

Blood Management in Cardiac Surgery What's new in 2008?

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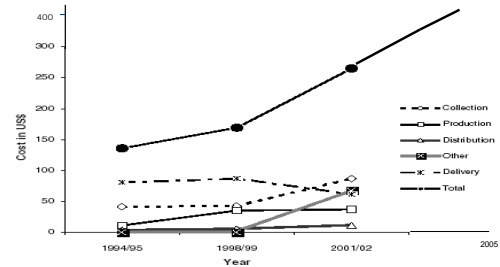
Objectives

- to understand the current need for blood conservation in today's medical climate
- to review the current perioperative blood conservation program at LHSC
- to present some of the current modalities that have been recently introduced into the program and see their outcomes

Comments on blood conservation

- efforts to reduce blood transfusion rates are not new
- cost and resource efficiency considerations now play an important role
- desire by both patient and physician to conserve blood perioperatively has led to many technical and pharmacological advances
- sporadic use of these has limited progress in field of "bloodless" surgery

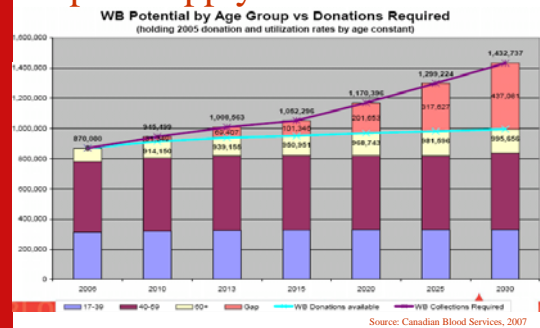
Cost of allogeneic blood products

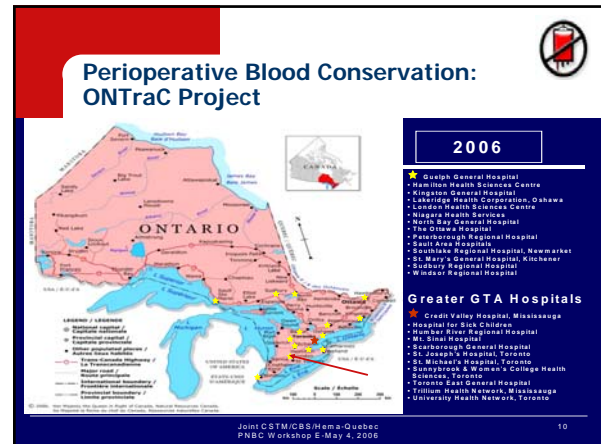
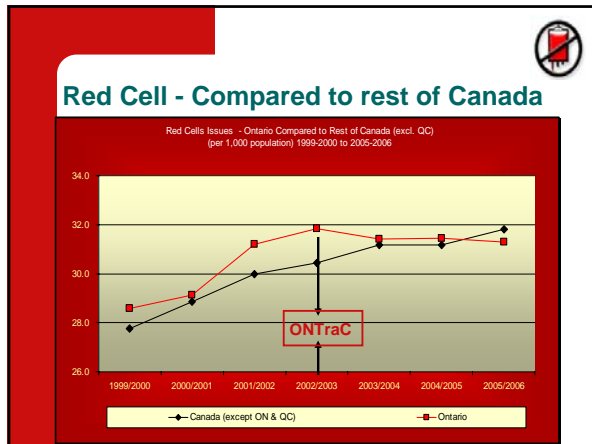


Price list of blood products

- Red blood cells \$400
- 4 units FFP \$700
- 5 units platelets \$500
- 8 units cryoprecipitate \$225
- EPO 40,000IU x 3doses \$1428
- Pentaspan 500mls \$70
- Tranexamic acid 5g \$62.45
- Factor VIIa /mg \$940

Gap in Supply Demand





- ### Reasons for blood conservation
- a potential for excessive bleeding exists in all patients undergoing cardiac surgery with CPB
 - 10-20% of the nations blood supply is consumed during cardiac surgery
 - transfusion of allogeneic blood in cardiac surgery is nowadays a major health issue
 - implementation of variety of blood conservation strategies can significantly reduce the incidence of blood transfusion

THE NEW ENGLAND JOURNAL OF MEDICINE

ORIGINAL ARTICLE

Duration of Red-Cell Storage and Complications after Cardiac Surgery

Colleen Gorman Koch, M.D., Liang Li, Ph.D., Daniel I. Sessler, M.D., Priscilla Figueroa, M.D., Gerald A. Hottel, M.D., Tomislav Mihajlovic, M.D., and Eugene H. Blackstone, M.D.

