Fluid Resuscitation and Massive Transfusion
CACCN
May 2012
Objectives

- case study
- review coagulation
- review shock
- treatment and administration
- future therapy
Case Study

• 16 yr old female pedestrian
• Struck at high speed, thrown 50ft
• GCS at scene 3, EMS to ER at 1330
• Straight to CT Scan and to ICU post
Case Study

• Arrived in ICU quickly in obvious crisis
• BP 60/40, HR 160, Ventilated manually
• Bilateral femoral cordis’ (8.5F)
• Radial art line insitu
• Phenylephrine and norepinephrine infusing
• PRBCS infusing, TM box in tow
Case Study

- Rapid infuser set up in right femoral line and left antecubital 18G insyte
- Massive infusion of PRBCs, FFP, platelets, cryo
- Given calcium gluconate, magnesium
- Total pc 20uts, FFP 20uts, plts 10uts, cryo 10u
- Bleeding profuse from all orifices
- CT report bilateral carotid dissections
Coagulation

• balance between thrombosis and fibrinolysis
• 30 protein and enzymes make up the coagulation system
• 13 of these are produced in liver
• three pathways each requiring calcium
Coagulation

- Thrombotic system
  - tissue damage stimulates release of procoagulants that initiate platelet aggregation/plugging initiating intrinsic pathway
  - release of tissue factors then initiates extrinsic pathway
  - both come together to prothrombin
Coagulation

• Fibrinolytic system
  - lysis of clot or fibrin
    - plasminogen to plasmin which splits fibrin and fibrinogen into FDP

Delicate balance between thrombin and plasmin
1. **Vascular phase**
   - Injury
   - Spasm in damaged muscle

2. **Platelet phase**
   - Platelet aggregation and adhesion

3. **Coagulation phase**
   - **Intrinsic pathway**
     - Platelet thromboplastin
   - **Common pathway**
     - Prothrombin → Thrombin
     - Fibrinogen → Fibrin
   - **Extrinsic pathway**
     - Tissue thromboplastin
     - Clotting factor VII
     - Ca²⁺
   - Platelet factors
     - Clotting factors VIII, IX, X, XI, XII
   - Ca²⁺
   - Tissue factors
   - Plasminogen

4. **Clot retraction**
   - Contraction of blood clot

5. **Clot destruction**
   - Enzymatic destruction of clot

**FIGURE 33-4.** Hemostasis. When the endothelial surface of a blood vessel is injured, several processes occur. In primary hemostasis, platelets within the circulation are attracted to the exposed layer of collagen at the site of injury. They adhere to the site of injury, releasing factors that stimulate other platelets to aggregate at the site, forming an unstable platelet plug. In secondary hemostasis, based on the type of stimulus, one of two clotting pathways is initiated—the intrinsic or extrinsic pathway—and the clotting factors within that pathway are activated. The end result from either pathway is the conversion of prothrombin to thrombin. Thrombin is necessary for fibrinogen to be converted into fibrin, the stabilizing protein that anchors the fragile platelet plug to the site of injury to prevent further bleeding and permit the injuring vessel or site to heal.

What Happened?

- DIC - consumptive coagulopathy
  - is a clotting issue with excessive thrombin production that deposits clots everywhere consuming all factors
  - fibrinolysis then becomes rampant resulting in deposits of FDP
  - antifibrinolytics
What Happened?

- Coagulopathy of Trauma
  - results from diffuse tissue injury and the physiological changes that follow
  - combined with dilutional effects of fluid replacement
Acidosis

- activity of factors Xa, Va, prothrombinase complex reduced by 50 to 90% at pH of 7.2 to 6.8
Coagulation

Hypothermia reduces enzyme activity and prevents activation of platelets - Ib, IX, V complex necessary for platelet activity stops functioning in 50% people at 30C
Coagulation

• Dilution

  -25% reduction proteins prothrombin and thromboplastin following 8 to 10 uts PC

  - similar dilutional effect seen with platelets
  50% drop for each 10 to 20 units PC
Fluid Resuscitation

Shock is a common, treatable cause of death in trauma second to traumatic brain injury as one of leading causes death

• Rapid volume repletion is indicated in severe hypovolemic

• Surgical, medical and traumatic hemorrhage all can challenge the CC team
Shock

- Imbalance in oxygen supply and demand
- Body goes into anaerobic metabolism which interferes with energy cycle
- Pyruvate is converted to lactate
- Compensatory SNS response with tachycardia, vasoconstriction and increase ventricular contractility
- Eventual vasodilation and cardiac collapse
Hemorrhagic Shock

- ATLS Class III before any significant drop in BP
- Up to 30% blood volume lost before this
- Can be massive from AAA, GI, trauma
- Retroperitoneal can hold 4 litres
- Thigh 1 to 2 litres
- Scalp lacerations
ATLS Class

- **Class I** - 15% BV, no change BP HR
- **Class II** – 15 to 30% BV, clinically tachy, drop in PP, tachypnic, SBP change minimal, cool
- **Class III** – 30 to 40% BV, significant drop in BP with mental changes HR> 120, RR>24, UO low
- **Class IV** - >40% loss BV with PP<25, cold, tachy tachypnic, no UO
Goals of Therapy

• restoring intravascular volume
• maintain adequate oxygen delivery
• limit ongoing blood loss
• map >65 or SBP of 90

