CODE RBC
Run, Bleeding Crisis !

A Non-trauma Center's Approach to Acute Hemorrhage in Critical & Perinatal Care

January 23, 2102
Southern California Patient Safety Colloquium
Randy German MT(ASCP)SBB
Sherry Lemasters, RN
Arell Shapiro, MD

Objectives

- The Lethal Triad of Trauma
- Damage Control Resuscitation
- California Maternal Quality Care Collaborative (CMQCC) Hemorrhage Task Force Practice Guidelines
- Developing a Protocol
- Hoag's CODE RBC Response
- Risk of Uncrossmatched Blood
- Factor VIIa
- Lessons Learned
- Metrics and Case Studies

What is a colloquium ?

Colloquium (noun) – an academic meeting or seminar usually led by a different lecturer and on a different topic at each meeting.

Massive Transfusion
A Not So New Subject

"To determine the coagulation defects associated with massive blood transfusions, coagulation studies were performed on 21 battle casualties admitted to the US Naval Support Activity Hospital, Da Nang, Vietnam"

Miller RD, Robbin TO, Tong MJ, et al. Coagulation defects associated with massive blood transfusion. Ann Surg 1971; 174:794-801.

Massive Transfusion

- Massive Transfusion (>10 Units in 24 hours)
  - 7% of military trauma patients
  - 3% of civilian trauma patients
  - 30 - 60% mortality rate
- 40% of 14 million annual transfusions
- Cause of Death in Trauma Patients
  - 40% Uncontrolled Hemorrhage/Exsanguination
  - Second only to CNS injury

Massive Transfusion

Hemorrhagic shock begins at ~20% of blood volume loss

Calculating Blood Volume
Males: weight in Kg (lbs ÷ 2.2) x 77 ml/kg
Females: weight in Kg (lbs ÷ 2.2) x 67 ml/kg

Example: 175 pound male
175 ÷ 2.2 = 79.5 kg
79.5 x 77 = 6.12 Liter Blood Volume
6120 mls x 20% = 1224 mls

Clinical Signs of Acute Hemorrhage

Blood loss (ml)	0-750	750–1500	1500-2000	>2000
% of total blood volume	0 -15%	15-30%	30-40%	>40%
Pulse rate	< 100	> 100	> 120	> 140
Blood pressure	Normal	Normal	↓	↓
Pulse pressure	Normal / ↑	↓	↓	↓
Orthostasis	Absent	Minimal	Marked	Marked
Capillary Refill (perfusion)	Normal	Delayed	Delayed	Delayed
Respiratory Rate	14 – 20	20 – 30	30 – 40	> 34
Urine Output (ml/hr)	> 30	20 – 30	5 – 15	< 5
CNS Mental Status	Slight Anxiety	Mild Anxiety	Anxious/ Confused	Confused/ Lethargic
Cardiac Index L/min (Δ %)	↓ 0-10%	↓ 20-50%	↓ 50-75%	↓ >75%

The "Lethal Triad of Trauma"

- Hypothermia
- Acidosis
- Coagulopathy

The Lethal Triad of Trauma
Hypothermia

- **Causes of Hypothermia**
  - Environmental factors: extrication and transport time
  - IV fluids and ongoing blood loss
  - Alteration of normal heat producing metabolism
- **Effects of Hypothermia**
  - Decreases platelet aggregation and adhesion
  - Decrease coagulation factor activity by 10% for each degree decrease in core temperature.
  - Both R (Rx Time) & K (Fibrin) prolonged on TEG
  - 100% fatal when core temperature reaches < 32° C.
- **Coagulation assays are run at 37 ° C.!**

The Lethal Triad of Trauma
Acidosis

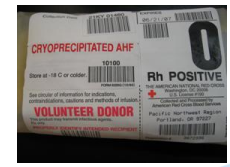
- **Causes of Acidosis**
  - Decreased perfusion leads to anaerobic metabolism and lactic acid production.
  - RL pH 6.0, normal saline 4.5, no buffering capacity
  - Red cells at two weeks have pH < 7.0
- **Effects of Acidosis**
  - Reduced clot formation demonstrated by TEG
  - Spherical platelets devoid of pseudopods
  - Reduced fibrinogen levels, platelet counts & Xa
- **Prevention of Acidosis**
  - Dependent on restoration of perfusion
  - Exogenous bicarb has mixed results

Whole Blood
40% Red Cells, 60 % Plasma

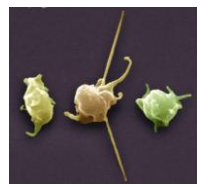
Red Blood Cells
Carries Oxygen, Does Not Help Blood Clot

Frozen Plasma
Clotting Factors

Cryoprecipitate
Fibrinogen Concentrate



Platelets



The Lethal Triad of Trauma
Coagulopathy

- **Causes**
  - Hypothermia & Acidosis
  - Dilution
  - Consumption
- **Effect**
  - Uncontrolled bleeding even if mechanical control achieved.

The "Blood Vicious Cycle" of Trauma*
Hypothermia, Acidosis, Coagulopathy

*Kashuk JL, Moore EE, Millikan JS, et al. J Trauma 22:672-679, 1982

Predictors of Massive Transfusion

• Base deficit	≤ - 10
• INR	≥ 1.5
• Temperature	< 96° F. or 35° C.
• Systolic BP	< 90 mm Hg
• Hemoglobin	< 11 g/dl
• Radial Pulse	absent or weak

Traditional Treatment of Acute Hemorrhage
ATLS Resuscitation Protocol

- **Insert two large bore IVs.**
- **Crystalloids to support volume and blood pressure**
  - ATLS: 2 L crystalloid if systolic BP <100
  - ACLS: 3 ml of crystalloid/1 ml of blood loss.
- **Red cells as an oxygen carrier**
  - If systolic BP remains or falls back to <100
  - If bleeding > 100 ml/min
- **Platelets, FFP and Cryo if coag tests abnormal**
  - INR > 1.5
  - Platelets < 50 K
  - Fibrinogen < 100 mg/dl

Coagulopathy of Trauma

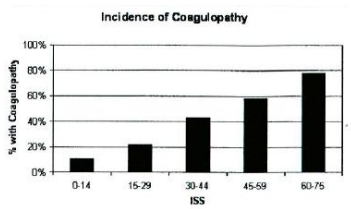
Brohi K, Singh J, Heron M, et al. Acute traumatic coagulopathy. Journal of Trauma 2003;54:1127-1130.

