Hematology ACS review

Terence O’Keeffe, MB ChB, MSPH
Bryan A. Cotton, MD, MPH
Overview

- Blood and Blood Components
- Massive Transfusion and Hemorrhage Resuscitation
- Acute Coagulopathy of Trauma
- Damage Control Resuscitation
- Hemostatic Adjuncts
- Coagulation Testing
- Coagulation Disorders
- Anemia in the ICU
- Thrombocytopenia and HIT
- Reversal of Anti-coagulants/anti-platelets
- Transfusion-associated complications
I. Blood and Blood Components
Blood and Blood Components

- RBC: 300 mL/unit; Hct of 29%; shelf-life up to 42 days; O group is universal donor

- Plasma: 200-250 mL/unit; 400-450 mg fibrinogen; other factors 60-70% range; AB group considered universal donor

- Plt: “6 packs” (40-50 mL/unit) random or “aphaeresis” single donor (200-250 mL) ~80,000 plt ct; no universal donor
Blood and Blood Components

- Cryo: concentrated plasma product; pooled units (4-6 unit pools); typical bag is 80-100 mL; each (10-15 mL) unit contains 100 IU of VIII, 250 mg of fibrinogen, and adequate stores of vWF and XIII

- As with platelets, compatibility testing is not strictly necessary, but AB type is the universal plasma donor
II. Massive Transfusion and Hemorrhage Resuscitation
Massive Transfusion

● Hemorrhage accounts for greatest number of deaths within the first hour of arrival
  Kauvar DS et al J Trauma 2006

● Responsible for >80% O.R. deaths, ~50% deaths in the first 24 hours after injury
  Hoyt DB et al J Trauma 1994
  Sauaia A et al J Trauma 2006

● Great potential for more effective approaches to prevent or control exsanguination
Massive Transfusion

- MT traditionally defined as $\geq 10$ units of RBC
- Other definitions include: one BV in 24 hours, 50% BV loss within a 3 hour period, or loss of blood at 150 mL/min
- Seen in 8-10% trauma patients in military setting and 1-3% in the civilian setting
MT Protocols

- MTP developed to address these problems

- MTP system whereby physician activates process by which predetermined blood products are delivered in rapid and sustained manner

- The ratios/units delivered per cycle are institution-specific; many centers also employ these protocols for non-trauma patients as well
MT Protocols

- MTP may include RBC, plasma, plts and cryo
- Some use pharmacologic adjuncts as well
- Plasma: RBC ratios are typically in the 1:3-1:1 range (plts and cryo use more variable)
- Well-developed protocols have been associated with dramatic reductions in mortality, MOF and ARDS, reduction in overall blood products

Cotton BA et al J Trauma 2008
Cotton BA et al J Trauma 2009
Riskin D et al JACS 2008
III. Acute Coagulopathy of Trauma (ACoT)
Acute Coagulopathy of Trauma (ACoT)

- An endogenous impairment of hemostasis that occurs early after injury

- ACoT common following major trauma, present on arrival in ≥25% of patients with major trauma
  
  *Brohi K et al, J Trauma 2003*
  
  *Tieu BH et al, World J Surg 2007*

- Mortality is increased dramatically when ACoT is present (more than 4-fold increase)
  
  *Brohi K et al, Ann Surg 2007*
Acute Coagulopathy of Trauma (ACoT)

- Hallmark is microvascular-bleeding leading to massive blood loss; possibly result of complex post-op hemostatic changes, consumption of factors, hemodilution and excessive fibrinolysis.

- Risk factors: extensive tissue damage, shock/acidosis (BD ≥10), prehospital IV fluid (≥3000 mL), and hypothermia (temperature <35°C).

- ACoT is associated with increased transfusion requirements and organ failure.

Brohi K et al, Ann Surg 2007
Cotton BA et al J Trauma 2008
IV. Damage Control Resuscitation (DCR)
Damage Control Resuscitation (DCR)

- Three tenets: permissive hypotension, limited crystalloids, higher ratios of plasma/plts
- All studies to date non-randomized, most retrospective, based on changes in practice
- Most demonstrate survival advantage with higher plasma: RBC and platelet: RBC ratios
- At this time, the optimal ratio of plasma: RBC appears to be between 1:1-1:2
DCR- Survival bias vs. availability bias

- Survival bias proposed by several authors
  Snyder CW et al, J Trauma 2009
  Magnotti LJ et al J Trauma 2011

- Survival bias: patients are not surviving BECAUSE they received higher ratios, they are RECEIVING (achieving) higher ratios because they are surviving long enough to get them

