

Patient Blood Management

Life's Liquid Organ

Cell Salvage in Obstetrics

Jonathan H. Waters, M.D.

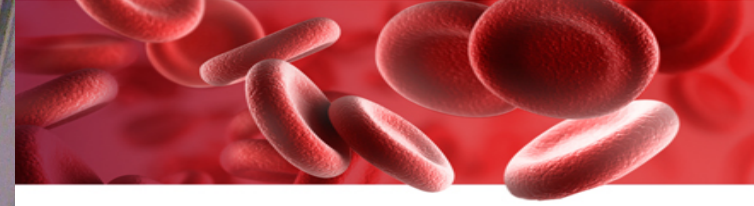
Chief, Dept. of Anesthesiology, Magee Womens Hospital of UPMC

Vice Chair, Clinical Research, Department of Anesthesiology, University of Pittsburgh

Professor of Anesthesiology and Bioengineering, University of Pittsburgh

Medical Director, UPMC Patient Blood Management Program

Medical Director, Acute Interventional Pain Program of UPMC



“Contraindications” to cell salvage

- Tumor
- Amniotic fluid contamination
- Bacterial contamination
- Betadine
- methylmethacrylate
- Antibiotics not licensed for parenteral use

Amniotic Fluid Embolism



- Hypotension
- Pulmonary edema
- Coagulopathy
- Cardiopulmonary arrest

Amniotic fluid embolism



- No definitive causative agent.
- May relate to biochemical component of amniotic fluid
- May relate to particulate components of amniotic fluid
- Incidence reported to range from 1:8000 to 1:30,000 deliveries.
- *Mortality rate 60-80%,*
- *25% of survivors neurologically intact.*

Sample size calculation

- Averaging the incidence of this problem to 1:19000 deliveries, the routine margin of error of 1% would not be reasonable because the confidence interval would include 0.
- A reasonable margin of error of would be 0.001%
- For a 5% type 1 error rate, you would need 1.7 million subjects in a study to evaluate the use of cell salvage in cesarean section.

Clinical use of Amniotic Fluid



- Amniotic fluid therapeutically infused into 27 peripartum women with prolonged coagulation time in doses of 5-500 ml with resolution of clotting abnormalities.
- Amniotic fluid given to 73 patients of all ages without effect.

Tio AG. Rev Peruana Obstet 1955;3:84

Tio AG. JAMA 1956;161:996

Amniotic Fluid Innocuous in Pregnant rhesus monkey



- 9 pregnant rhesus monkey's had amniotic fluid removed.
- 10-45 mL injected over 60 seconds.
- BP, respiratory rate, acid-base status, fibrinogen concentration, and fetal well-being unchanged following injection.

Cell free extracts of placenta result in cardiac arrest in monkeys



- Cell free placental extracts injected causing immediate cardiac arrest.
- Immediately following arrest, circulation found to contain clot.
- Effect dose related.
- Resuscitated animals had little fibrinogen.

Meconium staining of Amniotic Fluid



- In a pig model, 3 ml/kg of meconium stained amniotic fluid caused severe coagulopathy and cardiorespiratory abnormalities.
- In the same model, clear amniotic fluid (meconium free) up to 10 ml/kg caused only minor effects.