- 1088 consecutive trauma patients
- 24% had a significant coagulopathy on admission
  - PT >18, PTT >60
- More severely injured you are, the worse the coagulopathy.
- Mortality rate higher in those with coagulopathy across range of injury severity

Trauma and Critical Care Unit, Royal London Hospital, London, UK

Coagulopathy of Trauma

Brohi K, Singh J, Heron M, et al. **Acute traumatic coagulopathy**. Journal of Trauma 2003;54:1127-1130.

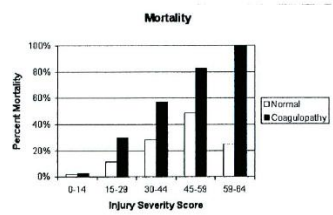


Severity of injury predicts coagulopathy

Trauma and Critical Care Unit, Royal London Hospital, London, UK

Coagulopathy of Trauma

Brohi K, Singh J, Heron M, et al. **Acute traumatic coagulopathy.** Journal of Trauma 2003;54:1127-1130.



Patients with coagulopathy have higher mortality rates across injury severity

Trauma and Critical Care Unit, Royal London Hospital, London, UK

Coagulopathy of Trauma

MacLeod JB, Lynn M, Kenney MG, et al. **Early coagulopathy predicts mortality in trauma**. Journal of Trauma 2003;55:39-44.

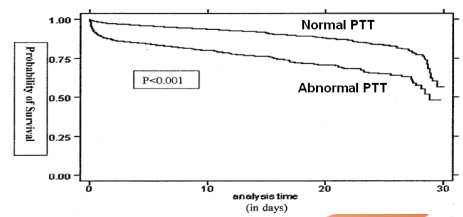
- 14,397 Patients in Trauma Registry
- Overall Mortality Rate 8.9%
- 28% abnormal PT, 8% abnormal PTT (median 31 min.)
- Predictors of Mortality:
  PT, PTT, ISS, BP, Hct, Base Deficit, Head Injury
  - Abnormal PT
    - adjusted odds ratio 1.35 (35%), p <0.001
  - Abnormal PTT
    - adjusted odds ratio 4.26 (326%), p <0.001

University of Miami,Jackson Memorial Hospital, Ryder Trauma Center, Miami, FL

Coagulopathy of Trauma

MacLeod JB, Lynn M, Kenney MG, et al. **Early coagulopathy predicts mortality in trauma.** Journal of Trauma 003;55:39-44.

Those who present with elevated PTT die at a higher rate.
50% within 2 hours, 80% within 6 hours, 90% within 12 hours
There is an urgency to correcting coagulopathy.



University of Miami/Jackson Memorial Hospital, Ryder Trauma Center, Miami, FL

2005 US Army Institute of Surgical Research International Symposium on Massive Transfusion

Holcomb JB, Hess JR: **Early massive trauma transfusion: State of the art.** J Trauma 60:S1-S2, 2006

- 2005: International Consensus Conference
  - Sponsored by US Army Institute of Surgical Research
  - 46 experts from US and Europe
- Conclusions
  - Transfusion practices and survival rates vary.
  - Increased plasma and platelet to red cells ratios associated with better survival.
  - **Guidelines should aim for 1:1:1 ratio.**

US Army Institute of Surgical Research, Ft. Sam Houston, San Antonio, Tx.

Improved Survival With ↑ Plasma to Red Cell Ratios

Borgman MA, Spinella PC, Perkins JG, et al. **The ratio of blood products transfused affects mortality in patients receiving massive transfusion at a combat support hospital.** Journal of Trauma 2007;63:805-813.

	Red Cell/Plasma		
	Low median 8 : 1	Medium median 2.5 : 1	High median 1.4 : 1
ISS (injury severity score)	18	18	18
Overall Mortality (%) p <0.001	65%	34%	19%
Fatal Hemorrhage (%) p < 0.001	93%	78%	37%
Time to Death (hrs) p < 0.05	2 hours	4 hours	28 hours

Trauma patients admitted to combat support hospital in Iraq 11-3 to 8-06

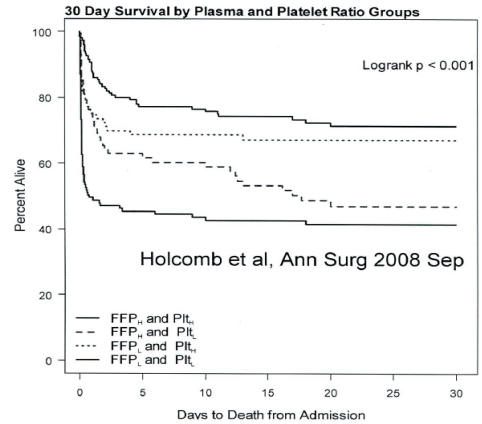
Improved Survival With ↑ Platelet to Red Cell Ratios

Holcomb JG, Wade CE, Michalec JE, et al. **Increased plasma and platelet to red cell transfusion rations improves outcome in 466 massively transfused civilian trauma patients**. Annals of Surgery 2008;248:447-458,

- 16 US Level I trauma centers
- 466 of 1574 (30%) patients massively transfused
- Divided into four groups:
  - High Plasma (red cell/plasma <2:1)
    - High (<2:1) & Low (>2:1) Platelet
  - Low Plasma (red cell/plasma > 2:1)
    - High (<2:1) & Low (>2:1) Platelet

16 US Level I Trauma Centers

30 Day Survival by Plasma and Platelet Ratio Groups



Decreased Red Cell:Plasma Ratios Associated With Improved Mortality Rates in Trauma Resuscitation Patients Nine Studies Oct 2007 – Feb 2009

study	n	outcome
Borgman et al 2007 J Trauma 63:805-807	246	r/p 8:1 mortality 65% r/p 2.5:1 mortality 34% r/p 1.4:1 mortality 19%
Duchesne et al 2008 J Trauma 65:272-276	385	r/p > 1:1 mortality 88% r/p ≤ 1:1 mortality 26%
Margele et al 2008 Vox Sang 95:112-119	713	r/p > 1.1 mortality 24.6% r/p 0.9-1.1 mortality 9.6% r/p < 0.9 mortality 3.5%
Holcomb et al 2008 Ann Surg 248:447-458	466	r/p > 1:2 mortality 60% r/p ≤ 1:2 mortality 40%
Kashuk et al 2008 J Trauma 65:986-993	133	r/p 4:1 in non-survivors r/p 2:1 in survivors
Sperry et al 2008 J Trauma 65:986-993	415	r/p > 1.5:1 mortality 12.8% r/p < 1.5:1 mortality 3.9%
Snyder et al 2008 J Trauma 66:358-362	134	r/p > 2:1 mortality 58% r/p < 2:1 mortality 40%
Gunter et al 2007 J Trauma 65:527-534	213	r/p > 3:2 mortality 62% r/p ≤ 3:2 mortality 41%
Johansson 2009 Vox Sang 96:111-118	832	no protocol mortality 31.5% 5:5:2 r/p/plt mortality 20.4%