Morbidity and mortality risk associated with red blood cell and blood-component transfusion in isolated coronary artery bypass grafting[®]

Colleen Gorman Koch, MD, MS; Liang Li, PhD; Andra I. Duncan, MD; Tomislav Mihajlovic, MD; Delsos M. Coagrove, MD; Floyd D. Loop, MD; Norman J. Starr, MD; Eugene H. Blackstone, MD

Transfusion in Coronary Artery Bypass Grafting is Associated with Reduced Long-Term Survival

Colleen Gorman Koch, MD, MS, Liang Li, PhD, Andra I. Duncan, MD, Tomislav Mihajlovic, MD, Floyd D. Loop, MD, Norman J. Starr, MD, and Eugene H. Blackstone, MD

Departments of Cardiothoracic Anesthesiology, Quantitative Health Sciences, and Thoracic and Cardiovascular Surgery, The Cleveland Clinic Foundation, Cleveland, Ohio

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- ### Attributed benefits of blood conservation
- improved patient outcomes
 - reduced morbidity and mortality
 - reduced immunomodulatory effect
 - reduced dissemination of metastases
 - shorter hospital stays
 - significant cost reduction to health care system
 - reduced strain on finite blood supply
 - improved patient satisfaction

The usual equation

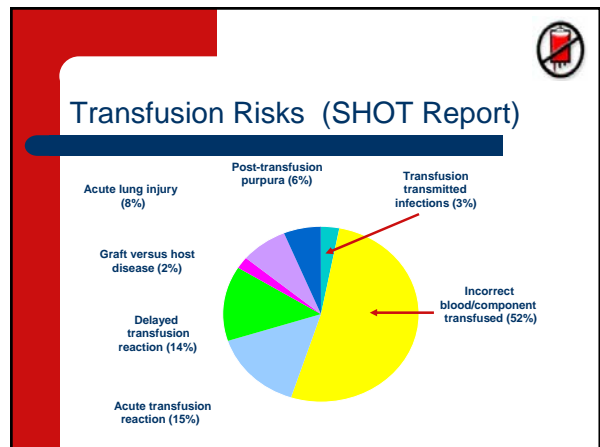
The image shows a golden scale of justice. The left pan is higher and contains the word 'BENEFIT'. The right pan is lower and contains the word 'RISK', indicating it is heavier.

Little known fact!

There is a surprising lack of evidence from clinical trials for the efficacy of blood transfusion”

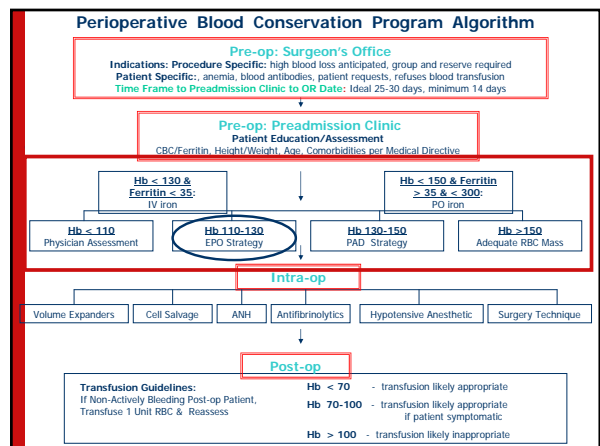
Risks associated with blood transfusion

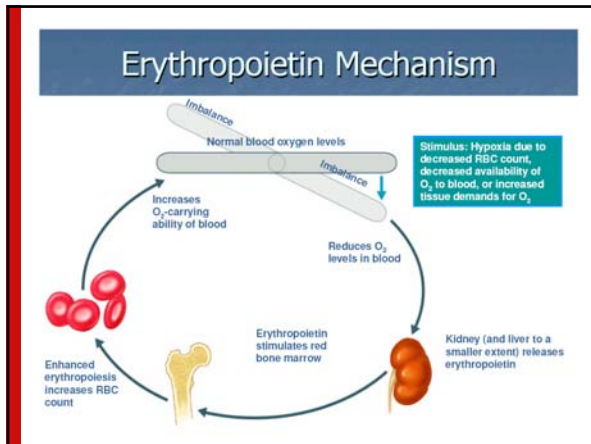
- mistransfusion
- immunological complications
- transmission of infectious diseases



