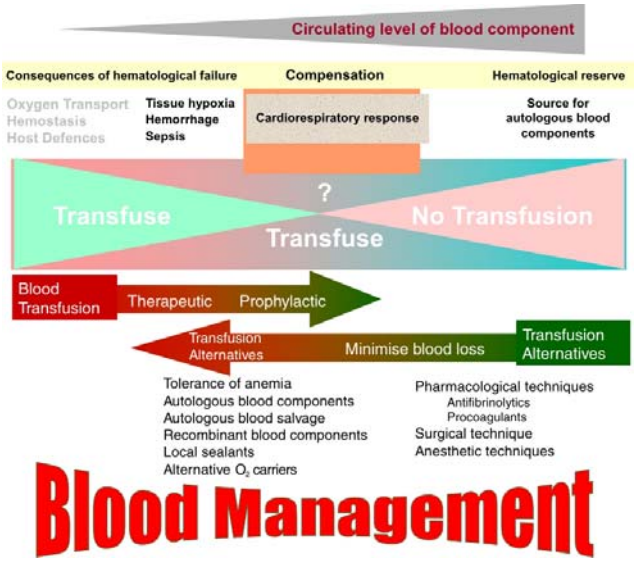
## 2/3 OF ALL RBC TRANSFUSIONS ARE GIVEN PERIOPERATIVELY

## BLOODLESS SURGERY


Ott DA, Cooley DA. Cardiovascular surgery in Jehovah's Witnesses. Report of 542 operations without blood transfusion. JAMA. 1977;238:1256-8.

Jehovah's witnesses who require operation represent a challenge to the physician because of the patients' refusal to accept blood transfusion. We report a 20-year experience with a consecutive series of 542 Jehovah's witness patients ranging inage from 1 day to 89 years who underwent operation. Early mortality (within 30 days after operation) was 9.4%. In 362 patients requiring temporary cardiopulmonary bypass, early mortality was 10.7%. Mortality was 13.5% among 126 patients who had single-or double-valve replacement. The only deaths among patients who had aortic valve replacement or repair of a ventricular septal defect occurred in those who had some serious complication before operation. Preoperative or postoperative anemia was a contributing factor in 12 deaths, and loss of blood was the direct cause of three deaths. Cardiovascular operations can be performed safely without blood transfusion.

## CIRCULATING LEVEL OF BLOOD COMPONENT




## BLOODLESS SURGERY: PERIOP BLOOD MANAGEMENT MODALITIES

Preoperative
- ↑ RBC (erythropoietin, Fe, folate)
- Autologous donation (PAD)
- Anti-PLT agents

Intraoperative
- Pharmacology: Antifibrinolytics
- Anesthesia & Surgical techniques

- Acute normovolemic hemodilution

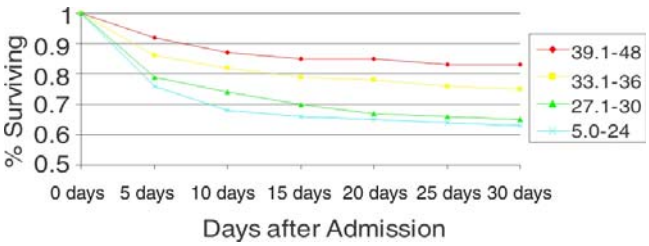
↓ transfusion triggers
- Shed blood salvage
- Oxygen carriers

Postoperative
- ↓ transfusion triggers
- ↑ RBC
- Shed blood salvage

Cheng D. Can J Anesth 2001;48: S41- S48

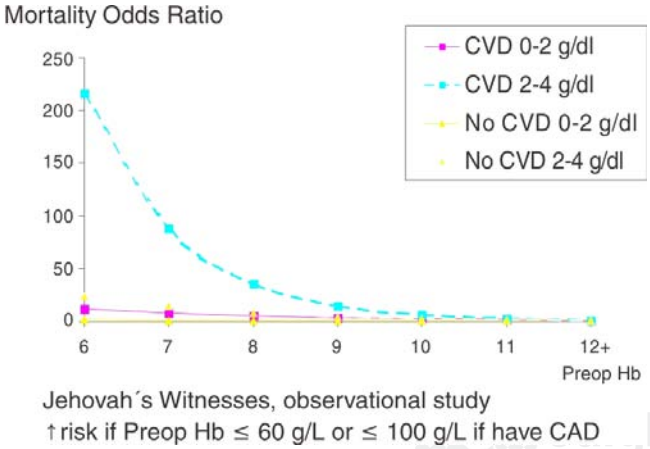
## ANEMIA: LOWER HB ASSOCIATED WITH HIGHER MORTALITY FOLLOWING AMI

- Study of 78,974 patients over 65 yrs old admitted with acute MI
- Lower Admission Hct ≥ higher 30-day mortality and longer hospitalization




Wu, W-C et al. NEJM, 345(17), Oct 25, 2001, 1230-36

## SAFE LEVEL OF ANEMIA IN SURGICAL PATIENTS?




Jehovah's witnesses, observational study '‡risk if Preop Hb d•60 g/l or d•100 g/l if have CAD
Carson. Lancet 1996;348:1055

## PREOP ANEMIA IN CARDIAC PATIENTS

| Diagnosis | Patients |
|---|---|
| • Hospital acquired | 37.3% |
| • Iron deficiency | 29.3% |
| • Renal failure | 10.7% |
| • Chronic disease | 8.0% |
| • Folate deficiency | 4.0% |
| • Thalassemia | 1.3% |
| • No diagnosis | 9.3% |