The Problem of Survivor Bias

- 50% of MTP patients die within 24 hours
- 25% die within first 4 hours, many within one hour.
- 1:1 red cell/plasma only applies to ~ 5% of patients.
- Patients that died before receiving plasma counted in non-survivor groups.
- "Does the plasma save the life or does plasma transfusion happen to those who live ?"

Jeannie Calum, MD, Toronto, AABB Annual Meeting 2008, Montreal, Canada

The PROMMT Study

Holcomb JB, del Junco D, Fox E, et al **The prospective, observational, multicenter major trauma transfusion (PROMMTT) study**: comparative effectiveness of a time-varying treatment with competing risks. Arch Surg 2012 Oct 15:1-10. doi: 10.10.1001/2013.jamasurg.387. [Epub ahead of print]

- Prospective, multicenter observational trial
- 10 Level I trauma centers, 905 patients
- Goal of the study design was to eliminate survivor bias
  - Real time data collection from time of admission
  - Not limited to massive transfusion patients
  - Ratios computed at 14 consecutive time intervals.
  - Data analyzed using a time-dependent proportional hazard regression analysis.

The PROMMTT Study

Holcomb JB, del Junco D, Fox E, et al The prospective, observational, multicenter major trauma transfusion (PROMMTT) study: comparative effectiveness of a time-varying treatment with competing risks. Arch Surg 2012 Oct 15:1-10. doi: 10.10.1001/2013.jamasurg.387. [Epub ahead of print]

- **Hemorrhagic Cause of Death:**
  - 60% within 3 hours, 94% occur within 24 hours
  - 81% of patients that died within 6 hours bled to death.
- **Red Cell/Plasma & Platelet/Red Cell ratios >1:2**
  - 3-4 times less likely to die in the first 6 hours
  - Benefit not seen after 24 hours
    - cause of death shifts to head injury, respiratory distress, organ failure and infection

Are MTPs Effective in Non-Trauma Cases ?

Mell MW, O'Neil AS, Callcut RA, et al. Effect of early plasma transfusion on mortality in patients with ruptured abdominal aortic aneurysm. Surgery 2010 Apr 6, Epub, in press

- **Non-elective ruptured AAA repair**
  - 128 patients received >10 units during OR
  - 30 day mortality 22.6%, 11 intra op deaths
  - 2 groups: p/r > 1:2 and p/r <1:2
- **High plasma group**
  - 30 day mortality 15% vs 39%
  - Colon ischemia 22.4% vs. 41.1%

Division of Vascular Surgery, Stanford University

The Changing Resuscitation Paradigm "Damage Control Resuscitation

- **Goal: Prevention of the "lethal triad" of acidosis, hypothermia and coagulopathy.**
  - Tolerance of moderate hypotension (~90 systolic) and minimal crystalloid use.
  - Delay surgery if possible until hypothermia, acidosis and coagulopathy are treated.
  - Short surgical procedures to control bleeding and minimize contamination.
  - Give plasma, platelets and cryoprecipitate earlier and in increased amounts.
  - Best achieved with a massive transfusion protocol

Growth of Massive Transfusion Protocols

- 2006: 3 academic trauma centers in the US
  J Trauma 2006;60:S91-S96
- 2010: 85% of 186 trauma centers
  Transfusion 2010;50:1545-1551
  - Most begin with 1:1:1 ratio
  - All include plasma by second delivery
  - 37% include Factor VIIa as part of their protocol

California Maternal Quality Care Collaborative (CMQCC)

- UCLA Maternal Quality Indicator Group evolved into the California Perinatal Quality Care Collaborative (CPQCC)
- 2004 – CDPH and CPQCC formed the CMQCC
- Mission – End preventable morbidity and mortality and racial disparities in Califronia maternity care by sharing data, facilitating collaborations and defining clinical best preactices realted to obstetrical care.
- 2009 – Hemmorhage Task Force practice guidelines

2009 CMQCC Hemorrhage Task Force Practice Guidelines

- Maternal deaths in California on the increase
  - 6 per 100,000 in 1996
  - 16 per 100,000 in 2006 (54 in African Americans)
- In US, transfusions in OB patients have increased 92% between 1998 and 2005.
- In California, 2% of all deliveries are complicated by hemorrhage.
- Obstetric hemorrhage is the leading cause of maternal death.

2009 CMQCC Hemorrhage Task Force Practice Guidelines

- **Categorized into 1 of 4 stages with actions defined for:**
  - Patient Assessment
  - Medication
  - Procedures
  - Transfusion Support
- **Detailed protocols, slide presentations, charts available at http://www.cmqcc.org**

2009 CMQCC Hemorrhage Task Force Practice Guidelines

- **Stage 0 - Assess for risk factors for hemorrhage**
  - **Low Risk: Hold Clot**
    - No previous uterine incision
    - Singleton pregnancy
    - ≤4 previous births
    - No known bleeding disorder
    - No history of PPH

2009 CMQCC Hemorrhage Task Force Practice Guidelines

- **Stage 0 - Assess for risk factors for hemorrhage**
  - **Medium Risk: Type & Screen**
    - Prior C-Section or uterine surgery
    - Multiple gestation
    - ≥4 previous vaginal births
    - Chorioamnionitis
    - History of previous PPH
    - Larger uterine fibroids
    - Estimate fetal weight > 4 Kg
    - Morbid obesitiy (BMI >35)

2009 CMQCC Hemorrhage Task Force Practice Guidelines

- **Stage 0 - Assess for risk factors for hemorrhage**
  - **High Risk: Type & Crossmatch**
    - Placenta previa, low lying placenta
    - Suspected placenta accreta of percreta
    - Hematocrit < 30 and other risk factors
    - Platelets < 100,000
    - Active bleeding (greater than show) on admission
    - Known coagulopathy

