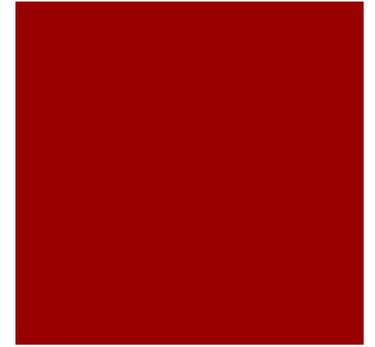
The background of the slide is a dense field of red blood cells, shown in a reddish-pink hue. The cells are biconcave and have a slightly glossy appearance, with some showing highlights and shadows that give them a three-dimensional look. They are packed closely together, filling the entire frame.

Auto Transfusion: Valuable

**University of Colorado Surgical
Grand Rounds**

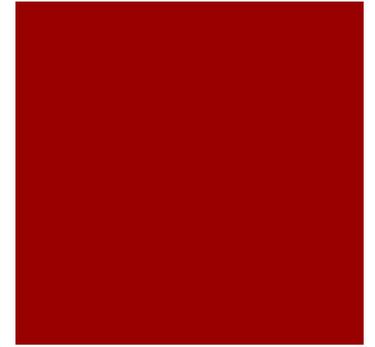
**Megan Anderson PGY 3
September 10, 2012**

Objectives



- Describe the risks of blood product transfusion
- Describe the utility of autotransfusion in certain surgical subspecialties
- Describe the cost benefits of autotransfusion

History of Transfusion

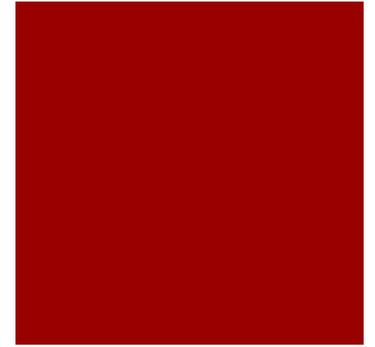


- 1665: Earliest blood transfusion
- 1818: First transfusion of human blood for the treatment of hemorrhage - Dr. James Blundell
- 1886: J. Duncan used auto transfusion during the civil war
- 1932: The first blood bank was established in Leningrad
- 1937: First blood bank in the United States opened at Chicago's Cook County Hospital

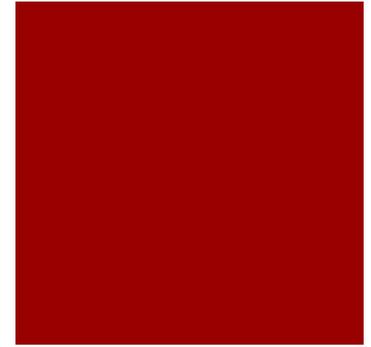


Viral Risks of Blood Transfusion

- Hepatitis A: 1 in 1,000,000
- Hepatitis B: 1 in 350,000
- Hepatitis C: 1 in 2,000,000
- HIV: 1 in 2,300,000
- HTLV 1 & II (Human T-Cell Leukemia Virus): 1 in 250,000 to 1 in 2,000,000
- CMV: 1 in 10 to 1 in 30
- EBV: 1 in 200
- West Nile Virus: 1 in 350,000



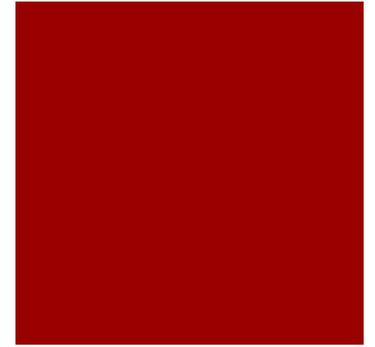
Non-Viral Risks of Blood Transfusion



- Parasitic Infections
 - Malaria: 1 in 4,000,000
- Prion Mediated Infections
 - Creutzfeldt-Jakob
- Bacterial Contamination – directly related to length of storage
 - Responsible for 10% of transfusion associated deaths
 - *Yersinia enterocolitica* is the most common bacterial contaminant of PRBC
 - Others: *serratia*, *pseudomonas*, *enterobacter*
 - Incidence 1 in 200,000 to 1 in 4,800,000

Cost

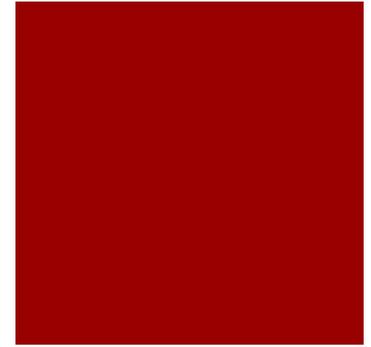
- Between January 1997 and July 2002 the cost of blood products increase 340% secondary to the stringent testing of blood and the introduction of leukocyte depleted blood, to reduce the risks of disease.
- This has also resulted in a decreased pool available for blood donation



Definitions

■ 2 Broad Classes

- 1 – Red Blood Cell Washing: collects the shed blood, washes, and centrifugally separates out RBCs and then reinfuses them. Removes toxic by products, but also removes platelets and clotting factors.
- 2 – Hemofiltration: collects the blood, filters it, and reinfuses it. Returns all blood elements. Does not remove harmful debris and contaminants.