Karski J, Cheng D, et al. Can J Anesth 1999; 46: 979-82

## ↑ RBC: FE, FOLATE

Advantages:
- Mainstay of treating iron-deficiency anemia

Disadvantages:
- Response to treatment is slow and must be started early - poor GI tract absorption

Spence RK. 28th ISBT, August 26-30, 2000
- In cases of on-going iron losses, oral iron does not provide enough iron to correct the iron deficient erythropoiesis, and intravenous iron should be considered

Goodnough LT. Alter in Trans Med 2:January 2000

## ↑ RBC: ERYTHROPOIETIN

↑ reticulocyte count, Hb levels
↓ allogeneic blood transfusion
Stowell. Orthopedics 1999;22:S110
Faris. J of Bone and Joint Surg 1996:78.
DeAndrade. Orthopedics 1996; 22: 534 - 542

Advantages:
- Once-weekly dose
- Measurable hemoglobin response 100–130 g/L
- Adjunct to PAD programs

Disadvantages:
- Must maintain oral iron and weekly monitoring
- Cost - $1100 - 2200 per pt
- Safety / efficacy not been established in pts with hx of seizure disorder or hematologic disease

## PREOPERATIVE AUTOLOGOUS DONATION (PAD)

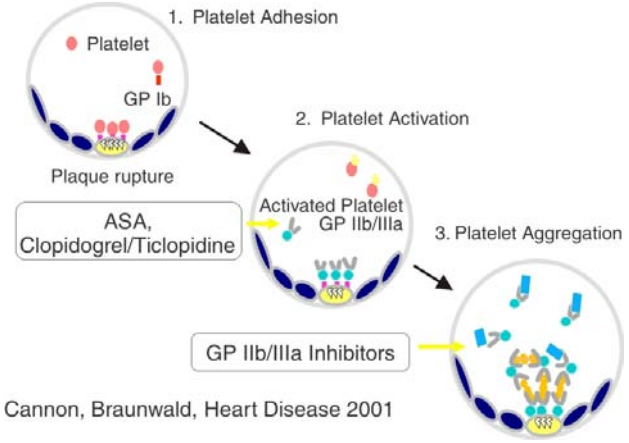
- 2-3 units of blood collected before surgery
- Benefits:
  — ↓ allogeneic transfusion rate
  — No risk of viral transmission
- Risks:

— ↑ overall transfusion rate and concomitant risks
— ↑ wastage: postoperative anemia, costs
— Risks of donation

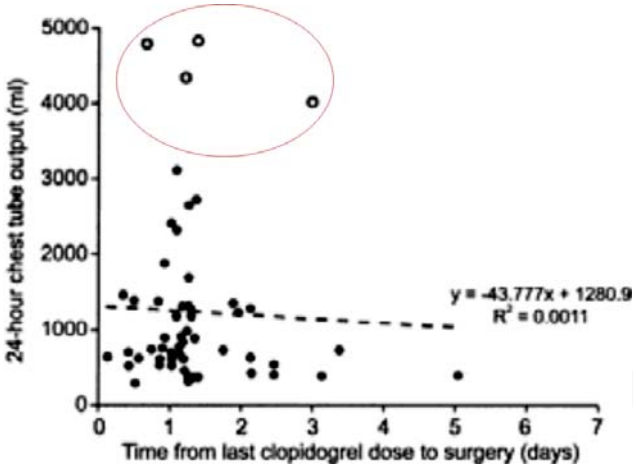
## COST EFFECTIVENESS OF PREOPERATIVE AUTOLOGOUS DONATION (PAD)

| Variable | Total Hip Replacement | Coronary -Artery Bypass Grafting | Abdominal Hysterec-tomy | Transurethral Prostatec-tomy |
|---|---|---|---|---|
| Mean age of patient (yr) | 62 | 67 | 49 | 68 |
| Added cost per unit transfused ($) | 68 | 107 | 594 | 4,783 |
| Incremental effectiveness per unit transfused (QALY) | 0.00029 | 0.00022 | 0.00044 | 0.00020 |
| Cost effectiveness ($/QALY) | 235,000 | 494,000 | 1,358,000 | 23,643,000 |

Etchason. New Eng J Med 1995; 332: 719

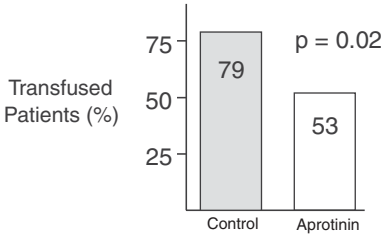



## 24-HOUR POSTOP CHEST TUBE OUTPUT AND CLOPIDOGREL-FREE INTERVAL BEFORE CABG SURGERY




Open circles =clopidogrel-pretreated pts underwent reoperation for bleeding
Solid circles = clopidogrel-pretreated pts no reoperation for bleeding
Hongo RH, et al. J Am Coll Cardiol 2002;40:231-7

## APROTININ IN CABG PATIENTS ON CLOPIDOGREL (PLAVIX)




van der Linden J et al. Circulation 2005;112:I-276–I-280

## SURGERY FOR THE PATIENT RECEIVING ANTI-PLATELET DRUGS: BLOOD MANAGEMENT STRATEGIES-1

- Stop drug administration
- Delay operation, if safe:
  — Aspirin & Plavix: 3-5 days
  — Integrilin & Aggrastat: 2-4 hours
  — ReoPro: 12-24 hours
- However, do not delay emergency CABG when it is otherwise indicated
- Aprotinin