Case reports of Autotransfusion in Obstetrics

TABLE 1. Main clinical studies on cell salvage in obstetrics

Year/first author/publication type	Number of cell saving procedures	Number of subjects transfused	Retransfusion rate of salvaged blood (%)	Clinical setting	Amount (mL/unit) of autologous blood transfused (T) or yielded (Y)	Units of allogeneic RBCs transfused
1983/Keeling ²⁰ /RS	43*	Not stated	Not stated	HY, CS, AP	700 mL (mean/Y)	Not stated
1993/Jackson ²⁰ /RS	119	64	53	CS	2 units (mean/T)	Not stated
1998/Rainaldi ²¹ /prospective controlled trial	34	34	100	CS	225 ± 18 mL (mean/T)	Not stated†
1998/Rebarber ²² /retrospective cohort	186	139	74	CS	250 (range, 125-4,750) mL 543 (range, 225-1,160) mL 450 (range, 200-11,250) mL (median/T)	Not stated
2007/Teig ²⁷ /RS‡	182	119	65	Not stated	Not stated	Not stated
2009/King ²¹ /RS	46	19	41	PP, suspected placental abruption, multiple pregnancy, multiple repeat CS, previous PPH, refusal of blood transfusion, CS at full dilatation, low preoperative Hb, at the discretion of the theatre team	300 (range, 200-800) mL (median/T)	2 in 4 patients 24 in 1 patient
2010/Parry ²² /RS	47	17	36	Patients at high risk of hemorrhage (PP, suspected placental abruption, multiple pregnancy, multiple repeat CS, previous PPH, refusal of blood transfusion, CS at full dilatation, low preoperative Hb, at the discretion of the theatre team, failed induction of labor, failed instrumental delivery)	229 (range, 125-534) mL (mean/T)	Not stated
2010/McDonnell ²³ /prospective cohort	51	21	41	PP, CS, ectopic pregnancy, JW	359 (range, 60-1,300) mL (median/T)	3 (mean) (range, 2-14)
2010/Malik ²⁶ /RS	77	Not stated	Not stated	PP, JW	95.5 (range, 0-1,800) mL (mean/Y) 13 units (total number/T)	31 (total number)

* Includes a not stated number of exploratory laparotomies.

† The use of allogeneic blood transfusion was significantly lower in patients submitted to cell salvage.

‡ Survey of cell salvage use (includes 63 episodes of cell salvage setup without processing blood).

AP = abdominal pregnancy; CR = case report; HY = hysterectomy; RS = retrospective series.

Details of fatal association of cell salvage and AFE



- 22 y.o. Jehovah's Witness patient at 30 weeks gestation with preeclampsia and HELLP syndrome.
- Hgb = 7.1 g/dl
- Platelet count = 48,000
- AST = 194 u/L
- ALT = 330 u/L

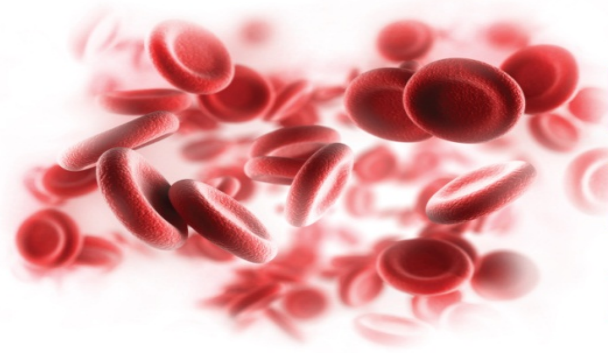
Details of fatal association of cell salvage and AFE

- Continuous Auto Transfusion System (CATS, Fresenius). Leukocyte depletion filter was **not** used.
- Baby delivered by cesarean section. EBL=600 ml which was processed into 200 ml and retransfused.
- Ten minutes after starting the transfusion, the patient became dyspnoeic, hypoxic (O_2 Sat = 85%) then arrested.
- Clinical Dx = amniotic fluid embolism
- Pathologic Dx = “Did not reveal any other cause...”

Considerations in safely applying cell salvage in Obstetrics




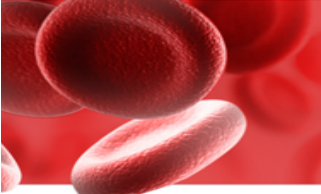
- Are the biochemical contaminants adequately washed out?
- Are the cellular contaminants adequately removed?
- Are the bacterial contaminants adequately removed?



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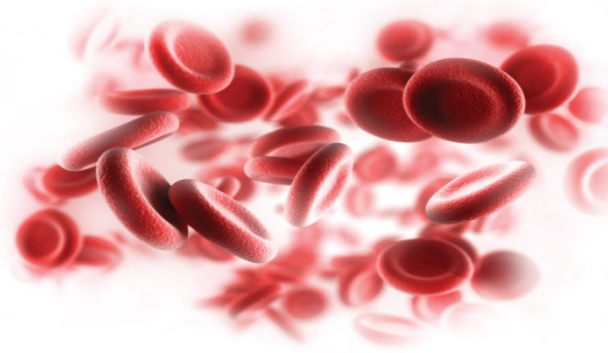
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Biochemical Contaminants

Specimen	TF conc (pM)		TF activity (pM)
	Prewash	Postwash	Postwash
1	4	0	0
2	2	0	0
3	1	0	0
4	1	0	0
5	1	0	0
6	1.2	0	0
7	5.2	0.3	0
8	6.2	0.4	0
9	13.7	3.3	0
Mean \pm SD	3.92 \pm 4.17	0.44 \pm 1.08	0

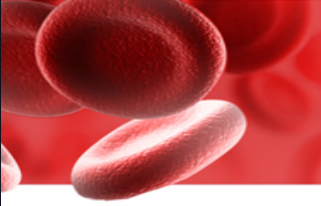
TF = tissue factor; TF conc = total TF concentration, TF activity = concentration of functionally active TF.