Examples of Devices

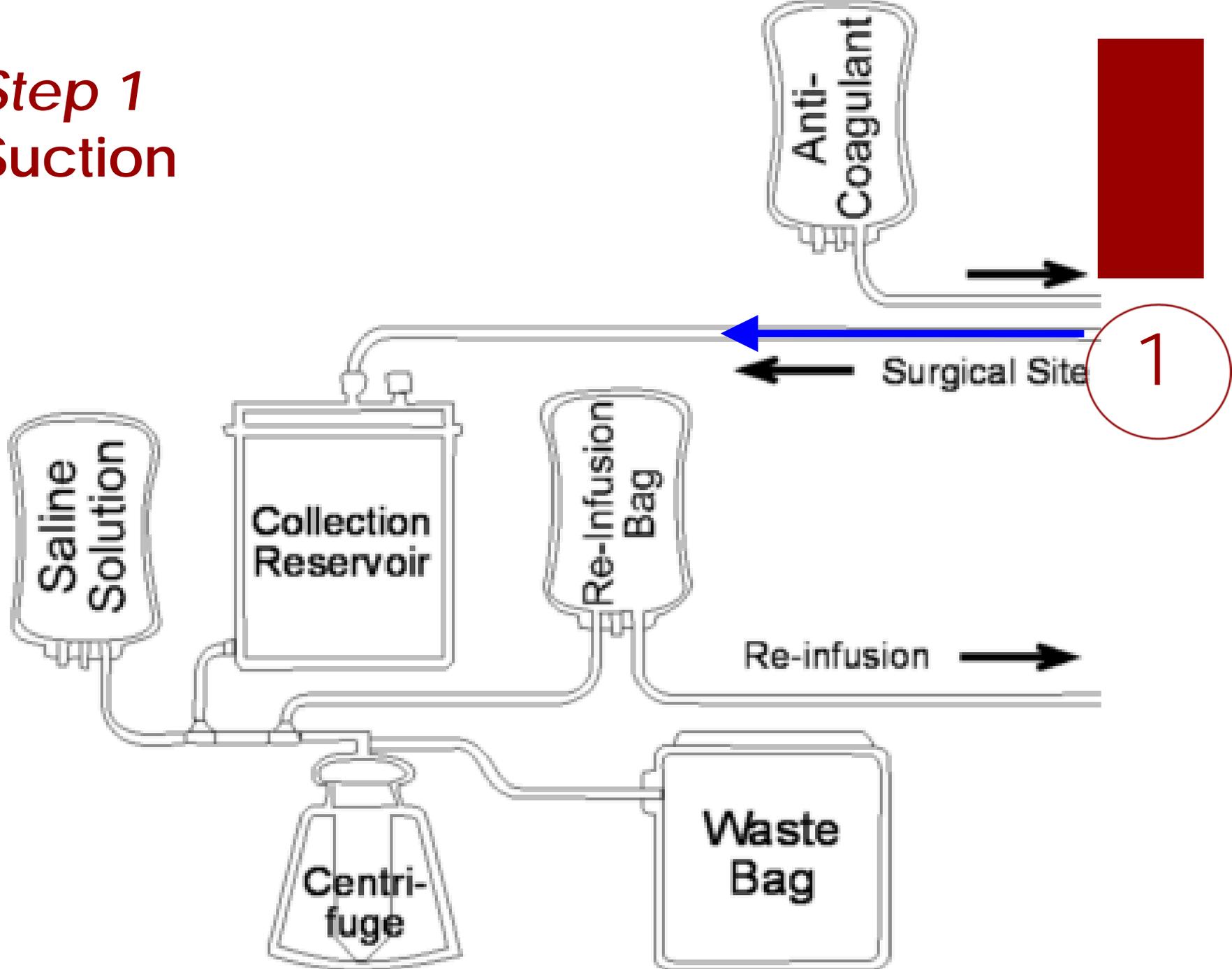


Table 1

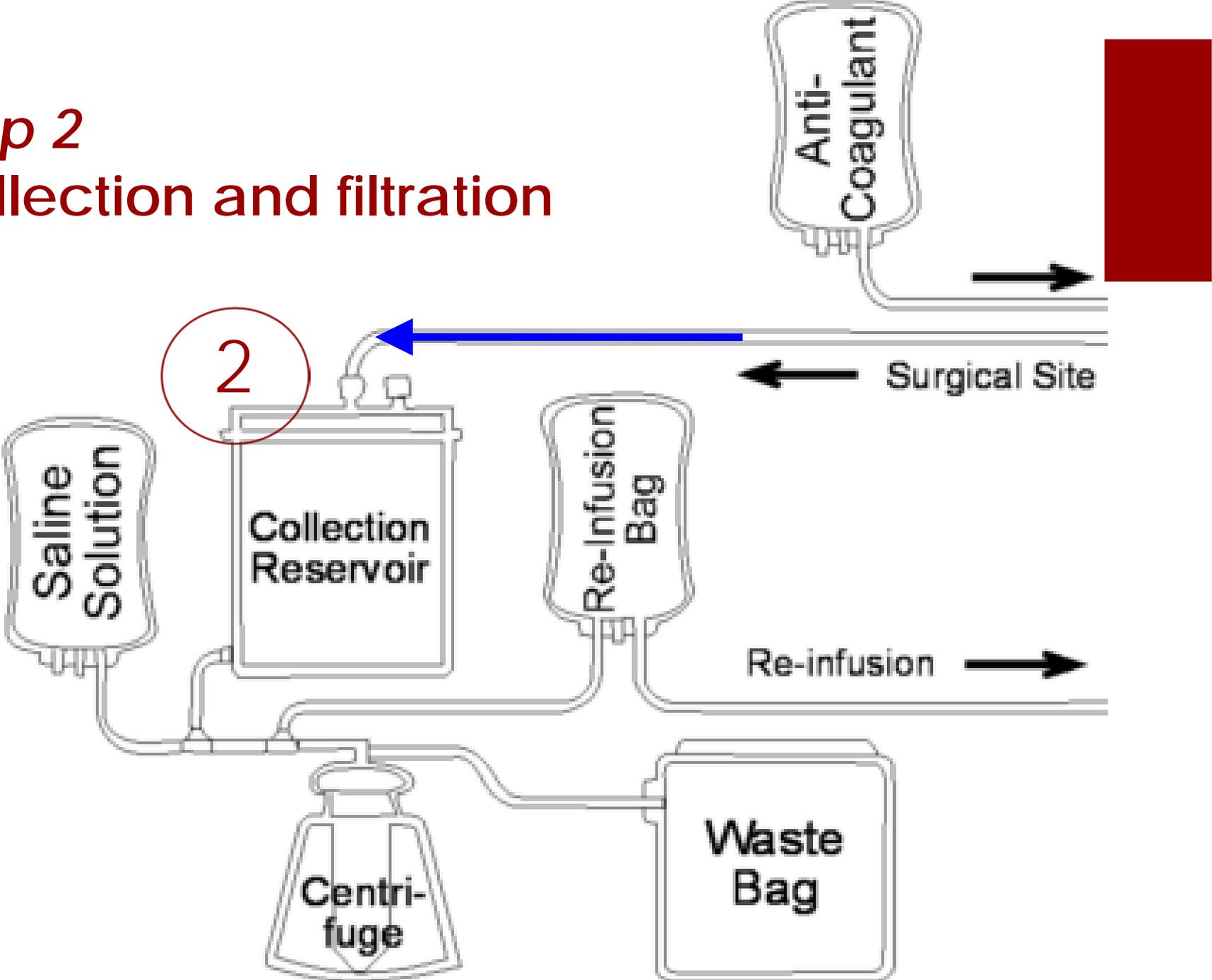
Examples of autotransfusion devices

Type of device		Manufacturer
Hemofiltration only	ConstaVac™ Blood Conservation System	Stryker
	Autovac™ Postoperative Orthopaedic Autotransfusion Canister	Boehringer Laboratories
	Solcotrans® Orthopaedic Autotransfusion System	Davol
	AT200™ Hemofiltration System	Hematec
Red blood cell washing	OrthoPAT™	Haemonetics Corp.
	Continuous Autotransfusion System (CATS)	Fresenius AG
	Cell-Saver or Cell Saver 5	Haemonetics Corp.
	Medtronic Autolog or Medtronic Sequestra 1000	Medtronic, Inc.
	Cobe Baylor Rapid Autotransfusion Device (BRAT or BRAT 2)	COBE Cardiovascular