## SURGERY FOR THE PATIENT RECEIVING ANTI-PLATELET DRUGS: BLOOD MANAGEMENT STRATEGIES - 2

- Use mammary artery if initial bleeding not too excessive
- Use full loading and maintenance heparin doses for CPB
- Maintain standard ACT's for CPB
- If excessive bleeding is present, transfuse platelets after protamine to reverse effect of drug

## PERIOPERATIVE PHLEBOTOMY

| ml/day | |
|---|---|
| 61-70 | Corwin et al. 1995 |
| 41 | von Ahsen et al. 1999 |
| 41.1 (39.7) | Vincent et al. 2002 |
| If arterial lines | |
| 73.9 *vs* 33.5 ml/d | Smoller et al. 1986 |
| 44% more drawn | Low et al. 1995 |

## PERIOP BLOOD MANAGEMENT MODALITIES

Preoperative
- ↑ RBC (erythropoietin, Fe, folate)
- — Autologous donation (PAD)
- — Anti-PLT agents

Intraoperative
- — Pharmacology: Antifibrinolytics
- — Anesthesia & Surgical techniques
- — Acute Normovolemic Hemodilution
- ↓ transfusion triggers
- — Shed blood salvage
- — Oxygen carriers

Postoperative
- ↓ transfusion triggers
- ↑ RBC
- — Shed blood salvage

Cheng D. Can J Anesth 2001; 48 (4): S41- S48

## TREATMENTS TO AVOID INTRAOP ANEMIA

| Therapeutic Control of Hemostasis | Therapeutic $O_2$ Delivery | Therapeutic Acceleration of Hematopoiesis |
|---|---|---|
| Minimize excess bleeding | Deliver $O_2$ to tissues | To replenish RBCs |
| Trasylol®<br>Amicar®<br>Cyklokapron®<br>DDAVP® | Oxygen Therapeutics | Procrit®<br>Epogen® |

## PROPHYLACTIC ANTI-FIBRINOLYTICS IN CARDIAC SURGERY: META-ANALYSIS

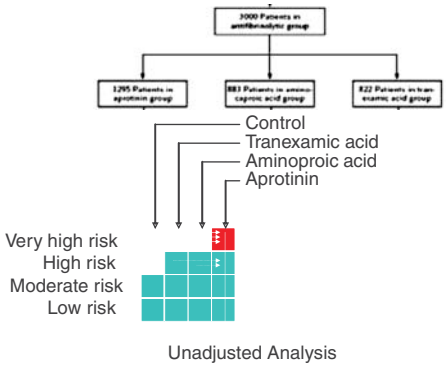
Outcomes: Chest tube blood loss, transfusion, re-exploration, perioperative mortality

Efficacy: Aprotinin = Tranexamic Acid ‘•DDAVP

Cost: $600-$980 $50-$200

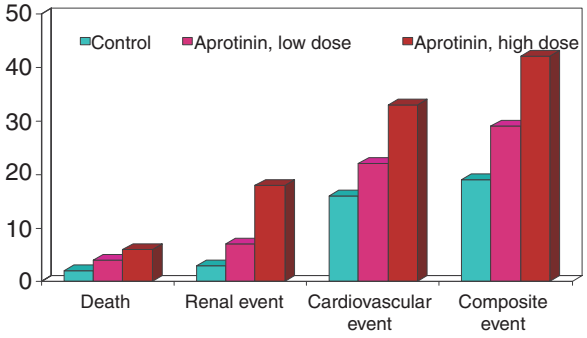
Fremes et al. Ann Thorac Surg 58:1580, 1994
Laupacis et al. Anesth Analg 85:1258, 1997

## MANGANO DT, ET AL. NEJM 2006;354:353-365.




Unadjusted Analysis

## APROTININ DOSE RESPONSE




Mangano DT, et al. NEJM 2006;354:353-365.

## COMPARISON OF OUTCOMES IN THE MATCHED GROUP

| Variables | Group Aprotinin (n = 449) Number | Pro-portion | Tranexamic acid (n = 449) Number | Pro-portion | Comparisons (p value) |
|---|---|---|---|---|---|
| Received at least 1 RBC unit | 354 | 0.79 | 342 | 0.76 | 0.3 |
| Received at least 5 RBC units | 157 | 0.35 | 135 | 0.30 | 0.1 |
| Received at least 10 RBC units | 60 | 0.13 | 46 | 0.10 | 0.2 |
| Received at least 5 PLT units | 252 | 0.56 | 223 | 0.50 | 0.06 |
| Received at least 1 FFP unit | 296 | 0.66 | 275 | 0.61 | 0.1 |
| Surgical reexploration | 59 | 0.13 | 51 | 0.11 | 0.4 |
| Myocardial infarction | 12 | 0.03 | 10 | 0.02 | 0.7 |
| Stroke | 15 | 0.03 | 13 | 0.03 | 0.7 |
| Renal dysfunction | 107 | 0.24 | 75 | 0.17 | 0.01 |
| Renal failure | 25 | 0.056 | 14 | 0.031 | 0.08 |
| Serious infection | 21 | 0.05 | 21 | 0.05 | 1.0 |
| Death | 30 | 0.07 | 33 | 0.07 | 0.7 |
| | Median | 25th, 75th percentiles | Median | 25th, 75th percentiles | |
| Duration of stay in the intensive care unit (days) | 2 | 1.4 | 2 | 1.4 | 0.4 |
| Duration of postoperative hospitalization (days) | 8 | 6.13 | 8 | 6.12 | 0.3 |