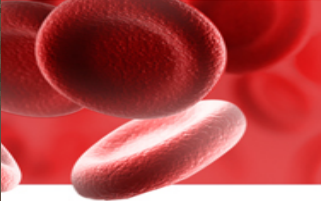
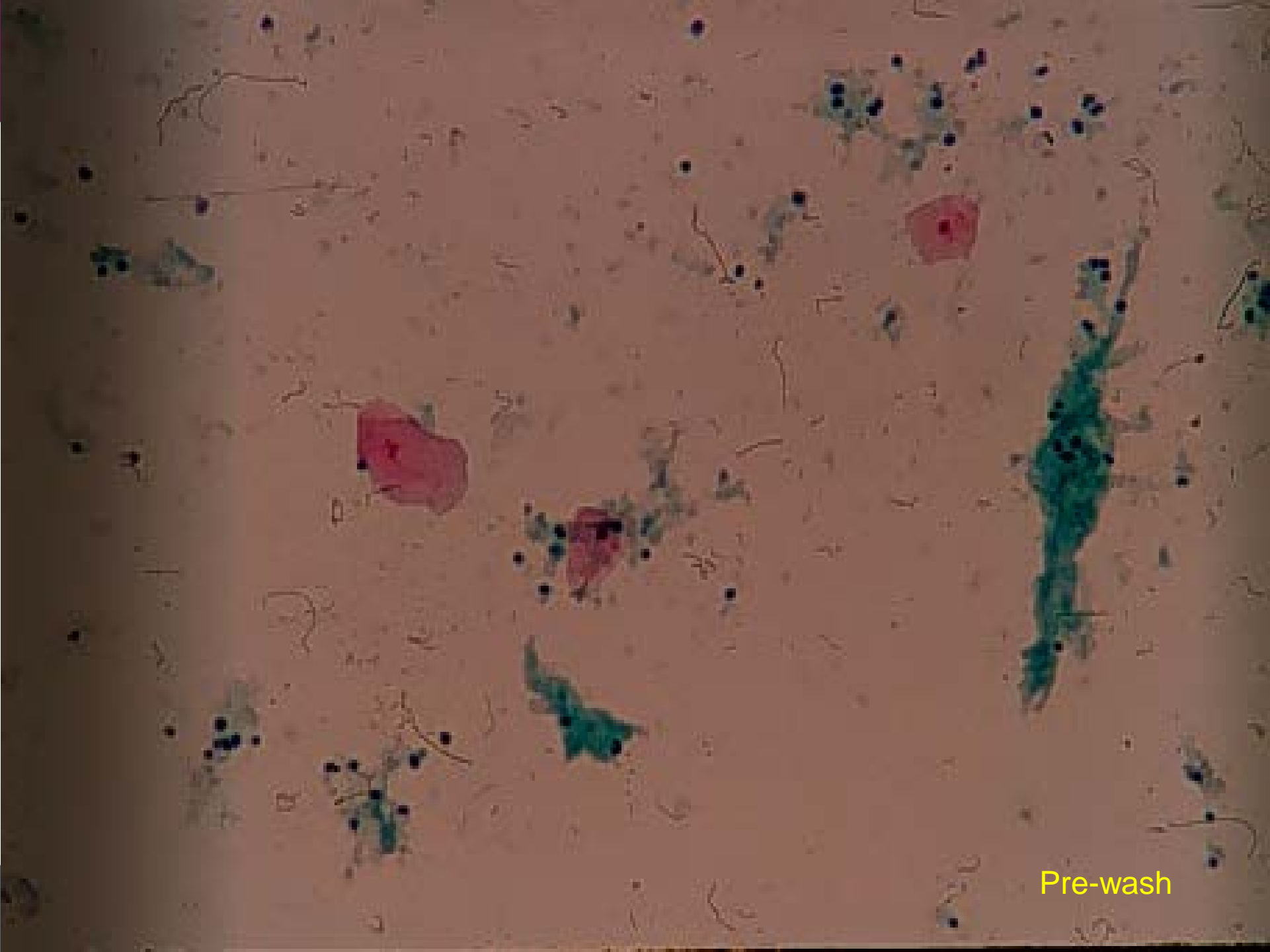