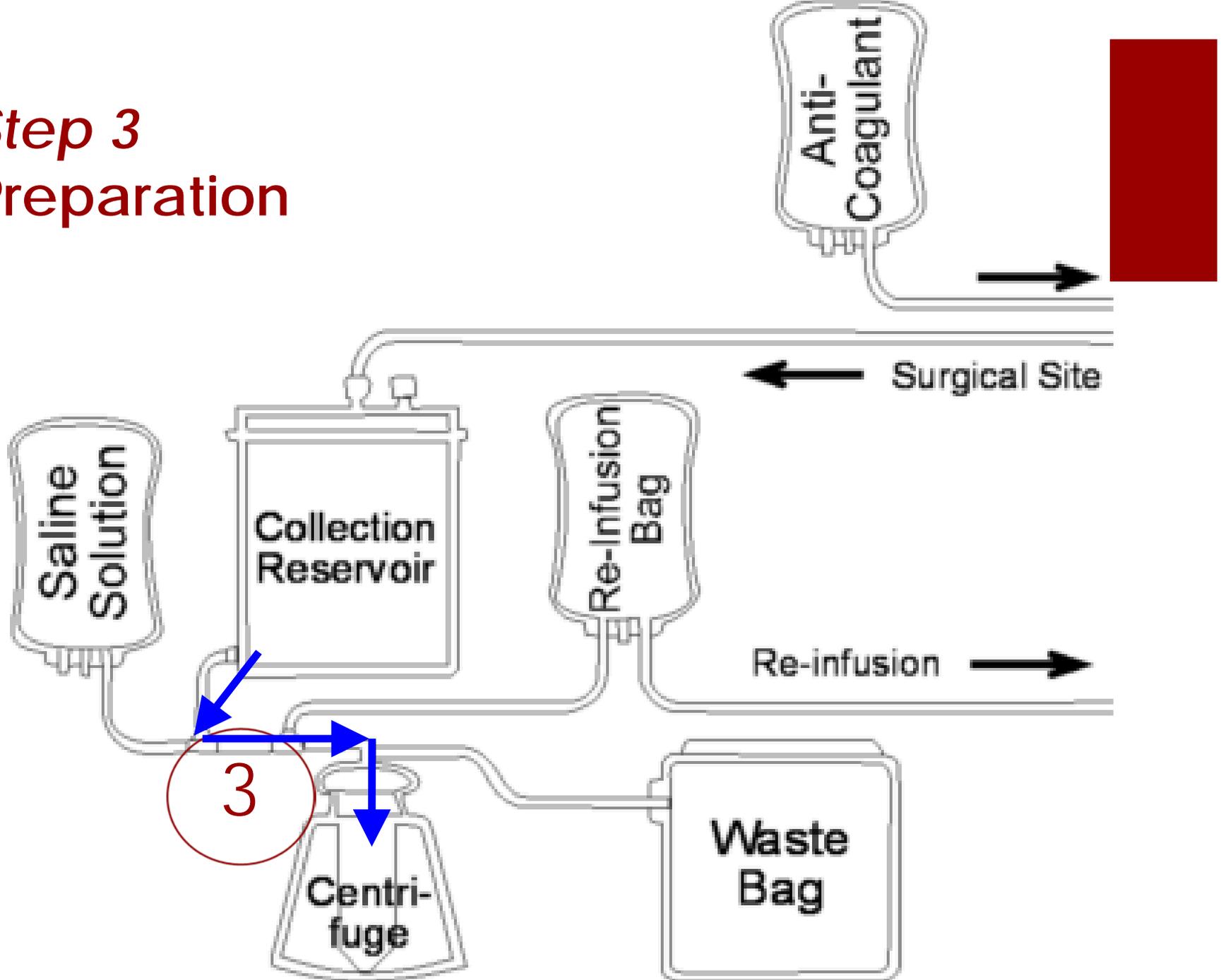
Step 1 Suction



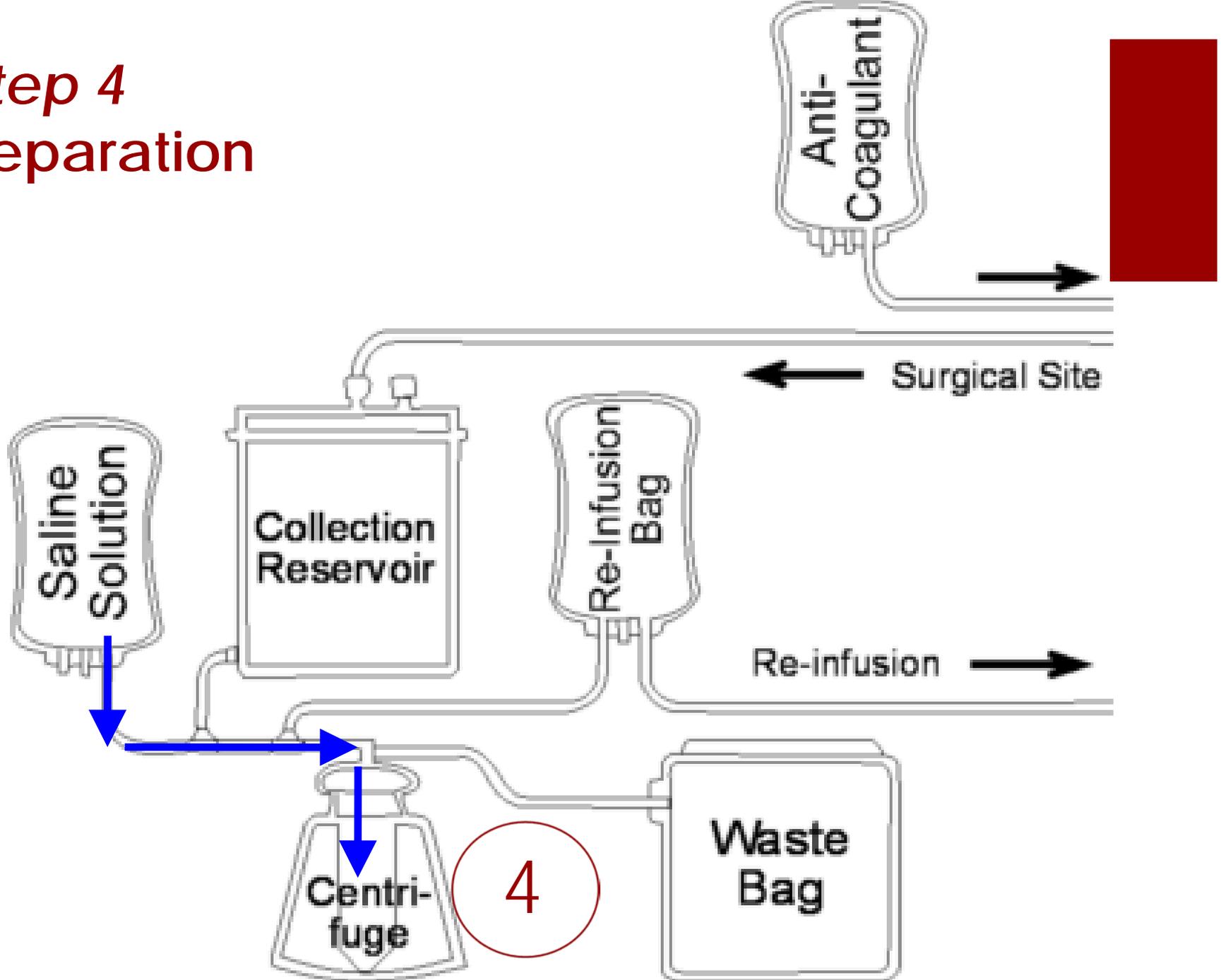
Step 2
Collection and filtration



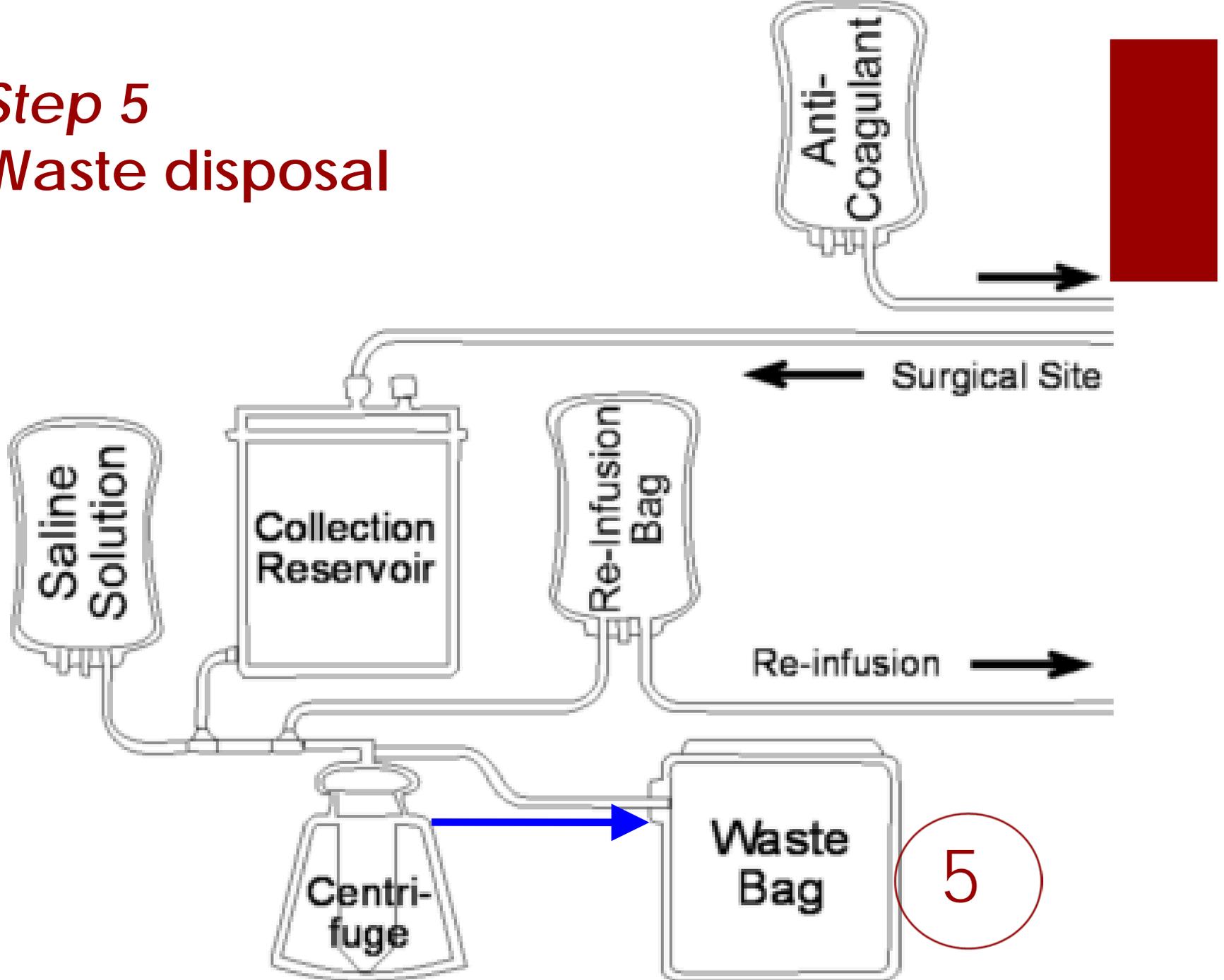
Step 3 Preparation



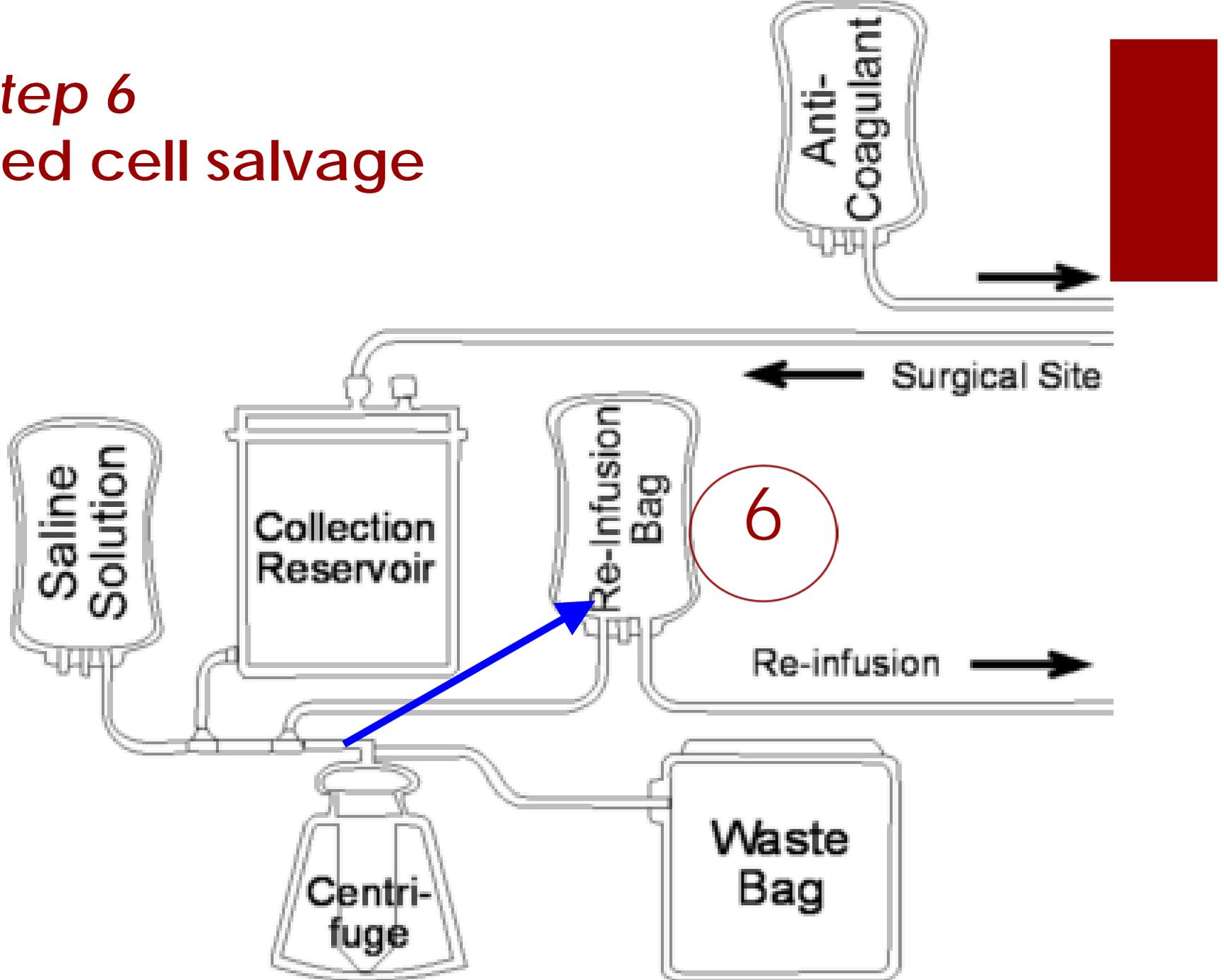
Step 4 Separation



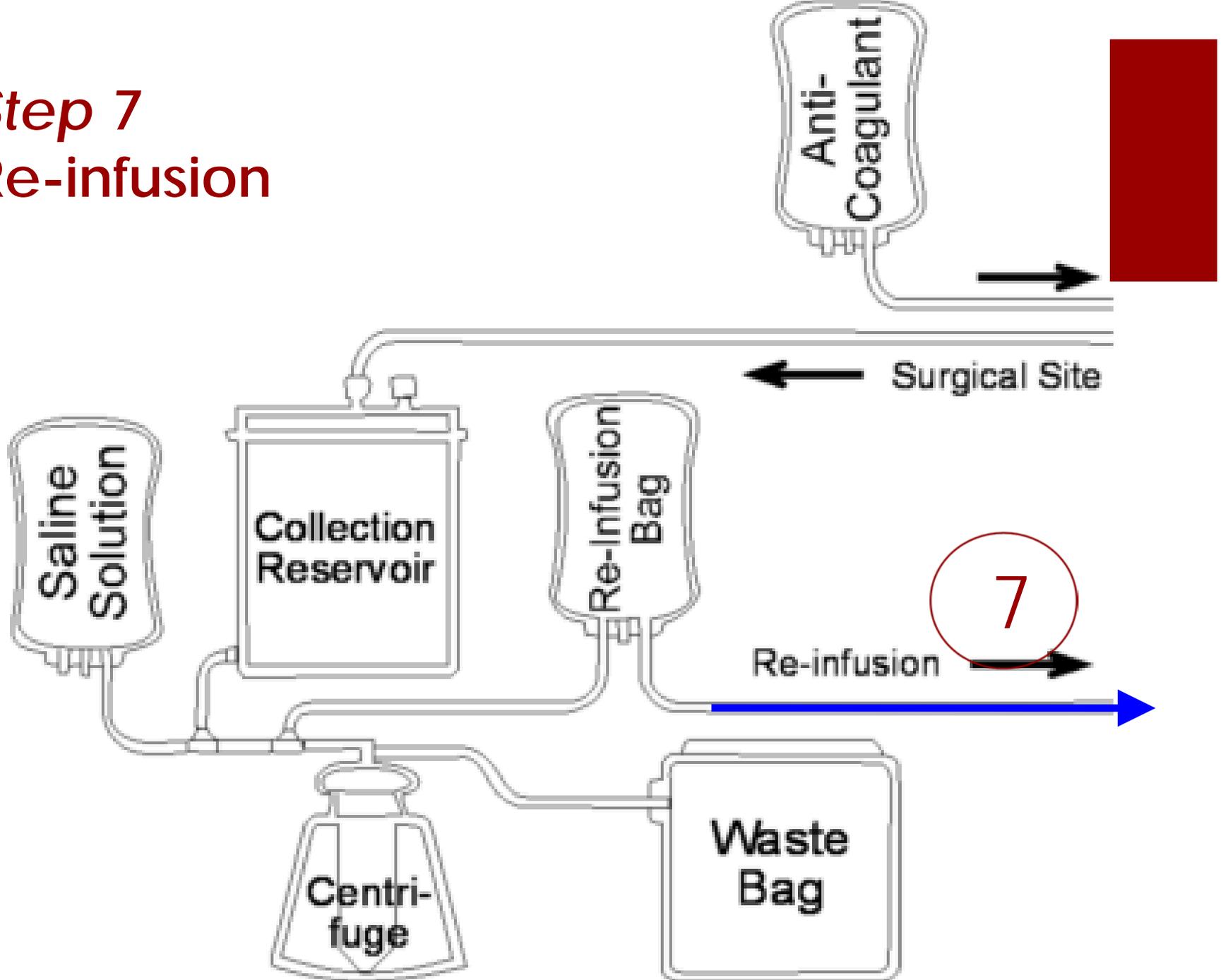
Step 5 Waste disposal



Step 6
Red cell salvage



Step 7 Re-infusion



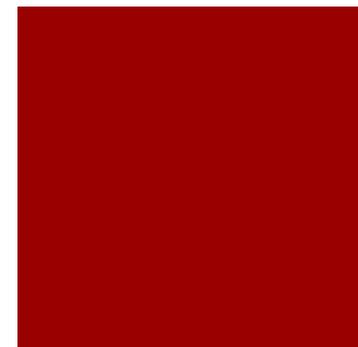
Intra-operative cell salvage: a fresh look at the indications and contraindications

Stephen A. Esper, Jonathan H. Waters

*Department of Anesthesiology, Magee Womens Hospital of University of Pittsburgh Medical Center,
Pittsburgh, United States of America*

Indications

- Anticipated blood loss is 20% or more of the patients blood volume.
- Cross matched compatible blood is unobtainable
- Patient is unwilling to consent to allogenic blood.
- More than 10% of patients undergoing the procedure require transfusion
- The mean transfusion for the procedure exceeds 1 unit.