2009 CMQCC Hemorrhage Task Force Practice Guidelines

- **Stage 1**
  - Blood loss >500 ml (vaginal) or 1000 ml C-section
  - Vital sign changes
    - HR > 110
    - BP < 85/45
    - O2 Sat < 95%
  - **Blood Bank Recommendations**
    - Ensure Type & Cross for 2 units

2009 CMQCC Hemorrhage Task Force Practice Guidelines

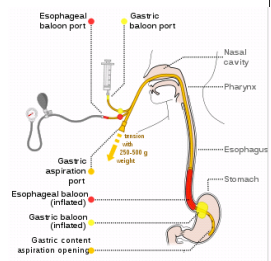
- **Stage 2**
  - Continued bleeding, total blood loss under 1500 ml
  - **Blood Bank Recommendations**
    - Deliver 2 units red cells to bedside
    - Transfuse per clinical signs, do not wait for labs
    - Consider thawing 2 units FFP
    - Give FFP if thawing > 2 units red cells
    - Determine availability of additional red cells & "coag products"

2009 CMQCC Hemorrhage Task Force Practice Guidelines

- **Stage 3 (CODE RBC Activated)**
  - Total blood loss over 1500 ml
  - > 2 units red cells given
  - Vital signs unstable or suspicion of DIC
  - **Blood Bank**
    - Massive "Hemorrhage Pack"
    - Near 1:1 red cell/plasma
    - 1 platelet
    - "unresponsive Coagulopathy" after 10 units red cells and "full coagulation factor replacement"
      - Consider Factor VIIa

April 2008 Case Review

- 45 year old male
- Uncontrolled esophageal varices.
- Blakemore tube placement.
- Esophageal rupture during procedure.
- Received 37 blood components



Hoag Hospital

- Community not-for-profit hospital
- Opened 1953, 75 beds
- Two campus system: 500 and 50 beds
- Specialties in Oncology, Heart & Vascular, Orthopedics, Neurosciences and Women's Health
- Annual Statistics
  - 6000 deliveries
  - 10,000 inpatient surgeries, 400 open heart
  - 70,000 ED visits
  - 25,000 blood components transfused

CODE RBC Team – August 2010

Arell Shapiro MD, Transfusion Medicine
Greg Super MD, Director, ED
Jennifer Keiner MD, Internal Medicine
Pau Lee MD, GI Lab
Victor Beretta MD, Anesthesiology
Grete Porteous MD, Anesthesiology
Tamerou Asrat MD, Perinatology
Rosemary O'Meeghan, MD, Critical Care
Dale Braithwaite, MD, Obstetrics
Stephanie Waldman, MD, Anesthesiology

Randy German, CLS, Transfusion Service
Carol Vanderree, CLS, Transfusion Service

Sherry Lemasters, RN, Performance Imprvt
Marilyn Lang, RN JD, Performance Imprvt
Carlene Green, Performance Imprvt

Tammy Valencia RN, ED
Molly Hewett RN, VP, Patient Care Svcs
Carole Metcalf RN, Director, Periop Svcs
Kelly Parra RN, Critical Care
Jamie Lynch, RN, Labor & Delivery
Kim Mikes RN, Director, Short Stay Unit
Kim Mullen RN, Exec Dir. Women's Health
Debbie Lepman, RN, Director, Critical Care
Debra Burzynski, RN, Nurse Educator, ICU

David Godoy, Support Services/Transport
Michele VanRy, Supervisor, Comm/PBX

Heather Paradee, Respiratory Therapy

Stephanie Chao, Mgr, Pharmacy
Dong Dao, Pharmacy Resident

Focus Group Outcomes

- Poor (and excessive) communication
- Empirical and non-standardized physician orders
- Transport delays
- Laboratory testing turn around time too slow to guide therapy.
- No blood warmer/rapid infusion device available
- Inexperienced and/or insufficient staff at the bedside
- Excessive paperwork
- No defined roles or protocols in the Transfusion Service.
- Differing protocols being developed in different areas.
- No guidelines for the use of Activated Factor VIIa

CODE RBC Goals

- Improve communications between the Nursing Unit and the Transfusion Service.
- Rapidly deploy equipment, blood & personnel to the bedside.
- Transfuse using a standardized ratio of blood components in accordance with the current Massive Transfusion literature.
- Prevent or minimize the "lethal triad of trauma"

CODE RBC Goals

- Improve patient monitoring and treatment through a customized Code RBC order set.
- Meet or exceed the CMQCC Hemorrhage Task Force Recommendations
- Universal protocol for all areas of the hospital.
- Develop guidelines for the use of Activated Factor VIIa.

Medical Subgroup

- Determine Blood component transfusion ratios
- Develop Order Sets
  - Nursing Care
  - Medications
  - Frequency and Type of Laboratory Monitoring

Response Subgroup

- Assemble CODE RBC Kits
- Develop Hospital Policies
- CODE RBC Documentation Form
- Conduct Training and Education

Transfusion Service Subgroup

- Select and validate coolers
- Develop multi-unit Transfusion Record
- Validate 5 day plasma
- Define internal protocol and train staff
- Obtain Belmont Rapid Infuser
- Develop computer workaround for Rh Negative patients
  - Switched to Rh Positive after Wave 3 (12 red cells)

Pharmacy Subgroup

- Medication Dosing Recommendations
- Approval via PNT for Off-label use of Factor VIIa

Metrics Subgroup

- Development and Monitoring of Patient Metrics
- Ongoing Case Review and Quality Improvements

CODE RBC Response

- Nursing Units
  - Call operator and announce "CODE RBC, Patient Location"
  - Call Blood Bank with
    - medical record number
    - ordering MD
  - Order CODE RBC testing panels in HIS:
    - CODE RBC Blood Bank Panel
    - CODE RBC Diagnostic Panel
  - Retrieve CODE RBC Kit from Crash Cart

CODE RBC Response

- Rapid Response Team to patient locations
- Respiratory to patient location
- Blood Bank prepares Wave One blood components.
- Transport to the Transfusion Service
  - Pick-up & deliver Wave One and Belmont Rapid Infuser.
  - Pick-up and deliver Wave Two
- Baseline labs drawn
  - Respirator runs gases on nearest POC instrument
  - Coagulation tests sent to Lab in green bag.
- MD completes paper order set