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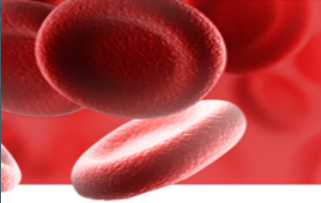
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Particulate Contaminants





Pre-wash



Post-wash



Post-filter

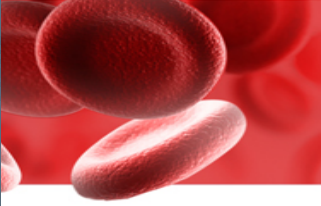




Table 1. Concentrations of Amniotic Fluid Markers

Test	Maternal (n = 14)	Prewash (n = 14)	Postwash (n = 14)	Postfiltration (n = 14)
Potassium (mEq/l)	3.8 (3.7–4.0)	3.8 (2.4–4.0)	1.5 (1.1–1.5)*	1.4 (1.0–1.5)*
Lamellar body count (K/ μ l)	31.0 (24.0–49.9)	22.0 (18.5–29.5)	3.0 (2.0–3.5)*	0.0 (0.0–1.0)*
Squamous cell count (count/HPF)	0.0 (0.0–0.0)†	8.3 (4.0–10.5)	4.4 (3.0–7.6)	0.0 (0.0–0.1)†
Quantitative bacterial culture (CFU/ml)	0.0 (0.0–0.1)†	3.0 (0.6–7.7)	1.3 (0.4–6.1)	0.1 (0.0–0.2)†
Fetal hemoglobin (%)	0.5 (0.3–0.7)	1.1 (0.7–1.5)‡	1.7 (1.0–2.1)‡	1.9 (1.1–2.5)‡

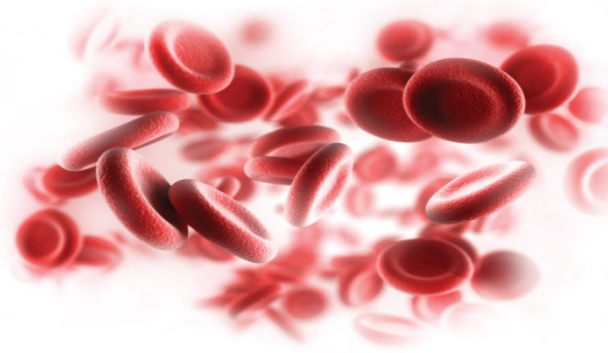
Values expressed as median (twenty-fifth to seventy-fifth percentile).

* $P < 0.05$ compared with prewash and maternal.

† $P < 0.05$ compared with prewash and postwash.

‡ $P < 0.05$ compared with maternal.

K = thousands; HPF = high powered field, CFU = colony-forming units.



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Bacterial Contaminants

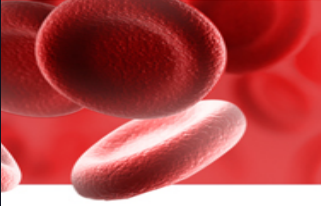




Table 2. Bacterial Reduction

Bacteria	Inoculum Concentration (cfu/ml)	Prewash Concentration* (cfu/ml)	Postwash Concentration† (cfu/ml)	Postfiltration Concentration‡ (cfu/ml)	Reduction, % (Prewash to Postfiltration)
<i>E. coli</i>	596,000 ± 57,200	1,920 ± 452	440 ± 113	19 ± 16	99.0
<i>S. aureus</i>	741,333 ± 889,163	3,691 ± 5,152	436 ± 256	4 ± 7	99.9
<i>P. aeruginosa</i>	611,000 ± 273,000	1,970 ± 1,020	227 ± 113	0.6 ± 2	100
<i>B. fragilis</i>	754,000 ± 84,751	4,603 ± 1,480	1,039 ± 236	111 ± 74	97.6
Control (n = 5)	0 ± 0	0 ± 0	0 ± 0	0 ± 0	–

