CODE RBC
Run, Bleeding Crisis!
A Non-trauma Center’s Approach to Acute Hemorrhage in Critical & Perinatal Care

January 23, 2012
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

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”


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

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.
Clinical Signs of Acute Hemorrhage

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

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.

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

- Hemorrhage
- Coagulopathy
- Resuscitation
- Fluids
- Acidosis
- Hemodilution & Hypothermia

Predictors of Massive Transfusion

- Base deficit $\leq -10$
- INR $\geq 1.5$
- Temperature $< 96^\circ $ F. or $35^\circ $ 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

- 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

Coagulopathy of Trauma

- 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

Coagulopathy of Trauma


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

• 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

• 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


Decayed Red Cell:Plasma Ratios Associated With Improved Mortality Rates in Trauma Resuscitation Patients

<table>
<thead>
<tr>
<th>study</th>
<th>n</th>
<th>outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borgman et al 2007 J Trauma 63:809-817</td>
<td>246</td>
<td>r/p 0.1 mortality 65% &lt;r/p 0.5 mortality 14% &lt;r/p 1.4 mortality 19%</td>
</tr>
<tr>
<td>Duchesne et al 2008 J Trauma 65:272-276</td>
<td>385</td>
<td>r/p &gt; 1:1 mortality 88% &lt;r/p ≤ 1:1 mortality 25%</td>
</tr>
<tr>
<td>Marpelle et al 2008 Vox Sang 95:112-119</td>
<td>713</td>
<td>r/p &gt; 1:1 mortality 24.6% &lt;r/p 0.6-1.1 mortality 56.4% &lt;r/p ≤ 0.9 mortality 19.0%</td>
</tr>
<tr>
<td>Holcomb et al 2008 Ann Surg 248:447-458</td>
<td>466</td>
<td>r/p &gt; 1:1 mortality 60% &lt;r/p ≤ 1:1 mortality 40%</td>
</tr>
<tr>
<td>Hauck et al 2008 J Trauma 65:006-993</td>
<td>133</td>
<td>r/p &gt; 1:1 in survivors &lt;r/p 1:1 in survivors</td>
</tr>
<tr>
<td>Sperry et al 2008 J Trauma 66:358-362</td>
<td>415</td>
<td>r/p &gt; 1:0.5 mortality 12.8% &lt;r/p &gt; 1:3 mortality 3.9%</td>
</tr>
<tr>
<td>Snyder et al 2008 J Trauma 65:572-574</td>
<td>134</td>
<td>r/p &gt; 2:1 mortality 58% &lt;r/p ≤ 2:1 mortality 40%</td>
</tr>
<tr>
<td>Coulter et al 2007 J Trauma 65:572-574</td>
<td>212</td>
<td>r/p &gt; 2:1 mortality 62% &lt;r/p ≤ 2:1 mortality 41%</td>
</tr>
<tr>
<td>Johansson 2009 Vox Sang 96:113-118</td>
<td>832</td>
<td>no protocol mortality 31.5% &lt;r/p &gt; 2:1 mortality 20.4%</td>
</tr>
</tbody>
</table>

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?”
  Jeanne Callan, MD, Toronto, AABB Annual Meeting 2008, Montreal, Canada
The PROMMT Study

- 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.

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?

- 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%

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 California maternity care by sharing data, facilitating collaborations and defining clinical best practices related to obstetrical care.
- 2009 – Hemmorhage 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

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

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 obesity (BMI >35)

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

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 Kainer MD, Internal Medicine
- Pax 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
- Grete Porteous MD, Anesthesiology
- 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 Improv
- Marilyn Lang, RN, Performance Improv
- Carlene Green, Performance Improv
- Tammy Valencia RN, ED
- Molly Hewett RN, VP, Patient Care Svcs
- Carole Metcalf RN, Director, Periop Svcs
- Kelly Perna RN, Critical Care
- Jamie Lynch, RN, Labor & Delivery
- Kim Miles RN, Director, Short Stay Unit
- Kim Mullin RN, Encl Dir, Women’s Health
- Debbie Lepman, RN, Director, Critical Care
- Debra Burszynski, RN, Nurse Educator, ICU
- Emily Hodge, Support Services/Transport
- Michele Vaikl, 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 VIII

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

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 gauge 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**

**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) Ptt (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
  - Pt Count, PT/APTT, Fibrinogen, Mg
- TEG (consultation required)
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)
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

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)


- 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


- Bleeding episodes in patients with known hemolytic A or B with inhibitors to Factor VIII and IX
- Surgical bleeding prophylaxis in patients with known hemolytic A or B with inhibitors to Factor VIII and IX
- Acquired hemolysis
- Complimentary Factor VIII deficiency
- Thrombocytopenia
- Trauma-associated hemolysis
- Hemolysis due to technetium-99m chromium-51, the lowest possible dose is recommended
- Other uses requiring a Medical Director

- Postpartum hemorrhage
- Other

- 90 mcg/kg
- 90 mcg/kg
- 90 mcg/kg
- 90 mcg/kg
- 90 mcg/kg
- 90 mcg/kg
- 90 mcg/kg
- Other

- 15 mcg/kg IV x 1
- 30 mcg/kg IV x 1
- 45 mcg/kg IV x 1
- Other: 15 mcg/kg IV x 1
The Role of Factor VIIa in Massive Transfusion

FDA Reported Adverse Events

184 events, 50 fatal

Event Type
- Venous thrombosis
- CVA
- Pulmonary embolism
- Acute MI
- Arterial thrombosis
- Clotted devices

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

<table>
<thead>
<tr>
<th>Location</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>ED</td>
<td>23</td>
</tr>
<tr>
<td>Critical Care</td>
<td>12</td>
</tr>
<tr>
<td>L&amp;D</td>
<td>10</td>
</tr>
<tr>
<td>OR</td>
<td>6</td>
</tr>
<tr>
<td>Cath Lab</td>
<td>3</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
</tr>
</tbody>
</table>

*Code RBC Call Location Sep 2011 - Oct 2012 (n=55)*

### Code RBC Diagnosis

69.1% Survival to Discharge (38/55)

- Expired
- Survivors
  - 14 post partum
  - 5 sets of twins
  - 2 DIC
  - 2 ruptured ectopic

### Code RBC Nadir & Ending Hemoglobin

<table>
<thead>
<tr>
<th>Hemoglobin (g/dl)</th>
<th>Nadir</th>
<th>Ending</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Code RBC Nadir & Ending Hemoglobin Sep 2011 - Oct 2012 (n=55)*

### Code RBC Nadir & Ending INR

<table>
<thead>
<tr>
<th>INR</th>
<th>Nadir</th>
<th>Ending</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Code RBC Nadir & Ending INR Sep 2011 - Oct 2012 (n=55)*

### Code RBC Nadir & Ending Platelet Count

<table>
<thead>
<tr>
<th>Platelet Count (k/ul)</th>
<th>Nadir</th>
<th>Ending</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Code RBC Nadir & Ending Platelet Count Sep 2011 - Oct 2012 (n=55)*

### Code RBC Nadir & Ending Fibrinogen

<table>
<thead>
<tr>
<th>Fibrinogen (mg/dl)</th>
<th>Nadir</th>
<th>Ending</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Code RBC Nadir & Ending Fibrinogen Sep 2011 - Oct 2012 (n=55)*
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, Ptt 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 VIII
- 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)