Order Set: Blood Components

☒ Wave 1: 6 red cells in a cooler
Belmont Rapid Infuser

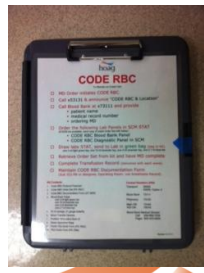
☒ Wave 2: 1 platelet, 10 cryo

- Wave 3: 6 red cells, 6 plasma (cooler)
- Wave 4: 6 red cells, 6 plasma, 1 platelet, 10 cryo
- Wave 5: 6 red cells, 6 plasma, 1 platelet
- Wave 6: 6 red cells, 6 plasma, 1 platelet, 10 cryo

Continue alternating Wave 5 & 6

CODE RBC Kits
Located on All Crash Carts

- Code RBC Protocol Flowchart
- Code RBC Order Set
- Code RBC Documentation Form
- Factor VIIa Order Form
- TEG Order Form
- Key Contact Numbers



Blood Draw Kits

- Carried by RRT & on Belmont Infuser
- Green specimen bag
- 20 ml syringe
- 21 bauge butterfly
- Blood transfer devices
- Pre-filled 10 ml saline flush
- Blood Draw Tubes
  - 3 ml light green top
  - 10 ml lavender top
  - 3 ml lavender top
  - 2.7 ml blue top

Color Coded Specimen Bags

HOAG MEMORIAL HOSPITAL PRESBYTERIAN

CODE RBC ORDER SET | 11/29/11 | 1 of 1

1 THERAPEUTIC BLOOD COMPONENT PRODUCT, WHICH HAS BEEN APPROVED BY THE PHARMACY AND THERAPEUTICS COMMITTEE OF THE MEDICAL STAFF MAY BE ORDERED AND ADMINISTERED UNLESS OTHERWISE SPECIFIED. CROSS OUT ANY ORDERS THAT DO NOT APPLY. MARK CHECK BOXES FOR ORDERS THAT DO APPLY.
DOCTOR: PLEASE STATE PERTINENT CLINICAL INFORMATION WHEN ORDERING RADIOLOGY PROCEDURES.

CURRENT PATIENT LOCATION: _____ **TRANSFER PATIENT TO:** _____

DIAGNOSIS/SOURCE OF BLEEDING: _____ **ALLERGIES:** _____

NURSING CARE:
- ☐ **Establish IV Access (Large Bore, Multiple lines if indicated)**
- ☐ **Apply Bair Hugger PRN temp _____ degrees C.**
- ☒ **Strict Intake and Output, save all blood product and IV fluid bags.**
- ☐ **Pulse, respirations and blood pressure every 5 minutes.**
- ☐ **Temp every 30 minutes, core temp if possible.**

LABS: Blood tubes and color coded specimen bags in Code RBC Kits
- ☐ **CODE RBC Blood Bank Panel:** Includes **Crossmatch(10) Plasma(6) Platelets(1) Cryo(10) Blood Issue Request**
- ☐ **CODE RBC Diagnostic Panel - Baseline and repeat every _____ minutes x _____**
  Arterial Blood Gases With Lytes: Includes **ABGs, Hgb, Na, K, Cl, Ionized Ca, Glucose, Lactate**
  Coag Panel (send to Lab) Includes **Plt Count, PT /APTT, Fibrinogen, Mg**
- ☐ **Other:** _____
- ☐ **TEG** (Consult Blood Bank Medical Director before ordering, pager 800-403-0649, ext. 46189, 45623)

MEDICATIONS:
- ☐ **Calcium Chloride:** Give 1 gm (13.6 MEq) in 50ml ☐ NS or ☐ D5W IVP or IV PB over 10 minutes (1 q 2 units RBC)
- ☐ **Magnesium Sulfate:** (EKG monitoring required): 1 gm = 2ml 50% IVP over 15 minutes (1 q 3 units RBC)
- ☐ **DDAVP:** 0.3 mcg/kg IV over 1 minute

Antifibrinolytics
- ☐ **Tranexamic Acid:** 1000 mg IV over 10 minutes, followed by 1000 mg IV over the next 8 hours
  OR
- ☐ **Aminocaproic Acid:** 5 gm IV PB in 250 ml NS or D5W over 60 minutes, followed by 2 gm / hr infusion
- ☐ **Factor VIIa:** per Factor VIIa Order Sheet
- ☐ **Other:** _____

CONSENT: ☐ **Signed Transfusion Consent On Chart** ☐ **Emergency Transfusion Documented in Progress Notes**

BLOOD COMPONENT TRANSFUSION ORDERS (Delivered in Waves, Administer as Clinically Indicated):
- ☐ **Infuse with Rapid Infusor/Warmer at a rate of _____ ml/min (maximum rate 500ml/min).**
- ☐ **Give uncrossmatched red cells if no crossmatched units available.**
- ☒ **Wave 1: 6 RBCs in cooler. Belmont Rapid Infuser**

Order Set – Nursing Care

☒ Establish IV Access (Large Bore, Multiple lines if indicated)

- Apply Bair Hugger PRN temp _____ degrees C.

☒ Strict Intake and Output, save all blood product and IV fluid bags.

- Pulse, respirations and blood pressure every 5 minutes.
- Temp every 30 minutes, core temp if possible.

Order Set – Laboratory Monitoring

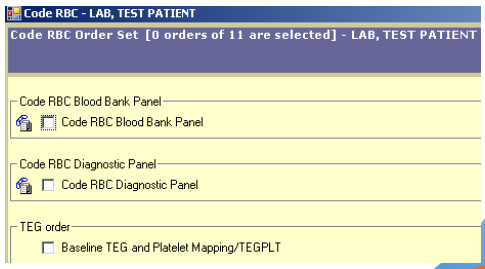
☒ **Code RBC Blood Bank Panel**
XM (10) Plasma (6) Plt (1) Cryo (10) Blood Issue Request

☒ **Code RBC Diagnostic Panel**

- **ABGs with Lytes (Point of Care on GEM 4000)**
  ABGs, Hgb, Na, K, Cl, Ionized Ca, Glucose, Lactic Acid
- **Code RBC Coag Panel**
  Plt Count, PT/APTT, Fibrinogen, Mg

- **TEG** (consultation required)

CODE RBC Order Sets



Importance of Laboratory Monitoring

- Citrate anticoagulant and elevated potassium in blood components
  - May result in hypotension & arrhythmias
  - Monitor ionized calcium, potassium & magnesium
- Guides to blood component therapy
  - Hemoglobin
  - Platelet count
  - PT, PTT, INR
  - Fibrinogen