Patient specific blood management

- arbitrary applications of blood conservation strategies are usually wasteful and ineffective particularly when using expensive new agents
- specific strategy should be designed from patient's medical history, preoperative Hb level and surgical procedure
- develop a *selective* algorithmic application of measures on the basis of patient risk factors for transfusion





Role of erythropoietin

- if the estimated blood loss is greater than the tolerable blood loss then strategies must be considered to optimize the patient's physiological condition, reduce blood loss and/or increase the patient's red cell mass
- use of rHuEpo allows more aggressive pre-operative blood procurement, intra-operative hemodilution and more rapid post-operative hemoglobin recovery.

Calculation of red cell volume

(Weight in kg x 70ml/kg[65ml/kg for women])
x
(preoperative hematocrit)

85 x 70 x 0.45 = 2678ml vs. 65 x 65 x 0.35 = 1479ml
(males) (females)

(30% loss = 803.4ml) (30% loss = 443.7ml)

Calculations of red cell volume

68kg female with initial Hct 0.32% after two doses of Eprex now has Hct of 0.46%

Initial red cell volume = 1414mls
(68 x 65 x 0.32)

Final red cell volume = 2033mls
(68 x 65 x 0.46)

619mls

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Why do we need EPREX?



PREOPERATIVE ANEMIA

- IS VERY PREVALENT
- anemia and blood transfusion are associated with increased risks and poorer outcomes
- correction of preoperative anemia cannot be overemphasized
- anemia should be treated with strategies that exclude allogeneic blood



PREOPERATIVE ANEMIA

- defined as Hb < 130g/L (Hct < 36%)
- incidence increase with age
- 33% patients prior to total joint arthroplasty have Hb between 100-130g/L
- patients with preoperative Hb between 100-130g/L have 3X transfusion risk of Hb > 140g/L
- study of patients refusing blood products for religious grounds 28% have Hb < 120g/L
- not all patients are candidates for PAD (e.g. cardiac)



Preoperative hemoglobin

Blood transfusion requirement prediction in patients undergoing primary total hip and knee arthroplasty

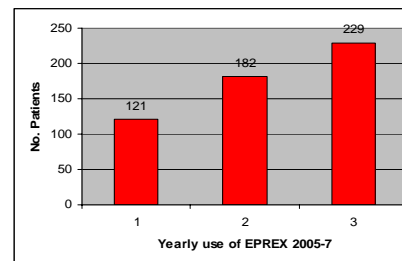
S. Guerin,* C. Collins,* H. Kapoor,** I. McClean† & D. Collins* *Departments of Orthopaedic Surgery, St Mary's Orthopaedic Hospital, Cork, Ireland, and †Department of Orthopaedic Surgery, Dumfries and Galloway Royal Infirmary, Scotland, UK

“The pre-operative haemoglobin level of the patient was the only variable to independently predict the need for blood transfusion after primary hip or knee arthroplasty.”

Transfusion Medicine, 2007, 17, 37-43



Use of Eprex at LHSC



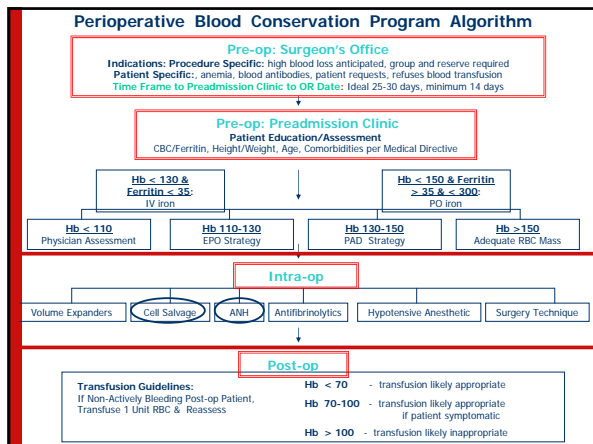
LHSC Data 2007

- # patients receiving Eprex = 229
- # patients transfused = 59/221 (25.3%)
- hemoglobin at PAC = 121.0 ± 8.9 g/L
- hemoglobin on DOS = 132.0 ± 12 g/L
- lowest Hb in non-transfused pts = 96 ± 12 g/L
- lowest Hb in transfused pts = 78 ± 11g/L



Alternative to EPREX?