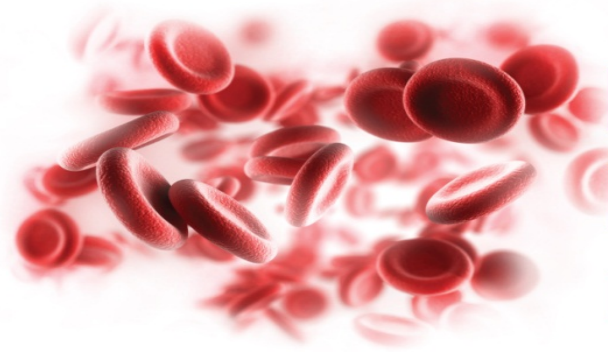
* $P < 0.03$ for comparison of prewash with postwash. † $P < 0.02$ for comparison of postwash with postfiltration. ‡ $P < 0.001$ for comparison of prewash with postfiltration.

cfu = colony forming units.

Organizations recommending blood salvage during the peripartum period:



- Confidential Enquiry into Maternal and Child Health (UK)
- National Institute for Health and Clinical Excellence (UK)
- Obstetric Anaesthetists Association (UK)
- Assoc. of Anaesthetists of Great Britain and Ireland (UK)
- California Maternal Quality Care Collaborative (US)
- American College of Obstetrics & Gynecology (US)



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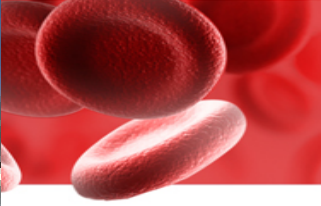
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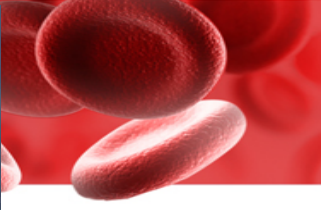
Practical Aspects to Making Salvage Successful in OB

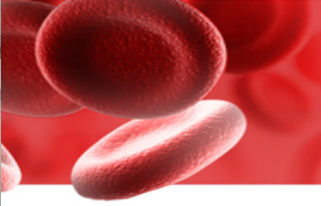
Keys to successful Red cell salvage



- ◆ Regulated suction
- ◆ Rinsing of sponges
- ◆ Restriction to wall suction
- ◆ Adequate anticoagulation
- ◆ Periodic flushing of reservoir
- ◆ Anesthetic choice

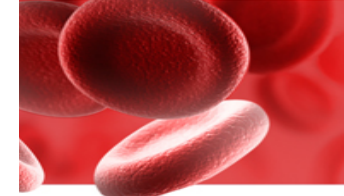






When to utilize:

- When 20 (4 packs) of swabs (laparotomy pads) have been utilized.



CASE REPORT

Severe hypotension related to cell salvaged blood transfusion in obstetrics

L. K. Kessack¹ and N. Hawkins²



R. Mamidanna

C. Stonell

O. Faiz

St. Mary's Hospital,

Imperial College

London, UK

Email: r.mamidanna@imperial.ac.uk

No external funding and no competing interests declared. Previously posted at the Anaesthesia Correspondence web site: <http://www.anaesthesiacorrespondence.com>.

Impact of advancing age on abdominal surgical outcomes. *Archives of Surgery* 2009; **144**: 1108–14.

doi:10.1111/j.1365-2044.2010.06587.x

Hypotension associated with leucocyte depletion filters following cell salvage in obstetrics

I read with interest the case report by Sreelakshmi and Eldridge [1] highlighting the risk of hypotension asso-

balloon-assisted occlusion of the internal iliac arteries before the start of surgery.

Uterine incision and delivery of a deceased female infant was associated with a haemorrhage of approximately 6 l. We transfused a further two units of allogenic blood, five units of fresh frozen plasma, one unit of platelets and two units of cryoprecipitate. Despite the degree of blood loss and a haemoglobin concentration measured at 5.7 g d.l⁻¹, intra-arterial blood pressure measurements con-

Misoprostol (Cytotec)



- Rectal or vaginal placement
- Profound vasodilator