Karkouti K et al. Transfusion 2006

U.S. Food and Drug Administration

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**FDA Statement**

FOR IMMEDIATE RELEASE
Statement
September 29, 2006

Media Inquiries:
Susan Bro, 301/827-3259
Susan.bro@fda.hhs.gov
Consumer Inquiries:
888-INFO-FDA

**FDA Statement Regarding New Trasylol Data**

Since January, 2006, the Food and Drug Administration (FDA) has been conducting a safety review of Trasylol (aprotinin injection). The review was triggered by the results of two published research studies: one that reported an increase in the chance of kidney failure, heart attack and stroke in patients treated with Trasylol compared to those treated with other similar drugs, and the other that reported an increase in kidney dysfunction compared to another drug. On September 21, 2006, FDA held a public meeting of the Cardiovascular and Renal Drugs Advisory Committee to discuss the safety and overall risk-benefit profile for Trasylol. At that meeting, the committee discussed the findings from the two published observational studies, the Bayer worldwide safety review, and the FDA review of its own post-marketing database.

On September 27, 2006, Bayer Pharmaceuticals told FDA that it had conducted an additional safety study of Trasylol. The preliminary findings from this new observational study of patients from a hospital database reported that use of Trasylol may increase the chance for death, serious kidney damage, congestive heart failure and strokes. FDA was not aware of these new data when it held the September 21, 2006, Advisory Committee meeting on Trasylol safety. FDA is actively evaluating these new data and their implications for appropriate use of the drug.

While FDA conducts its evaluation of this new safety study, we recommend the following to healthcare providers:

- Physicians who use Trasylol should carefully monitor patients for the occurrence of toxicity, particularly to the kidneys, heart, or brain, and promptly report observed adverse event information to Bayer Pharmaceuticals, the drug manufacturer, or to the FDA MedWatch program, by phone (1-800-FDA-1088), by fax (1-800-FDA-0178), or by the Internet at http://www.fda.gov/medwatch/index.html.
- Physicians should consider limiting Trasylol use to those situations where the clinical benefit of reduced blood loss is essential to medical management of the patient and outweighs the potential risks.

**FDA Alert [12/2006]**

**NOTE: The full prescribing information (labeling) for Trasylol was updated on December 15, 2006 to include important new safety information as mentioned below.**

**This Alert highlights important revisions to the full prescribing information for Trasylol. The new labeling for Trasylol (December 2006) has a more focused indication for use, a new Warning about renal dysfunction, a revised Warning about anaphylactic reactions, and a new Contraindication. Trasylol is now indicated only for prophylactic use to reduce peri-operative blood loss and the need for blood transfusion in patients who are at an increased risk for blood loss and blood transfusion undergoing cardiopulmonary bypass in the course of coronary artery bypass grafting (CABG) surgery. Trasylol should be administered only in the operative setting where cardiopulmonary bypass can be started quickly. Trasylol should not be administered to any patient with a known or suspected exposure to aprotinin within the past 12 months. FDA is evaluating additional recently submitted epidemiological safety study data (discussed below), in the context of all other safety and efficacy information available on aprotinin. This review may result in other actions, including additional changes to the full prescribing information (product labeling).**

*This information reflects FDA's preliminary analysis of data concerning this drug. FDA is considering, but has not reached a final conclusion about, this information. FDA intends to update this sheet when additional information or analyses become available.*

**The new labeling for Trasylol has a more focused indication, a new Warning about renal dysfunction, a revised Warning about anaphylactic reactions, and a new Contraindication.** The new labeling changes are summarized here:

**Indication and Usage—more limited and focused**
Trasylol is now indicated for use only in patients *who are at increased risk for blood loss and blood transfusion* in association with cardiopulmonary bypass in the course of coronary artery bypass grafting. It should be administered only in the operative setting where cardiopulmonary bypass can be rapidly initiated.

**A new Warning about renal dysfunction**
Trasylol administration increases the risk for renal dysfunction and may increase the need for dialysis in the perioperative period.

**Stronger Warnings about anaphylactic reactions including a new Contraindication for previous aprotinin exposure**
Anaphylactic reactions, including fatal reactions, are one of the important risks associated with Trasylol administration. As a consequence of the higher risk for anaphylactic reactions, administration of Trasylol to patients with a known or suspected exposure during the past 12 months is contraindicated.

**Mortality Associated With Aprotinin During 5 Years Following Coronary Artery Bypass Graft Surgery**

Dennis T. Mangano, PhD, MD
Yinghui Miao, MD, MPH
Alain Vuylsteke, MD
Julia C. Tudor, PhD
Rajiv Juneja, MD
Daniela Filipescu, MD
Andreas Ebedi, MD
Manuel L. Fontes, MD
Zsk Hillel, PhD, MD
Elisabeth Ott, MD
Tatiana Titov, MD, PhD
Cynthia Dorsel, MD
Jack Levin, MD
for the Investigators of The Multicenter Study of Perioperative Ischemia Research Group and the Ischemia Research and Education Foundation

**Context** Acute safety concerns have been raised recently regarding certain hemorrhage-sparing medications commonly used in cardiac surgery. However, no comprehensive data exist regarding these associations with long-term mortality.