Indications

Table I - General indications for cell salvage.

Specialty	Surgical procedure	Comments
Cardiac	Valve replacement Redo bypass grafting	
Orthopaedics	Major spine surgery Bilateral knee replacement Revision of hip replacement	
Urology	Radical retropubic prostatectomy Cystectomy Nephrectomy	Individualised by surgeon Limited to patients with prior radiation therapy When tumour involves major vessels
Neurosurgery	Giant basilar aneurysm	
Vascular	Thoraco-abdominal aortic aneurysm repair Abdominal aortic aneurysm repair	Should be individualised by surgeon and patient's characteristics
Liver Transplant		
Other	Jehovah's Witnesses Unexpected massive blood loss Red cell antibodies	When accepted by patient

Contraindications

- Absolute Contraindications
 - Anything that results in cell lysis (Hydrogen peroxide, alcohol, sterile water, hypotonic solution).

Table II - Relative contraindications to cell salvage.

Pharmacological agents

Clotting agents (Avitene, Surgicel, Gelfoam, etc.)

Irrigating solutions (betadine, antibiotics meant for topical use)

Methylmethacrylate

Contaminants

Urine

Bone chips

Fat

Bowel contents

Infection

Amniotic fluid

Malignancy

Haematological disorders

Sickle cell disease

Thalassaemia

Miscellaneous

Carbon monoxide (electrocautery smoke)

Catecholamines (phaeochromocytoma)

Oxymetazoline (Afrin)

Papaverine

Cell salvage for minimising perioperative allogeneic blood transfusion (Review)

Carless PA, Henry DA, Moxey AJ, O'Connell D, Brown T, Fergusson DA

Cochrane Review



- 75 randomized trials of cell salvage over 29 years (1979-2008).
- Reduced per-operative allogeneic RBC transfusion by 38% (RR 0.62; 95% CI 0.55-0.70)
- Average absolute reduction in risk (ARR) was 21%
 - NNT 4.8
- Efficacy greatest in orthopedic surgery
 - Reduced risk of allogeneic blood transfusion by 54% compared with 23% in cardiac surgery
- Average saving of 0.68 units of RBC per patient

Cochrane Review Cont.

- Relative risk reduction of 37% when cell salvage combined with another active intervention (pre-operative autologous donation, acute normovolemic haemodilution, apoprotinin).
- Relative risk reduction of 39% when compared to control
- Mortality, re-operation for bleeding, infection, wound complication, non-fatal MI, thrombosis, stroke and hospital LOS were not adversely affected by cell salvage.
- FEWER cell salvage patients experienced infection

Cardiac Surgery: Cochrane Review



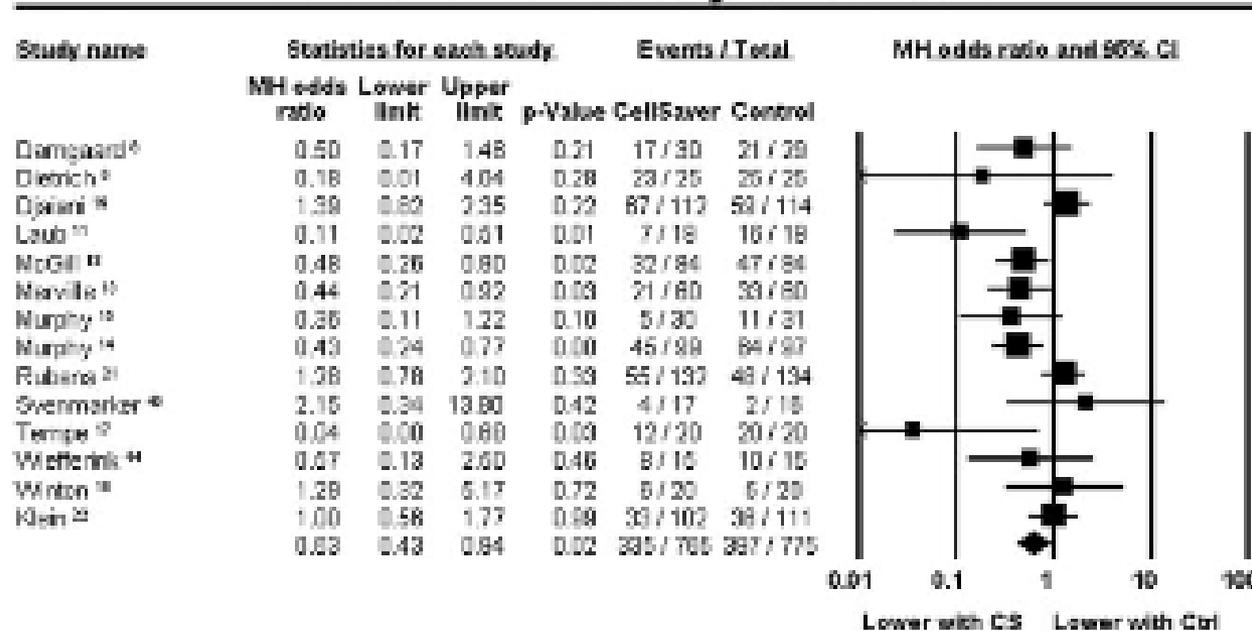
- Reduced risk of exposure to allogenic blood transfusion by 23%
- Washed cell salvage significantly reduced red cell transfusion rates compared with unwashed which was only marginally effective

The Efficacy of an Intraoperative Cell Saver During Cardiac Surgery: A Meta-Analysis of Randomized Trials

Cardiac Surgery



Patients Transfused Any Blood Product



- During cardiac surgery, the use of a CS significantly reduced the odds of exposure to any allogeneic blood product

- That's a decreased exposure of 37%

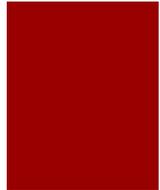
- CS did **not** increase the number of patients transfused FFP or platelets

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[☆]

Cardiac Surgery

- Hemoglobin concentration fell significantly in all groups on POD 1
- Twenty-four hours postoperative blood loss in the four groups was not significantly different
- There was a significant rise in prothrombin time on POD 1 from preoperative levels ($P \ll 0.0005$) in all groups with no statistical difference between groups, and remained elevated at POD 5 with no difference between groups





- Homologous blood transfusion in the on-CPB group without cell saver (group B) was significantly higher than in the other groups ($p < 0.005$)