Order Set - Medications

- **Calcium Chloride**
  - 1 gm (13.6 mEq) in 50ml NS
  - D5W IVP or IV PB over 10 minutes (1 q 2 units RBC)
- **Magnesium Sulfate**
  - EKG monitoring required
  - 1 gm = 2ml 50% IVP over 15 minutes (1 q 3 units RBC)
- **DDAVP**
  - 0.3 mcg/kg IV over 1 minute (Pharmacy to mix)

Order Set - Medications

- **Antifibrinolytics**
  - **Tranexamic Acid:** 1000 mg IV over 10 minutes, followed by 1000 mg IV over the next 8 hours
  - **Aminocaproic Acid:** 5g IV PB in 250cc NS or D5W over 60 minutes, followed by 2g/hr infusion
- **Factor VIIa**: per Factor VIIa Order Sheet

Order Set - Medications

- **Calcium Chloride**
  - 1 gm (13.6 mEq) in 50ml NS or
  - D5W IVP or IV PB over 10 minutes (1 q 2 units RBC)
- **Magnesium Sulfate**
  - EKG monitoring required
  - 1 gm = 2ml 50% IVP over 15 minutes (1 q 3 units RBC)
- **DDAVP**
  - 0.3 mcg/kg IV over 1 minute (Pharmacy to mix)

Order Set - Medications

- **Antifibrinolytics**
  - **Tranexamic Acid:** 1000 mg IV over 10 minutes, followed by 1000 mg IV over the next 8 hours
    or
  - **Aminocaproic Acid:** 5g IV PB in 250cc NS or D5W over 60 minutes, followed by 2g/hr infusion
- **Factor VIIa**: per Factor VIIa Order Sheet

Transport Coolers

- On Wheels
- 3 Frozen Coolants
- Good for 7 hours
- Can follow patient

Belmont Rapid Infuser

- Multiple leads
- Built in filters
- **Up to 500 ml/minute at 37°**
- Deployed from the Transfusion Service
- Delivered with Wave 1 blood components

CODE RBC TRANSFUSION RECORD: Wave Number ______

Patient Name: ______________ MRUN: __________ Location/Room of Code RBC: ________

☐ Red Cell Units Are Crossmatch Compatible (Physician Signature NOT Required)

☐ **Red Cell Units are Uncrossmatched – Physician Authorization Required Prior to Transfusion**
Physician must sign prior to transfusion or document verbal order & have physician sign when time allows

☐ **Patient has red cell alloantibody (ies); red cell units may be incompatible.**

I certify that the condition of this patient requires red cell transfusion prior to completion of compatibility testing.

Verbal order per Doctor ______________ Date: ________ RN: ______________ (RN Signature)

Physician Signature: ______________ Date: ________

Unit Number	Name and MRUN Match on Armband and Unit Label: Transfusionist Signature	2nd Check Signature	Infusion Start Date/Time	Infusion Complete Date/Time
RED CELLS				
PLASMA				
PLATELETPHERESIS * DO NOT RUN THROUGH RAPID INFUSER*				
CRYOPRECIPITATE – 5 Unit Pool * DO NOT RUN THROUGH RAPID INFUSER*				

CODE RBC TRANSFUSION RECORD
PS 1540 Rev 06/16/11
[1620]

Risk of Uncrossmatched Red Cell Transfusions Frequency or Red Cell Alloimmunization

- Risk related to pre-existing red cell alloantibodies
  - No transfusions or pregnancies 0%
  - Healthy Blood Donors 0.2%
  - General patient population 1.0 – 1.5%
  - Previous transfusions
    - 5 units 1.0%
    - 10 units 2.4%
    - 20 units 3.4%
    - 30 units 5.8%
    - 40 units 6.5 %
  - Previously Pregnancy - ? (lower red cell exposure)

Risk of Uncrossmatched Red Cell Transfusions

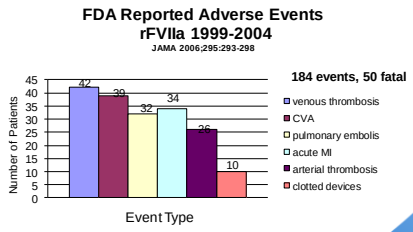
Risk of hemolytic transfusion reactions following emergency-release rbc transfusion. Goodell P, Uhl L, Mohammed M, Powers American Journal of Clinical Pathology 2010;134:202-206.

- 262 patients (265 episodes), 1002 red cell transfusions.
- Clinically significant antibodies 17/265 (6.4%)
- 15 incompatible units to 7 patients 7/265 (2.6%)
- **1 delayed hemolytic reaction 1/1002 (0.1%/unit)**
  - Anti c, Jk(a), E in plasma and eluate
  - 36 hours following transfusion
    - LD 1057, T Bili 2.2, Haptoglobin < 20
  - **No clinical sequelae**

FDA-labeled indications			Dose (IV)	Frequency
☐	Bleeding episodes in patients with known Hemophilia A or B with inhibitors to Factor VIII and IX	90 mcg/kg IV bolus every 2 hours until hemostasis achieved or treatment judged ineffective	**90 mcg/kg**	
☐	Surgical bleeding prophylaxis in patients with known Hemophilia A or B with inhibitors to Factor VIII and IX	90 mcg/kg IV bolus immediately before surgery, repeat every 2 hours for duration of surgery and up to 48 hours, then every 2-6 hours until healed. In major surgery, may continue every 2 hours x 5 days, then every 4 hours until healed.	**90 mcg/kg**	
☐	Acquired hemophilia	70-90 mcg/kg IV bolus every 2-3 hours until hemostasis achieved	**90 mcg/kg**	
☐	Congenital Factor VII deficiency	15-30 mcg/kg IV bolus every 4-6 hours until hemostasis achieved	**30 mcg/kg**	
Uses in patients without hemophilia or Factor VII deficiency: Massive hemorrhage refractory to standard therapy secondary to surgery or trauma			**Must write new order for each repeat dose desired for uses below:**	
☐	Peri- and post-operative bleeding	15-45 mcg/kg IV, may repeat after 30 minutes for up to 3 doses **(Due to thromboembolic risks, the lowest possible dose is recommended)**	☐ **15 mcg/kg IV x 1**	
☐	Trauma-associated bleeding	15-90 mcg/kg IV, may repeat after 20 minutes for up to 3 doses **(Due to thromboembolic risks, the lowest possible dose is recommended)**		
Other uses requiring a Medical Director, Transfusion Medicine; Pathology; or Hematology consult before or after the initial dose			☐ **30 mcg/kg IV x 1**	
☐	Post-partum hemorrhage	50-100 mcg/kg IV bolus every 2 hours until hemostasis achieved		
☐	Reversal of anticoagulation therapy	Non-emergent bleeding: 15-40mcg/kg IV bolus, may repeat Emergent/life-threatening bleeding: 41-90mcg/kg IV bolus, may repeat	☐ **45 mcg/kg IV x 1**	
☐	Intracerebral hemorrhage	40-80mcg/kg IV bolus x 1 dose		
☐	Severe thrombocytopenia	50-100mcg/kg IV bolus, may repeat		
☐	Severe hepatic dysfunction	5-137mcg/kg IV bolus, may repeat		
☐	Other: ______________		☐ **Other: ____ mcg/kg IV x 1**	