**Objective** To contrast long-term all-cause mortality in patients undergoing coronary artery bypass graft (CABG) surgery according to use of 2 lysine analog antifibrinolytics (aminocaproic acid and tranexamic acid), the serine protease inhibitor aprotinin, or no antibleeding agent.

**Design, Setting, and Participants** Observational study of mortality conducted between November 11, 1996, and December 7, 2006. Following index hospitalization (4374 patients, 69 medical centers), survival was prospectively assessed at 6 weeks, 6 months, and annually for 5 years after CABG surgery among 10 676 patients enrolled in a 62-center international cohort study. The associations of survival with hemorrhage-sparing medications were compared using multivariable analyses including propensity adjustments.

**Main Outcome Measure** Death (all-cause) over 5 years.

**Results** Aprotinin treatment (223 deaths among 1072 patients [20.8%; 5-year mortality]) was associated with significantly increased mortality compared with control (1258 deaths among 9309 patients [12.7%]; covariate adjusted hazard ratio for death, 1.48; 95% confidence interval, 1.19-1.85), whereas neither aminocaproic acid (132 deaths among 834 patients [15.8%]; adjusted hazard ratio for death, 1.03; 95% confidence interval, 0.80-1.33) nor tranexamic acid (65 deaths among 442 patients [14.7%]; adjusted hazard ratio for death, 1.07; 95% confidence interval, 0.80-1.45) was associated with increased mortality. In multivariable logistic regression, either with propensity adjustment or without, aprotinin was independently predictive of 5-year mortality (adjusted odds ratio with propensity adjustment, 1.48; 95% confidence interval, 1.13-1.93; P= .005) among patients with diverse risk profiles, as well as among those surviving their index hospitalization. Neither aminocaproic nor tranexamic acid was associated with increased risk of death.

**Conclusions** These findings indicate that in addition to the previously reported acute renal and vascular safety concerns, aprotinin use is associated with an increased risk of long-term mortality following CABG surgery. Use of aprotinin among patients undergoing CABG surgery does not appear prudent because safer and less expensive alternatives (ie, aminocaproic acid and tranexamic acid) are available.

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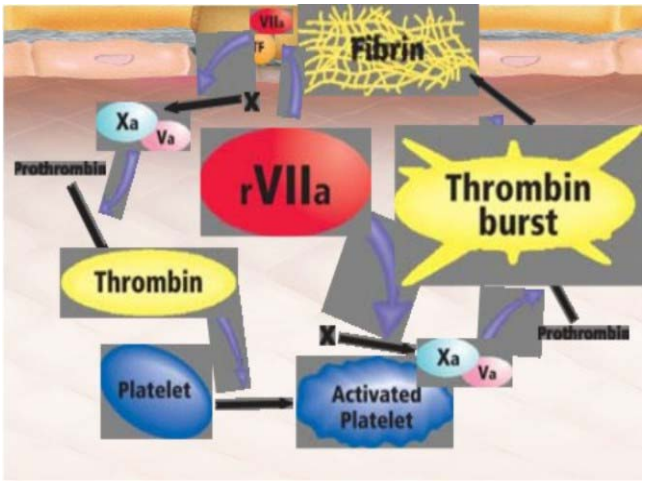
For editorial comment see p 527.



## FVIIA MECHANISM OF ACTION: BOOSTS THROMBIN GENERATION ON ACTIVATED PLATELETS




## GUIDELINE FOR CONSIDERATION OF RFVIIA USE AS RESCUE THERAPY IN CV SURGERY

- Excessive blood loss
  > 2,000 ml blood loss OR transfusion of ³ 5 units of RBC
- Ongoing blood loss
  > 200 cc/h OR inability to close sternum
- Eliminate surgical bleeding
  further exploration or re-exploration
- Normalize/optimize coagulation
  - Full dose of antifibrinolytics
  - Transfused at least: 5 U platelets and 4 U FFP
  - Hemoglobin concentration at least 80 g/L
  - INR/PTT/Fibrinogen corrected to at least 50% normal

Karkouti et al, TGH-UHN 2005

## rFVIIa POTENTIAL COMPLICATIONS

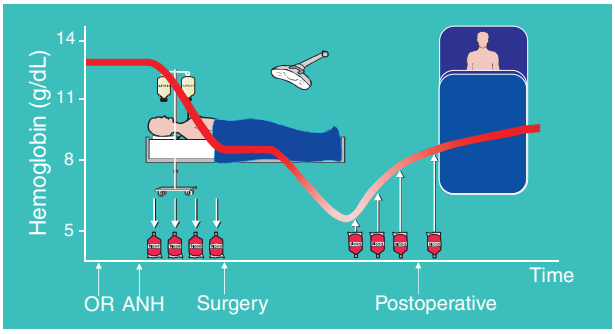
- Myocardial infarction
- DVT
- Pulmonary embolism
- ? Anastomotic/vascular occlusion



Rosenfeld SB, et al. Thromb Haemost 2002;87:925-926.
Robinson KL, et al. Haemophilia 6, 349. 2000.
D'Oiron R, et al. Thromb Haemost 2000;83:644-647.
Peerlinck K, Vermylen J. Thromb Haemost 1999;82:1775-1776.
Brown JL. Anaesthesia 2003;58:1245.