- Availability bias: “you can’t give what you don’t have”; initial “survival bias” studies didn’t give plasma within the first 90 minutes of arrival
DCR- Crystalloid Volumes

• Higher volumes associated with increased frequency/longer recovery from ALI/ARDS

• Increased GI dysmotility and anastomotic leak rates, more frequent coagulation disturbances and higher mortality

• Complications more common (and seen with even less fluid administration) in the elderly
Permissive hypotension & reducing fluids

- Civilian and military guidelines recommend prehospital fluid restrictive strategies
  *Cotton BA et al J Trauma 2009*

- Titrate small fluid boluses (250 mL) for palpable radial pulse, normal mental status

- RCT demonstrated no survival benefit from resuscitating to SBP >100mmHg vs. >70 mmHg
  *Dutton R et al J Trauma 2002*

- Pilot study penetrating torso trauma: patients randomized to intra-operative MAP>50 mmHg (vs. >65mmHg) received less fluid and blood
  *Morrison CA et al J Trauma 2011*
V. Hemostatic Adjuncts
Factor VIIa (Novoseven)

- Recombinant protein
- Originally developed for use in bleeding disorders associated with Hemophilia
- Now often used in
  - Reducing stroke hemorrhage
  - Trauma, surgery, liver disease
Factor VIIa (Novoseven)

- Indications for use
  - Factor VIII or IX inhibitor
  - Life-threatening hemorrhage in surgery, trauma or liver failure
  - Congenital deficiency of VIIa
  - Life-threatening hemorrhage in setting of platelet disorder
Factor VIIa Mechanism of action

- Binds to and activates Factor X on platelet surface
Factor VIIa (Novoseven)

- Very expensive
  - 4.8mgs Vial $4500
  - 2.4mgs vial $2500
  - Typical dosing costs >$5,000 !!
- Risk of thrombotic events - CVA, MI, PE
- Efficacy not yet clear
  - In trauma patients - reduced transfusion but not mortality
  - Trial in CVA patients - reduced ICH size increase and reduced mortality
  - Cardiac surgery – reduced transfusions
Prothrombin Complex Concentrates

- E.g. Profilnine
  - Contains II, IX, X (+ small amount of VII)
  - FDA Approved

- For prevention and control of bleeding in patients with Factor IX deficiency due to hemophilia B
Prothrombin Complex Concentrate

- Trauma uses -
- Reverse Coumadin anticoagulation effect
- Stauch massive hemorrhage
  - In combination with FFP, Cryo, platelets, etc.
Prothrombin Complex Concentrate

- Dosing
  - Initial **INR <5**
    - Dose = 25 units per kg
    - Recheck INR 10 to 20 minutes after dose
    - May re-dose 25 units/kg to achieve goal INR ≤1.5
    - If INR >1.5 after 2 doses, give FFP to achieve goal INR
Prothrombin Complex Concentrate

- Dosing
  - Initial INR ≥5
    - Dose = 50 units per kg
    - Recheck INR 10 to 20 minutes after dose
    - If INR >1.5, give FFP to achieve goal INR

- Use 100 kg maximum weight if patient is >100 kg
Prothrombin Complex Concentrate

- Dosing
  - For all patients who receive PCC
  - Give Vitamin K 10 mg IV as an infusion over 15 minutes
  - Failure to administer Vitamin K may result in a rebound increase in INR after 6 hours.
External Hemorrhagic adjuncts - QuikClot Powder

- Mineral zeolite powder
- 1% residual moisture
- Rapid water absorption
- Concentration of factors
- Exothermic reaction (very)
- $30 per packet
Quikclot

Grade V liver injury in swine

**Effective in animal models**

**Problems**
- Severe exothermic reaction
- Granules difficult to remove

Pusateri et al., J Trauma 2004
Thermal Injury with QuikClot

Wright et al, J Trauma 2004
Next Generation Quikclot

- QuikClot ACS
  - Larger diameter beads
  - Mesh bag
  - Easier to handle
  - Easier to remove
  - Less exothermic
  - Similar efficacy reported
External Hemorrhagic adjuncts - Woundstat

- Clay mineral (Smectite)
- Swells with water/blood
- High adhesiveness/plasticity
Swine Groin Injury Model

Kheirabadi et al., J Trauma: in press
External Hemorrhagic adjuncts - Combat Gauze

- 4 yard, 3 inch wide roll
- Surgical gauze
  - Rayon/polyester
- Coated with powerful clot activating agent
  - Kaolin 1:10 ratio
Swine Groin Injury Model