- **3 times greater**

- Patients receiving cell saver autologous blood transfusion (groups A and C) resulted in significantly reduced volumes of homologous blood transfusion ($p < 0.001$)

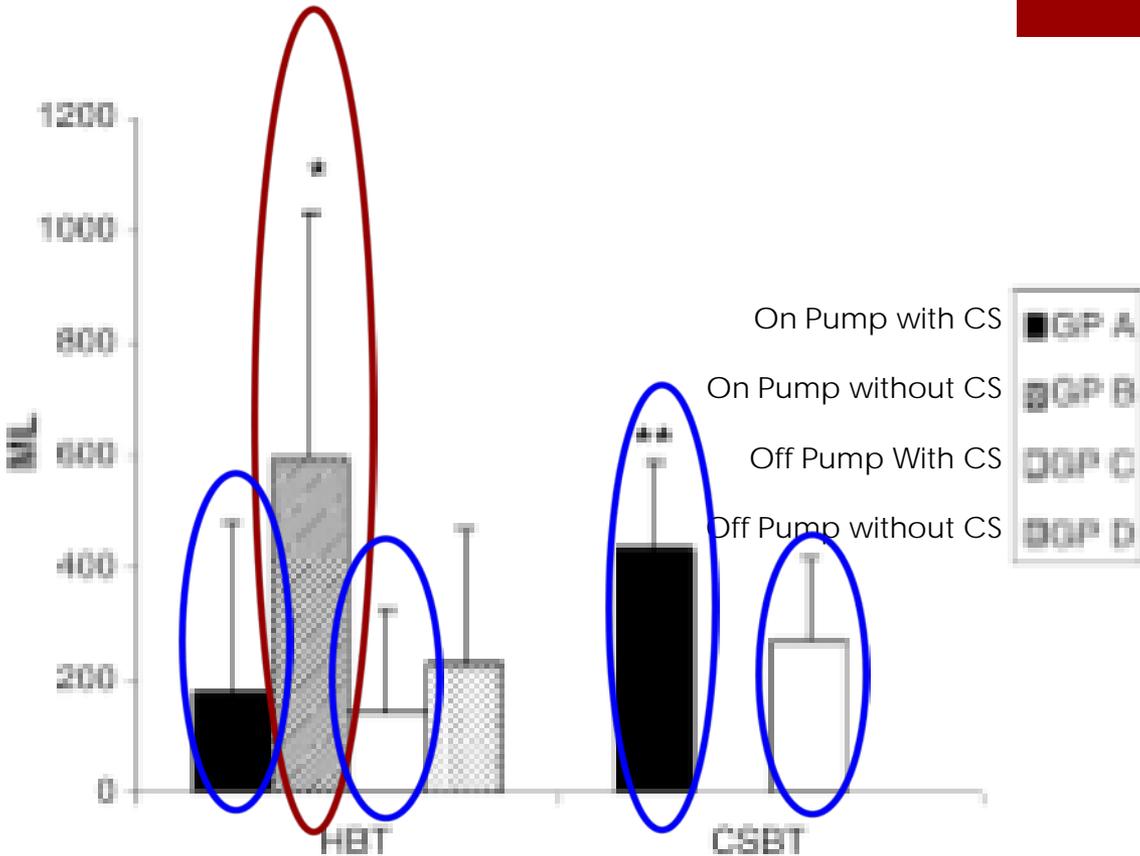


Fig. 2. Homologous and autologous transfusion volumes. HBT; homologous blood transfusion; CSBT; cell saver blood transfusion. * $P < 0.005$ group B vs groups A, C and D. ** $P < 0.05$ group A vs group C.

Niranjan G, Asimakopoulos G, Karagounis A., et al. 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. European Journal of Cardio-Thoracic Surgery 30(2006): 271-277.

Orthopedic Surgery Cochrane Review

- Cell salvage reduced risk of exposure to allogenic blood transfusion by 54%
- Little difference observed between washed cell salvage (RR 0.48; 95% CI 0.36-0.64) and unwashed cell salvage (RR 0.47, 95% CI 0.36 to 0.63).

Decreasing the blood transfusion rate in elective hip replacement surgery using an autologous drainage system

Orthopedic Surgery

Table 2 Drainage volume and transfusion details for both groups

	Normal drain group (<i>n</i> = 43)	Autologous drain group (<i>n</i> = 43)
Mean volume of blood drained [ml] (range)	641 (500–1070)	675 (200–1700)
Mean volume of autologous blood re-transfused (ml)	n/a	441 (50–1050)
Number requiring homologous blood transfusion	10	2
Number of units of homologous blood used	37	5
Mean no. of units transfused per patient	0.86	0.12 <i>P</i> < 0.01
Transfusion rate	23%	6% <i>P</i> < 0.02
Mean number of nights' stay	11	9 <i>P</i> < 0.05)

n/a, not applicable.

Sturdee SW, Beard DJ, Nandahra G, Sonanis SV. Decreasing the blood transfusion rate in elective hip replacement surgery using an autologous drainage system. *Ann R Coll Surg Eng.* 2007 Mar; 89 (2): 136-9.

Should the Cell Saver Autotransfusion System Be Routinely Used in Elective Aortic Surgery?

Vascular Surgery



Table I. Surgical procedure and incidence of use of IAT

Reconstruction for	Total	Patients subjected to IAT (%)
Thoracoabdominal aneurysm	15	100
Abdominal aortic aneurysm	192	81
Ao-Ao	63	75
Ao-Iliac	46	91
Ao-BF	62	77
Ao-I-F	21	86
Occlusive disease	227	56
Ao-F	26	19
Ao-BF	201	61
Total	434	68

Ao-Ao, aorto-aortic bypass; Ao-BF, aortobifemoral bypass; Ao-F, aortofemoral bypass; Ao-I-F, aortoiliac femoral bypass; Ao-Iliac, aortoiliac bypass.

Table IV. Volume of IAT-recovered blood

	Mean blood volume (mL)
Total series	708 ± 637
TAA	1732 ± 1435
AAA	
Total	857 ± 547
Ao-BI	1085 ± 539
Ao-IF	1048 ± 838
Ao-Ao	819 ± 450
Ao-BF	617 ± 390
AOD	
Total	406 ± 328
Ao-BF	414 ± 330
Ao-F	208 ± 236

Ao-Ao, aorto-aortic bypass; Ao-BF, aortobifemoral bypass; Ao-BI, aortobiiliac bypass; Ao-F, aortofemoral bypass; Ao-IF, aortilio-femoral bypass.