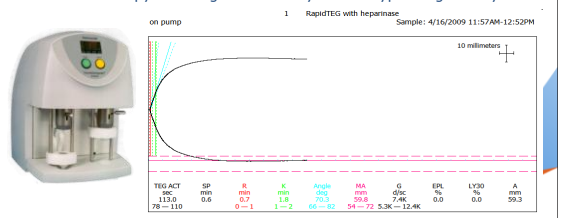
The Role of Factor VIIa in Massive Transfusion

O'Connell KA, Wood JJ, Wise RP. Thromboembolic adverse events after use of recombinant human coagulation factor VIIa. JAMA 2006;295:293-298.



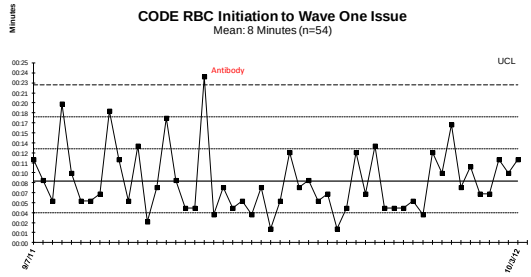
Thromboelastograph (TEG)
Net Clot Strength

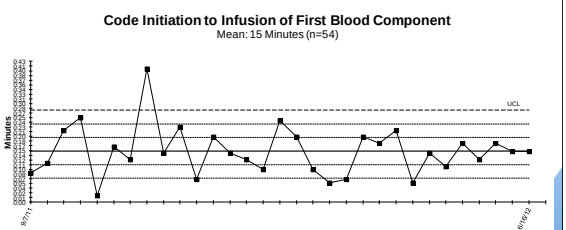
Measures **Net Clot Strength** taking into account combined effects of platelets & coagulation factors. Helps direct component-specific transfusion therapy and diagnose fibrinolysis and hypercoagulability.



Metrics

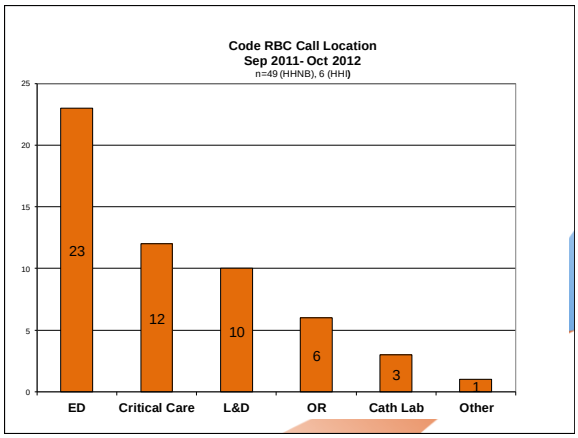
- Time to issue of Wave One
- Time to infusion of first unit
- Mean blood use
- Diagnosis & location
- Nadir and ending labs – Hgb, INR, Fibrinogen, Plt Count
- Use of Factor VIIa
- Survival to discharge
- Case review

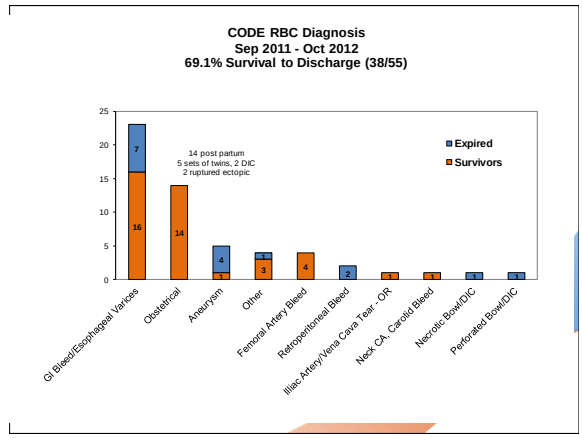


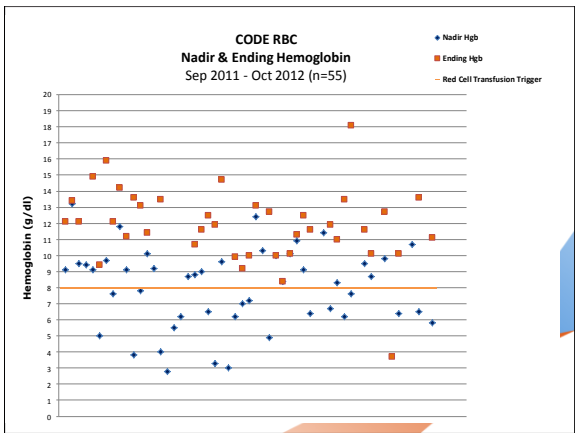


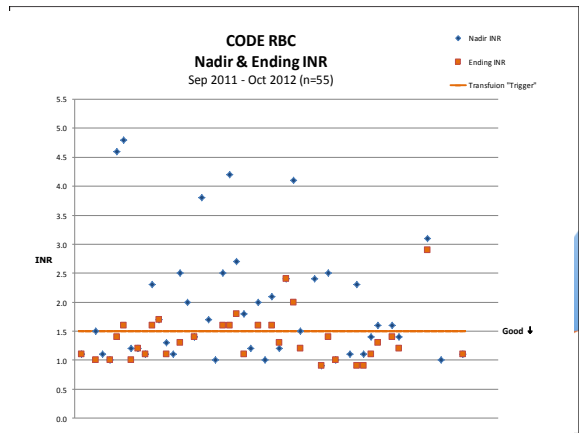
Mean Blood Use (number of units)