Survival Time

Kheirabadi et al., J Trauma: in press
Internal hemostatics

Topical Hemostat Classification

<table>
<thead>
<tr>
<th>Mechanical Hemostats</th>
<th>Flowable Hemostats</th>
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<tbody>
<tr>
<td>Gelatin sponge</td>
<td>Gelatin</td>
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<tr>
<td>Collagen</td>
<td>Gelatin + thrombin matrix</td>
</tr>
<tr>
<td>Cellulose</td>
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<td>Polysaccharide spheres</td>
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<table>
<thead>
<tr>
<th>Fibrin Sealants</th>
<th>Active Hemostats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fibrinogen + thrombin</td>
<td>Thrombin products</td>
</tr>
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</table>

Also hemostatic “Biogluces”: Cyanoacrylates, 2-component PEG polymers, and bovine albumin + glutaraldehyde
Mechanical Hemostats

Porcine gelatin
- Gelfoam® (Pfizer, Pharmacia)

Bovine collagen
- Surgifoam® (Ethicon, J&J)
- Avitene Sheets® (non-woven web) (Davol)
- Ultrafoam™ Collagen Sponge (Davol)

Cellulose
- Surgicel® (J&J)
- Surgicel Nu-Knit™ (J&J)

Polysaccharide spheres
- Arista® (Medafor)
Surgicel

- Plant derived cellulose
- Fibrillar, loose and tight weave forms
- > 30 years of use
- No intrinsic coagulation components
- Reabsorbed in 14 days.
Surgicel

**SURGICEL NU-KNIT**
Absorbable Hemostat

*Excellent strength and coverage for heavier bleeding.*
Flowable Hemostats

Gelatin matrix + thrombin

- FloSeal™ (Baxter)
  - Bovine gelatin
  - Human pooled plasma thrombin

- Surgiflo™ (J&J)
  - Porcine gelatin
  - Bovine thrombin may be added
Floseal

- Gelatin Matrix
  - Bovine Collagen
  - Microgranules
- Human Thrombin
- Stored at room temp
- Readily available
Fibrin Sealants

- Tisseel, Evicel
- Fibrinogen + Thrombin
- +/- FXIII (cross-linking)
- +/- Aprotinin (inhibits plasmin)
- Topical use on raw surfaces
Fibrin Sealants

- **Tisseel™ (Baxter)**
  - Human Thrombin
  - Human Fibrinogen
  - Synthetic Aprotinin

- **Evicel™ (J&J)**
  - Human Thrombin
  - Human Fibrinogen
  - Human Albumin
  - (Replaced Crosseal)
Tisseel

- 1\textsuperscript{st} fibrin sealant approved
- Human fibrinogen and thrombin
- Bovine aprotinin
- Needs stirring and warming for 20 mins
- FDA approved
  - CardioPulmonary Bypass
  - Splenic injury
  - Colostomy closure
Achilles heel
Evicel

- Human thrombin and fibrinogen
- Storable for 30 days at 2–8°C
- Storable for two years at -18°C
- Immediately available
- Can be applied with a pressure regulator
Evicel efficacy data

**HEMOSTATIC EFFICACY**

*In vascular surgery*

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<th>EVICEL™</th>
<th>CONTROL</th>
<th>P Value</th>
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<td>4 minutes</td>
<td>83.3</td>
<td>39.7</td>
<td>&lt; .001</td>
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<tr>
<td>7 minutes</td>
<td>87.5</td>
<td>61.8</td>
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<tr>
<td>10 minutes</td>
<td>91.7</td>
<td>70.6</td>
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*Control of soft-tissue bleeding in general, gynecologic, and urologic surgery*

<table>
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<tr>
<th>Time Point</th>
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<th>CONTROL</th>
<th>P Value</th>
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<td>7 minutes</td>
<td>90.9</td>
<td>76.8</td>
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<tr>
<td>10 minutes</td>
<td>95.5</td>
<td>81.2</td>
<td>&lt; .05</td>
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VI. Coagulation testing
Limitations to coagulation testing

- Rapid identification of clotting abnormalities appears critical to improving survival.

- Majority of tests focus on single part of clotting cascade; PT and INR reflect intrinsic pathway defects while PTT reflects the extrinsic pathway.