## ANESTHESIA TECHNIQUES: CONTROLLED HYPOTENSION; NORMOTHERMIA

## ACUTE NORMOVOLEMIC HEMODILUTION (ANH)

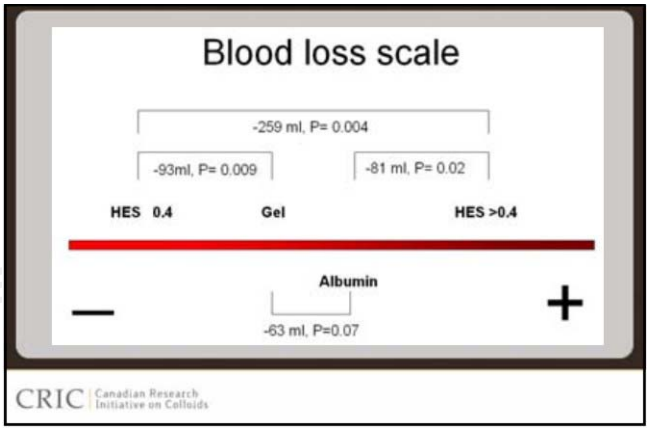



## ACUTE NORMOVOLEMIC HEMODILUTION

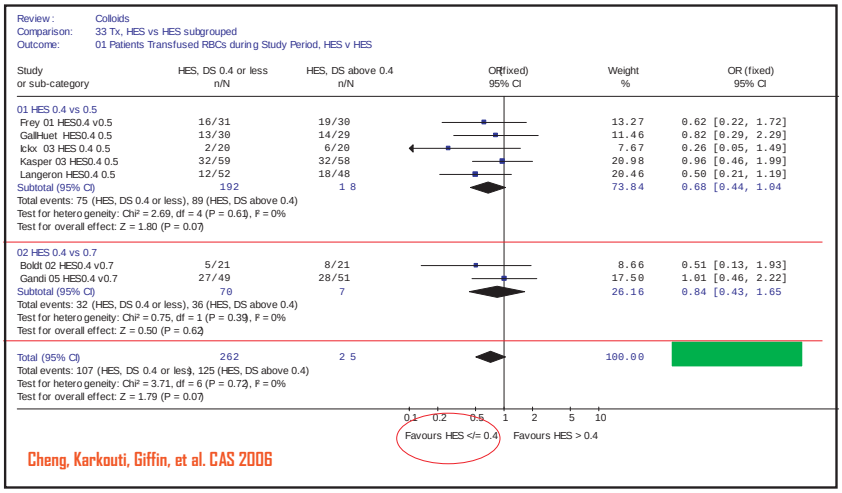
## COAGULATION MONITORING

- Thromboelastograph (TEG) whole blood test of viscoelastic blood clot formation
- Ultegra platelet response to a thrombin receptor agonist peptide (TRAP)
- Clot Signature Analyzer (CSA) measure platelet reactivity
- Plateletworks platelet count ratio to assess platelet reactivity

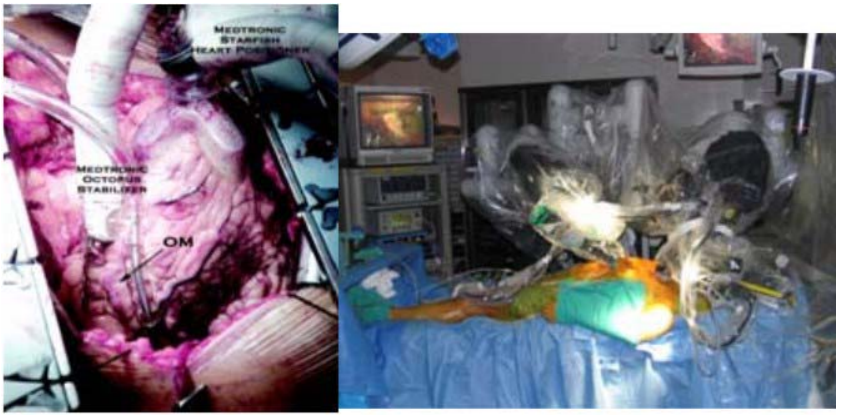
## PERIOPERATIVE BLOOD LOSS: COLLOID *VS* COLLOID



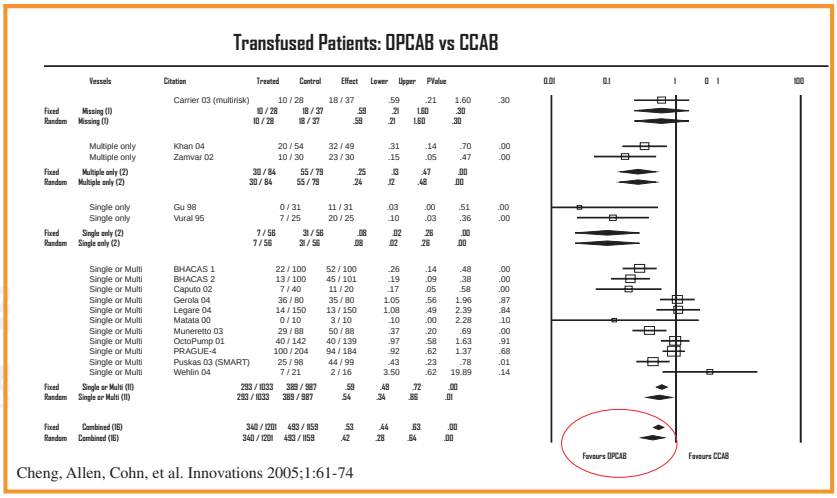
**PATIENTS TRANSFUSED: HES 0.4 *VS* (HES 0.5 OR HES 0.7)**