**THIS CAN BE ACHIEVED
BY ONE PHONE CALL**



Acute normovolemic hemodilution

- removal of blood from a patient immediately before surgery either before or shortly after induction of anesthesia and simultaneous replacement with an appropriate volume of crystalloid or colloid fluids
- risk of hemodilution can be minimized by limiting extent to target hct of 24-30%
- extreme hemodilution to hct 20% is likely to be more efficacious but the risks are correspondingly higher

Acute normovolemic hemodilution

- reduces red cell lost during surgery by decreasing red cell mass immediately prior to the operation
- amount of surgical blood loss is not appreciably changed but fewer red cells are lost due to the patient's acute anemia
- need to define patient's safe lower limit for hematocrit

Safety of ANH

- depends on maintenance of normovolemia
- appropriate blood collection packs must be used to ensure a standard anticoagulant/blood ratio
- approximate volume of blood to be removed to achieve the desired hct can be calculated from

$$V = EBV \times (H_o - H_t / H_{av})$$

where EBV=70ml/kg x wt

- all units must be labelled with patients name, PIN#, time and date collected and time expires

Acute normovolemic hemodilution

- first introduced in the 1970s
- designed to allow patients to maintain a hct that does not precipitate myocardial ischemia
- value lies in the reduced volume of rbc loss during surgery
- return of whole blood when required aids coagulation
- recommended for patients who might have been candidates for pre-donation

Acute normovolemic hemodilution

- Factors determining efficacy of hemodilution
 - red cell mass (initial Hct, blood volume)
 - magnitude of hemodilution
 - intraoperative blood loss
 - intraoperative management
 - must maintain normovolemia
 - return red cells after surgery if possible.

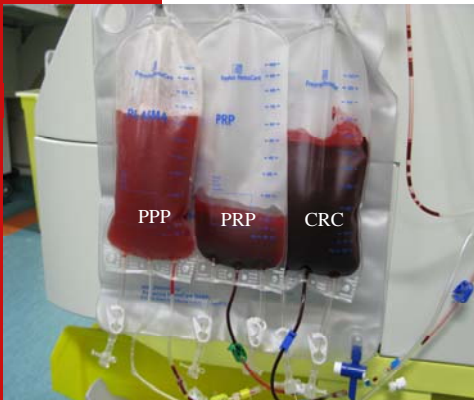
Acute normovolemic hemodilution

- has been advocated as a simpler, less expensive alternative or supplement to autologous pre-donation
- no wastage as all units are re-transfused usually prior to the patient leaving the OR
- units do not need to be tested as they never leave the OR and therefore there is no possibility of administrative error
- however studies of its efficacy have produced conflicting conclusions



Acute normovolemic study

- 5 patients undergoing complex cardiac procedures (2 Bentalls, 2 redo CABG, 1 repair ascending aorta + AVR)
- mean CPB time was 193 ± 51.5 min.
- ANH blood was equivalent to receiving 2 units RBC, 3-4 packs platelets and 1.5-2 units of FFP
- in ICU Hb 94.6 ± 13.8g/L, platelet count 158.4 ± 54.4 10⁹/L, INR 1.3 ± 0.14, PTT 29.4 ± 2.07sec.
- mean allogeneic transfusion 1.8 ± 2.1 units with 60% requiring no transfusion



Component values (mean ± SD)

BAGS	ASSAY	RESULT
RBC	Volume (ml)	378 ± 38.34
	Hct	>0.75%
	Haemolysis	None
PPP	Volume (ml)	372 ± 41.5
	Factor II	0.70 ± 0.16
	V	0.78 ± 0.13
	VII	0.74 ± 0.06
	V	0.67 ± 0.22
	VII	0.86 ± 0.25
	IV	0.74 ± 0.13
	XI	0.98 ± 0.15
	XII	0.86 ± 0.38
	Platelet Count (10 ⁹ /L)	103.6 ± 40.3
	Hct (%)	0.02 ± 0.04
	PRP	Volume (ml)
Platelet Count (10 ⁹ /L)		677.6 ± 187.9
Hct		0.11 ± 0.04