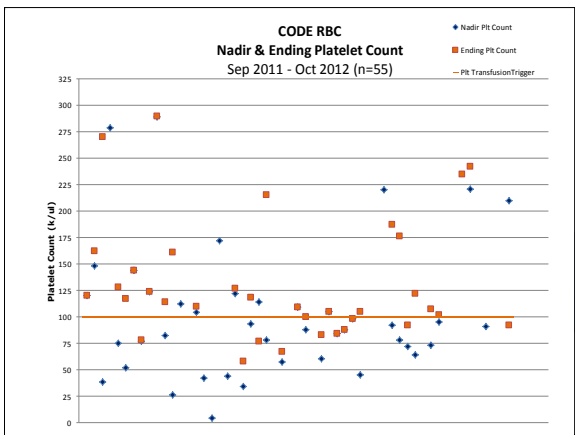
Red Cells	8.1	(1-37)
Plasma	3.2	(0-37)
Platelets	1.4	(0-6)
Cryo	9.5	(0-40)
Total	22.3	(1- 120)

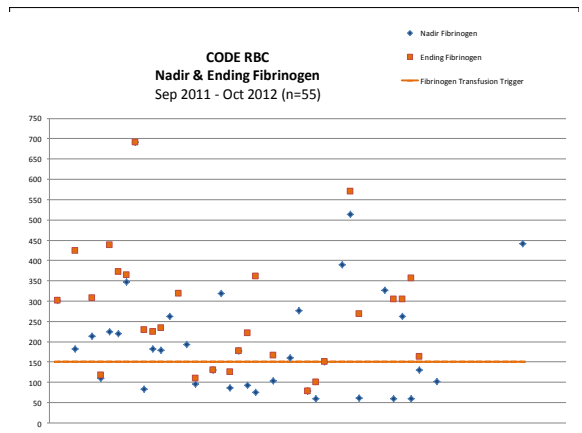

Code RBC Call Location
Sep 2011- Oct 2012
n=49 (HHNB), 6 (HHI)
25
20
15
10
5
0
23
12
10
6
3
1
ED
Critical Care
L&D
OR
Cath Lab
Other


CODE RBC Diagnosis
Sep 2011 - Oct 2012
69.1% Survival to Discharge (38/55)
25
20
15
10
5
0
7
16
14 post partum
5 sets of twins, 2 DIC
2 ruptured ectopic
14
4
1
3
4
2
1
1
1
1
Expired
Survivors
GI Bleed/Esophageal Varices
Obstetrical
Aneurysm
Other
Femoral Artery Bleed
Retroperitoneal Bleed
Illiac Artery/Vena Cava Tear - OR
Neck CA, Carotid Bleed
Necrotic Bowl/DIC
Perforated Bowl/DIC


CODE RBC
Nadir & Ending Hemoglobin
Sep 2011 - Oct 2012 (n=55)
Nadir Hgb
Ending Hgb
Red Cell Transfusion Trigger
Hemoglobin (g/dl)
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0


CODE RBC
Nadir & Ending INR
Sep 2011 - Oct 2012 (n=55)
Nadir INR
Ending INR
Transfuion "Trigger"
INR
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Good


CODE RBC
Nadir & Ending Platelet Count
Sep 2011 - Oct 2012 (n=55)
Nadir Plt Count
Ending Plt Count
Plt TransfusionTrigger
Platelet Count (k/ul)
325
300
275
250
225
200
175
150
125
100
75
50
25
0


CODE RBC
Nadir & Ending Fibrinogen
Sep 2011 - Oct 2012 (n=55)
Nadir Fibrinogen
Ending Fibrinogen
Fibrinogen Transfusion Trigger
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0

Lessons Learned

- Literature review key to physician member buy-in
- Initial and ongoing education critical
- Ongoing case review for continuous improvement
- Some physicians still "want what we want"
- Additional components may be indicated.
- Poor compliance with laboratory monitoring
- Staff love standardized approach, order from chaos.
- Success breeds acceptance !
- **A massive transfusion protocol can be very beneficial in non-trauma center hospitals !**

Case Review – Tumor Debulking

- 54 y/o female - hysterectomy and tumor debulking.
- Estimate blood loss 6200 ml
- 1.5 L Cell Saver Blood
- 47 Blood Components
  - 13 red cells, 9 plasma, 5 platelets, 20 cryo
- Nadir Labs
  - Hgb 9.5, Plt 239, Fibrinogen 182, INR 1.5
- Post-op Day One Labs
  - Normal kidney and liver function
- Discharge post-op day 7

Case Review – Placenta Accreta

- 29 y/o g1p1
- Mild preeclampsia
- Rupture of membranes at 35 weeks.
- Started on Pitocin and IV antibiotics
  Normal delivery, apgar 9 & 9
- No placental delivery after 30 minutes or after attempts at manual extraction
- Probable placenta accreta
  - abnormally deep attachment of the placenta, through the endometrium and into the myometrium

Case Review – Placenta Accreta

- 750 ml blood loss, became tachycardia and hypotensive
- Taken urgently to the OR and CODE RBC called.
- Second attempt at manual extraction, only partially successful
- Exploratory lap and abdominal hysterectomy performed.
- 3000 ml blood loss.

Case Review – Placenta Accreta

- 48 total blood components
  - 21 red cells, 13 plasma, 4 platelets, 10 cryo
- 5000 unit factor VIIa
- Labs
  - Hemoglobin 4.3 – 9.3
  - Platelet 25 – 72
  - Fibrinogen 274 -274
  - INR 1.4 – 1.2
- Discharged day 5

Case Review – Back Procedure

- 55 year old female
- Elective L4-L5 laminectomy, discectomy and expandable cage inter-body fusion using minimally invasive technique
- Vena cava and iliac artery laceration
- 10,000 ml EBL
- 50 total blood components
  - 18 red cells, 9 plasma, 3 platelets, 20 cryo
  - 3600 ml cell saver blood

Case Review – Back Procedure

- Labs
  - Hemoglobin 9.6 – 14.7
  - Platelet 78 - 215
  - Fibrinogen 76 -362
  - INR 1.8 – 1.1
- Discharged 10 days later, completed fusion procedure two months later.

"Act as if what you do makes a difference. It does"
-William James (1842-1910)