Vascular Surgery

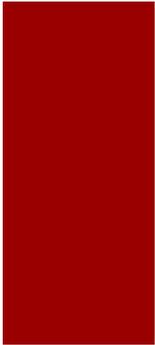


Table V. Administration of homologous blood (mean units per patient)

	IAT	No IAT	<i>P</i>
AAA	2.5 ± 3.8	2.9 ± 3.2	NS
AOD			
Whole series	1.6 ± 2	2.5 ± 2.6	<0.01
Ao-BF	1.7 ± 2	3 ± 2.8	<0.01
Ao-F	1 ± 1	1.2 ± 1.4	NS

Ao-BF, aortobifemoral bypass; Ao-F, aortoilemoral bypass; NS, not significant.

Table VI. Patients not requiring homologous blood during hospitalization

	IAT (%)	No IAT (%)	<i>P</i>
Whole series	32.7	21.4	<0.05
AAA	29	13	0.057
AOD			
Whole series	41	24	<0.05
Ao-BF	41	17	<0.05
Ao-F	40	47	NS

Ao-BF, aortobifemoral bypass; Ao-F, aortoilemoral bypass; NS, not significant.

Impact of blood salvage during liver transplantation on reduction in transfusion requirements¹

Transplant



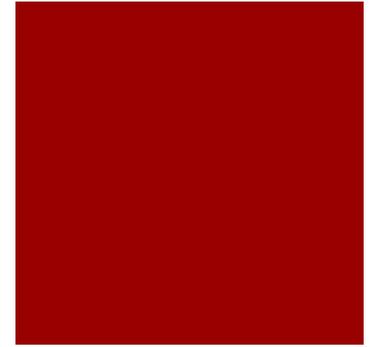
TABLE 2 - Distribution of patient characteristics, surgical data and transfusion of blood components according to the utilization or not of intraoperative red blood cell salvage.

<i>Patients characteristics</i>	IRBCS utilized	IRBCS not utilized
Male/Female	14/8	17/2
Age (years)	45 ± 11,4	51,8 ± 9,4
MELD	15,1 ± 4,99	14,9 ± 4,3
Total blood loss	8362 ± 3994 ml	10824 ± 7002 ml
Blood salvage	5074 ± 3055 ml	
Autologous transfusion	4063 ± 2554 ml	
Operative time	603 ± 94 min	671 ± 117 min
Packed red blood cells	9,6 ± 8 units	22,3 ± 21 units
Platelet concentrates	9,6 ± 12,3 units	12,5 ± 15,9 units
Fresh frozen plasma	10,2 ± 12,7 units	23,8 ± 23,8 units

IRBCS - intraoperative red blood cell salvage; MELD - Model End Liver Disease

**A Prospective Study Investigating the Cost
Effectiveness of Intraoperative Blood Salvage during
Liver Transplantation**

Transplant



- The type of presentation with liver disease was predictive of red cell transfusion and mean savings per case.
 - Retransplantation was associated with greater transfusion than presentation with acute liver failure or chronic liver disease

- Preoperative biochemical indices do not predict intraoperative red blood cell transfusion requirements, although low preoperative hemoglobin was a significant indicator

Transplant

- Over a period of 5.5 years, a total of 2366 units of PRBCs were salvaged.
- The total would have been £503,443 (\$719,923).
- With the use of the cell-saver the figure was brought down to £371,542 (\$531,305), a saving of 26%.

TABLE 1. Actual fixed and variable costs of providing cell saver services

Item	Cost (£)
Reservoir/case	11 (\$15.73)
Aspiration assembly/ACDA/suction tubing/saline	31 (\$44.33)
Processing bowl and tubing/case	96 (\$137.28)
Clinical perfusion scientist salary/annum	35,000 (\$50,050.00)
Maintenance cost/annum	2100 (\$3,003.00)

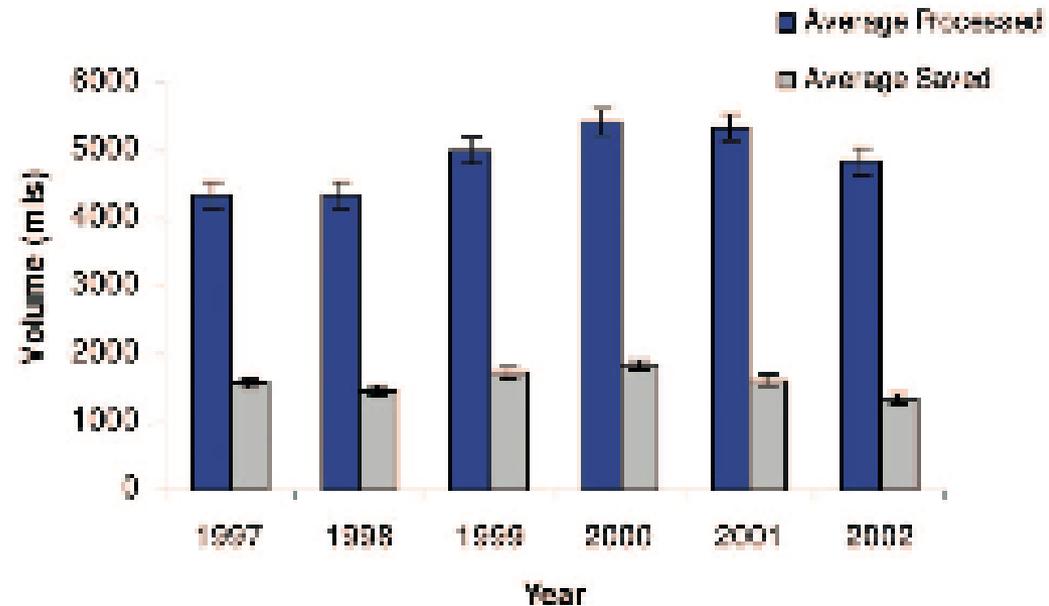


FIGURE 1. Volume of Processed and Saved Blood from the Cell Saver During Liver Transplantation 1997–2002.

Cost

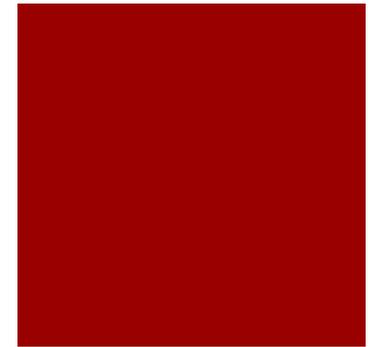


- Net benefit of cell salvage was between £112 and £359 (\$178-\$572) per person compared with allogenic blood transfusion.
- Use of cell salvage could result in net reductions in the volume of allogenic blood transfused of between 6,500 and 320,000 units.
- This would translate to a savings to the NHS of £0.73 million to £36 million (\$1,162,452 - \$57,326,400)

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- Wang G, Bainbridge D, Martin J, et al.: The efficacy of an intraoperative cell saver during cardiac surgery: a meta-analysis of randomized trials. *Anesth Analg*. 2009 Aug;109(2):320-30.



Would you
want
this guy
operating you
(without a cell
saver)??