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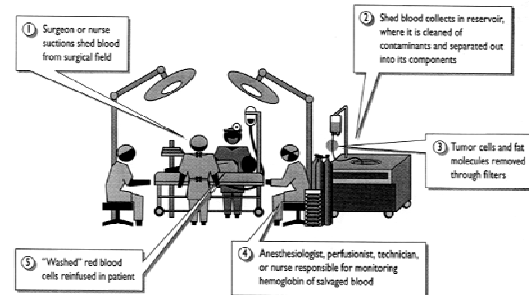
Conclusions

- component bags contained the product as directed without any obvious deleterious effect on the blood components per se
- this technique led to a significant reduction in transfusion rate in these complex, cardiac surgical procedures in our institution (from 100% to 40%)
- the ability to remove the plasma and platelets from the RBC, allows the RBC if necessary, to be returned during CPB to reduce its hemodilutional effect, previously the major factor limiting the volume of blood that could be removed.
- this allows the plasma and platelets to be returned after the end of CPB and protamine administration for maximal effect

Fresenius Cell Salvage Technology



CELL SALVAGE IN BRIEF

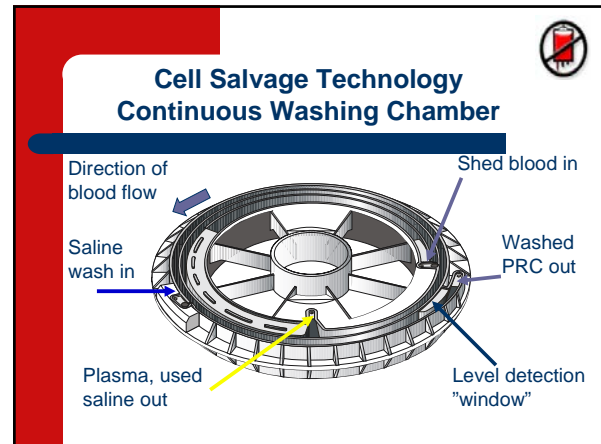
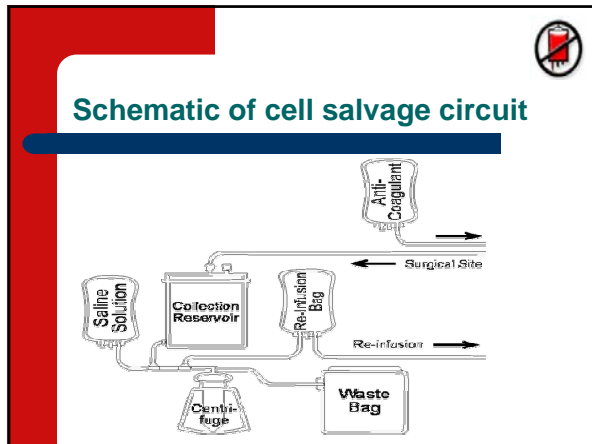


Cell salvage

- intraoperative cell salvage machines suction, washes, and filters blood so it can be given back to the patient
- advantage is that patient receives his/her own blood instead of donor blood

Cell salvage technique

- blood is sucked from the surgical field using a dual lumen tube which mixes the blood immediately with an anticoagulant into a reservoir connected to a suction pump
- fluid in the reservoir is filtered to remove large clots and debris and then drawn into a centrifuge for processing
- a sterile isotonic saline solution is pumped into the centrifuge bowl



- ### Cell salvage technique
- the force supplied by the centrifuge holds the more dense rbc against the outer wall of the bowl
 - the less dense wbc, platelets, plasma with all the clotting factors and anticoagulant solution move toward the centre of the bowl where they spill over into a waste bag and are discarded
 - rbc are sent to a transfusion bag for re-transfusion to the patient within 6hrs of collection

- ### Cell salvage
- indicated for surgical procedures with expected blood loss > 20% total blood volume or >10% patients undergoing procedure require a transfusion
 - has excellent long standing safety record
 - becomes increasingly cost effective with large volume losses
 - often accepted by Jehovah Witness patients with some restrictions

- ### Contraindications and adverse effects
- bacterial contamination of the wound
 - malignant disease
 - sickle cell disease and sickle cell trait are relative contraindications
 - with large volume losses there is the risk of a dilutional coagulopathy as only rbc are returned to the patient
 - training required by operator

The Use of Recombinant Activated Factor VII in Cardiac Surgery Patients