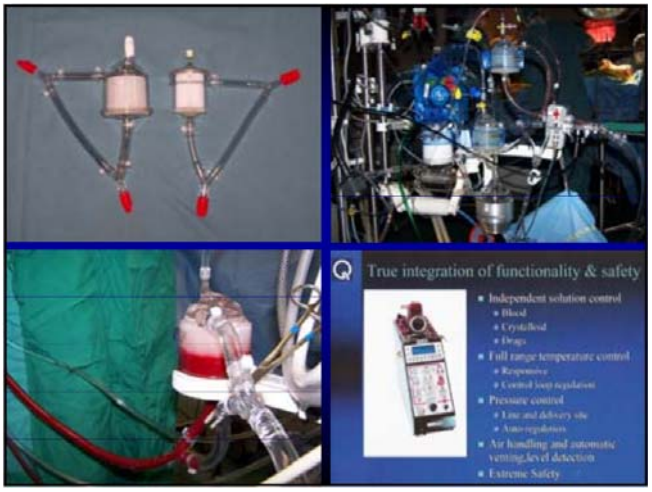

**SURGICAL TECHNIQUES: OPCAB SURGERY, MINIMALLY INVASIVE SURGERY**



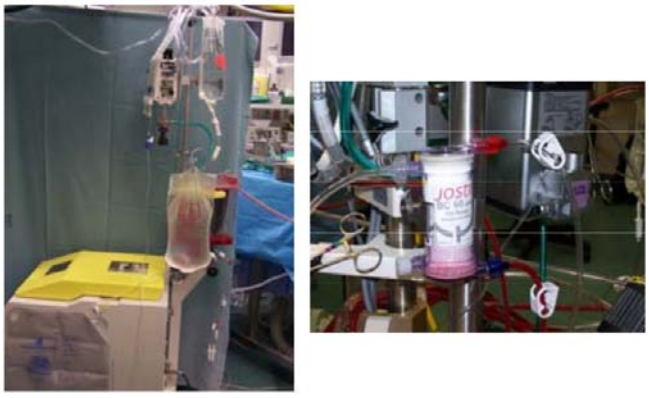

**SURGICAL TECHNIQUE: MINIMALLY INVASIVE SURGERY**



## SURGICAL TECHNIQUE: ENDOSCOPIC VEIN HARVESTING WOUND DRAINAGE, NECROSIS, INFECTION, AND LEG EDEMA



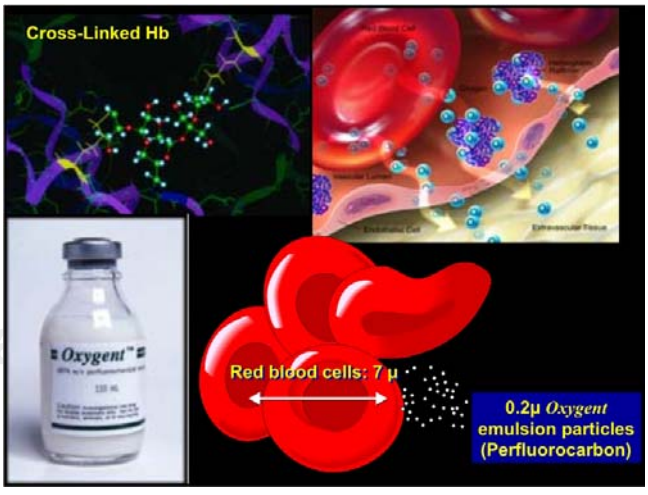

## SURGICAL EQUIPMENT: HARMONIC SCALPEL



## PERFUSION TECHNIQUES

- Prime reduction
  - Smaller circuits
  - Mini circuits
  - Retrograde autologous prime
  - Microplegia systems

- Hemoconcentration
  - Cell Salvage
  - Ultra filtration



## OXYGEN THERAPEUTICS

| Product | Source | Hb Conc & Cross -link | T 1/2 ( hr ) | Trial Phase |
|---|---|---|---|---|
| Hb raffimer / Hemolink ™ | Human RBCs | 100 g/L o -raffinose cross linked polymerized | 14-20 | II Orthopedic<br>II Renal anemia<br>II CABG<br>III CABG |
| HBOC -201/ Hemopure ® | Bovine RBCs | 130 g/L glutaraldehyde polymerized | 9- 24 | II Cardiac/Vascular<br>III Orthopedic |
| Poly SFH -P/ PolyHeme ™ | Human RBCs | 100 g/L glutaraldehyde polymerized | 24 | II Trauma<br>III Vascular/AAA |
| DCLHb */ HemAssist ™ | Human RBCs | 100 g/L diaspirin cross - linked | 2- 11 | III Cardiac<br>III Trauma |
| AF0144*/ Oxygent ™ | PFC | Egg yolk phospholipid | 6 - 9 | II Cardiac<br>II Orthopedic<br>III Non-cardiac<br>III CABG |

Cheng D. Can J Anesth 2001; 48 (4): S41- S48

## STATUS OF OXYGEN THERAPEUTICS

| Product name | Type of product | Areas of investigation | Stage of developement | Company |
|---|---|---|---|---|
| **Gelenpol** | **Polymerized human Hb** | **Approved in Russia for blood loss resuscitation** | **N/A** | **Institute of Macromolecular Compounds, St Petersburg Russia** |
| **Hemospan ™** | **PEG-Hb (human)** | **Temporary substitute for blood Tx during Sx, injuries with loss of blood** | **Phase I completed July 2002** | **Sangart, San Diego CA, USA** |
| **Hemozyme ®** | **Polynitroxilated human** | **Surgery, hemorrhagic shock** | **Preclinical** | **Synzyme Technologies, Irvine CA, USA** |