• Initial approach different for each patient
Type of Fluid

- Still a source of debate:
- Isotonic NS up to 2 litres, excess amount can lead to hyperchloremic metabolic acidosis
- Ringers in excess generates bicarb as lactate is metabolized causing metabolic alkalosis
- Many studies have not proven the superiority of either
Type Fluid

• Hypertonic Saline
  -some benefit from osmotic movement fluid from interstitium to intravascular with end result of reduced inflammation
  -some studies show improved outcomes others not, so no consensus even overall with TBI.
  - Needs more research
Type of Fluid

• Colloids
  - albumin, dextran, voluven, pentaspan
  - effectively increase intravascular volume and maintain plasma oncotic pressure at more normal level
  - value unproven in review of trials
Resuscitation

• Delayed fluid resuscitation or controlled hypotension ...SBP 70
  - much debate and research
  - may be beneficial in torso injuries as aggressive fluids may cause dilutional coagulopathy
    - detrimental to blunt injuries that may include TBI
Blood Products

• Recommendation is a policy for massive transfusion
• some studies favor 1:1:1 ratio packed cells, FFP, random donor platelets (1ut=5-6 uts)
• If >4uts/hr or 10 - 12 uts/24hrs must add factors and platelets
• large numbers observational studies report lower mortalities with aggressive approach
Management of Patients with Critical Bleeding with Coagulopathy and Massive Transfusion* Requirement

Identify and manage surgical bleeding i.e Surgery, Angiographic Embolization, Endoscopy

Appropriate Conventional Medical Interventions
- Admit patient to acute monitor bed
- Venous accesses with volume replacement
- Prevent and reverse hypothermia
- Prevent and reverse acidosis
- Correct coagulopathy
- Heparin reversal
  - Protamine 1mg IV per 100 units of Heparin
- Warfarin reversal (Vit K 5mg IV)
- Consider antifibrinolytic agents
  - Tranexamic acid 10mg/kg IV
  - DDAVP 0.3mcg/kg IV x 1
  - CRF and Von Willebrand’s disease

Laboratory Tests
- Baseline CBC, INR, PTT, TT
- Repeat blood test after each 4-6 units RBCs
- INR > 1.5 - Give 6 units FFP
- Fibrinogen < 1 g/L - Give 10 units of cryoprecipitate
- Platelet count < 50 X 10^9/L - Give 6 units of platelets
- Consider calcium chloride 1 gm IV slowly

If bleeding and coagulopathy continue after conventional therapy
- Usually:
  - 10 units RBC
  - 6 units FFP
  - 6 units platelets
  - 10 units cryoprecipitate

Call Transfusion Medicine

Surgery optimized?
- Consider 2nd dose rFVIIa 4.8 mg

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* Massive Transfusion: Replacement of blood volume in 24 hrs or replacement of 50% of blood volume in 3 hrs or 4 units of RBC in 4 hrs in the setting of a major bleeding or blood loss >150cc/hr.

- Based on various level of evidences and expert consensus

Trauma Services/Hematology
August 2006
Blood Type

- Universal Donor “O”
- Universal recipient “AB”
- Type determines the presence of surface antigen including Rhesus (Rh) factor D
- Screen determines presence antibodies
- O – no antigens
- AB – no antibodies
Blood Products

• Packed cells
  - when exsanguination is imminent or no hemodynamic improvement with 2 litres NS
  - otherwise “when” remains unclear inspite of hypotension
  - TRICC Trial hgb 70
Blood Products

• Clotting Factors
  - many combat studies
  - early transfusion to prevent the dilution
  - several retrospective studies suggest higher survival with higher plasma to PC ratio
  - some centres 2uts FFP for 6uts PC, others 1:1
  - cryoprecipitate 10 uts from 1ut blood
Blood Products

• Platelet
  - early transfusion critical
  - 1 ut apheresis platelets or blood derived platelets equivalent to 6 uts random donor
  - remember the effect of hypothermia and dilution
Blood Products

• Complications
  - acute or delayed hemolysis
  - allergic reactions
  - volume overload
  - dilutional coagulopathies
  - citrate toxicity
  - TRALI
Resuscitation

• Vasopressors
  -no studies to support in resuscitation of multiple trauma
  -use may be detrimental
Resuscitation

• Developing treatments:
  - hemostatic agents like ‘quick clot powder’ and fibrin sealant dressings used in combat settings
  - antifibrinolytics like tranexamic acid showing reduced mortality from hemorrhage if given in first three hours. CRASH study
  - factor Vlla and red cell substitutes
Delivery

- Pressure bag 300psi
- 20G or 18G insytes
- 1 litre/ 10 to 12 mins
- Watch pressure gauge
Delivery

- Blood tubing
- Hot line warmer
- Minimal 18G peripheral
- Cordis 7F
- TLC 18G, 18G, 16G
- Manual squeeze will deliver one litre/5 mins
Delivery

- Rapid infuser/warmer
- Massive transfusion
- Undivided attention
- 1 litre/min
Summary

• Best approach to fluid resuscitation remains controversial!
• Best approach to blood transfusion in trauma is unknown!
• Many combat studies vs civilian
Things to remember

- effects of acidosis and hypothermia
- effects of dilution on platelets and clotting
- tranexamic in first three hours
- calcium 1 to 2 gm per 2uts pc
- reconsider fluid after 2l NS
- 1utPC =1gm hgb and 3% increase HCT
- good access is the key