## POTENTIAL CLINICAL APPLICATIONS

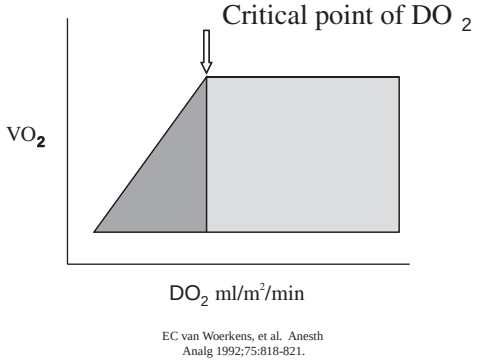
- Elective Surgery
  - — Plasma expansion, IAD, cardioplegia
- Trauma and Emergency Ressuscitation
  - — Transfusion immediately available
  - — Bank blood spared until bleeding controlled
  - — Hypotension associated with septic shock
- Replacement in patients with multiple antibodies, sickle cell anemia, JW
- Extracorporeal organ perfusion
- Radiosensitive tumors

## PERIOP BLOOD MANAGEMENT MODALITIES

- Preoperative
  - — ↑RBC (erythropoietin, Fe, folate)
  - — Autologous donation (PAD)
  - — Anti-PLT agents
- Intraoperative
  - — Pharmacology: Antifibrinolytics
  - — Anesthesia & Surgical techniques
  - — Acute Normovolemic Hemodilution
  - — ↓ Transfusion triggers
  - — Shed blood salvage
  - — Oxygen carriers
- Postoperative
  - — ↓ transfusion triggers
  - — ↑ RBC
  - — Shed blood salvage

Cheng D. Can J Anesth 2001;48:S41-S48.

## TOLERANCE OF ANEMIA: $VO_2$ *VS* $DO_2$




EC van Woerkens, et al. Anesth Analg 1992;75:818-821.

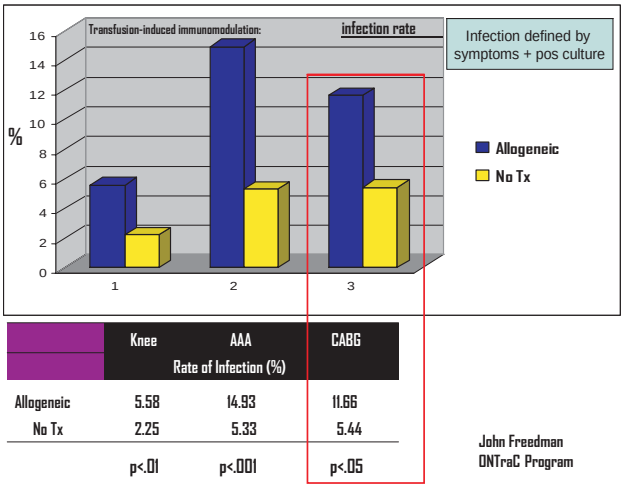
EC van Woerkens, et al. Anesth Analg 1992;75:818-821.

## ↓ TRANSFUSION TRIGGER

| Haemoglobin (g/l) | Risk | Strategy |
|---|---|---|
| > 100 | Very low | Avoid |
| 80–100 | Low | Avoid; May occasionally require transfusion based on clinical evaluation† |
| 60–80 | Moderate | Try to avoid; Decrease oxygen consumption; Base transfusion decision on clinical evaluation† |
| < 60 | High | Usually requires transfusion |

†Clinical evaluation: volume, respiratory, cardiac, and cerebrovascular status, duration of anaemia, symptoms, ongoing blood loss, risk of rebleed, extent of surgery

Perioperative Transfusion Medicine, Chapter 3




| | Knee | AAA | CABG |
|---|---|---|---|
| | Rate of Infection (%) | | |
| Allogeneic | 5.58 | 14.93 | 11.66 |
| No Tx | 2.25 | 5.33 | 5.44 |
| | p<.01 | p<.001 | p<.05 |

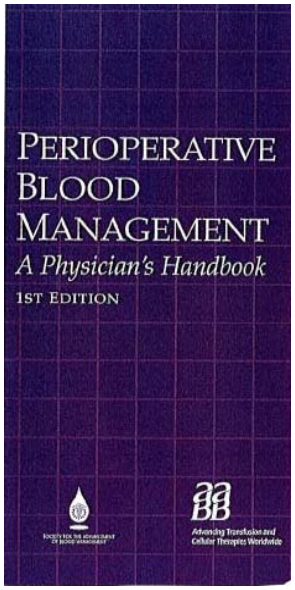
John Freedman
ONTraC Program

## A SUCCESSFUL BLOODLESS MEDICINE AND SURGERY PROGRAM

- Commitment $: Hospital
- Leadership, Knowledge Translation: A coordinated multidisciplinary approach to avoid allogeneic transfusion in patients for both elective and emergent situations
- More than just NOT administering blood to patients
- Risks of not transfusing must be weighed against the Morbidity, Mortality and Cost

"Blood transfusion is like a marriage: It should not be entered into lightly, unadvisedly, or wantonly, or more often than is absolutely necessary."

Beal RW, Aust NZ. J Surg 1976.

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2006