- In unstable/bleeding patient, tests often worthless due to long intervals inherent in drawing blood, processing specimen, and obtaining results.
Coagulation testing

- PT, INR, and PTT measure plasma proteins, neglecting contribution of other components

- These tests were developed/validated in patients being treated with oral (warfarin- PT and INR) or intravenous (heparin-PTT) anticoagulants

- While PTT may occasionally be prolonged with newer anticoagulants (dabigatran, rivaroxaban), PT and INR are normal

- Platelet and fibrinogen count: purely quantitative values, lack functional/qualitative assessment
Coagulation testing

- Whole blood-based, viscoelastic testing recently gained popularity; technology around >50 years

- Thrombelastography (TEG) and rotational thromboelastometry (ROTEM) are available in the US for evaluating the ACoT

- TEG and ROTEM correlate with plasma, platelet and cryoprecipitate/fibrinogen transfusions

- TEG identifies hypercoagulability risk, specifically in-hospital venous thromboembolism, myocardial infarction, and stroke
TEG® Analyzer Tracing

Coagulation

Fibrinolysis

Platelets (MA)

Enzymatic (R)

Fibrinogen (K, α)

Thrombolysis (Ly30, EPL)

LYSIS

Clotting time

Clot kinetics

Platelet function

Clot strength (G)

Clot stability

Clot breakdown

Time (min)
Normal clotting with TEG

Sample: 2/9/2006 01:12PM-01:51PM

ICU

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<tr>
<th>SP min</th>
<th>R min</th>
<th>K min</th>
<th>Angle deg</th>
<th>MA mm</th>
<th>PMA</th>
<th>G d/sc</th>
<th>EPL %</th>
<th>A mm</th>
<th>CI</th>
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<tbody>
<tr>
<td>5.2</td>
<td>5.8</td>
<td>2.2</td>
<td>60.4</td>
<td>56.6</td>
<td>0.0</td>
<td>6.5K</td>
<td><em>0</em></td>
<td>57.4</td>
<td>-0.9</td>
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<tr>
<td>2 - 8</td>
<td>1 - 3</td>
<td>1 - 3</td>
<td>55 - 78</td>
<td>51 - 69</td>
<td></td>
<td>4.6K - 10.9K</td>
<td>0 - 15</td>
<td></td>
<td>-3 - 3</td>
</tr>
</tbody>
</table>
Hypocoagulable state with TEG

Sample: 2/9/2006 02:05PM-02:42PM
Hypercoagulability with TEG

Sample time: 2/17/00 03:32:25 PM - 04:24:45 PM

(hypercoagulability)
Hyperfibrinolysis with TEG
VII. Coagulation disorders
Coagulation disorders

- Hemophilia A: sex-linked recessive factor VIII deficiency; prolonged PTT and normal PT; Rx-VIII or cryoprecipitate

- Hemophilia B: sex-linked recessive factor IX deficiency; prolonged PTT and normal PT; Rx-factor IX or cryoprecipitate

- Acquired inhibitors: antibodies that inhibit activity of factors; most commonly Ab to VIII; seem with SLE and cancer; check PT and PTT mix- if mix does not correct, then inhibitor (+); Rx-steroids
Coagulation disorders-vWD

- vWD: most common congenital bleeding disorder; several types, minimal bleeding > hemorrhage
- Type I/II autosomal dominant, type III recessive
- Both the PT/PTT can be normal, check bleeding time (ristocetin test)
- Type I/II treated with cryoprecipitate and DDAVP, type III with cryoprecipitate or VIII:vWF
- Administer (6 U) cryoprecipitate approximately 6 hours prior to intervention
VIII. Anemia in the ICU
Transfusion - Clinical Relevance

- 85% of patients in ICU > 1 week
  - Receive a Transfusion

  **Right Shift**
  - Acidosis, Incr. PaCO2
  - Incr. Temp, 2,3 DPG

  **Left Shift**
  - Alkalosis, decr. 2,3 DPG, Hypothermia
Transfusion

- 1 unit PRBCs raises the Hct approx 3%

- Decision to transfuse
  - Probability of bleeding
  - Co-existing disease

- DON’T give two units at a time
  - Unless you need to 😊
Indications for Transfusion

● OLD
  ■ Hct of 30% or Hgb of 10mg/dL

● NEW
  ■ Hct of 21% or Hgb of 7g/dL
  ■ Evidence-based
  ■ Some caveats
TRICC trial - NEJM 1999

- Transfusion requirements in Critical Care
- Multi-institutional trial in Canadian ICU’s
- Patients randomized to
  - Restrictive transfusion strategy 7-9 g/dL
  - Liberal transfusion strategy 10-12 g/dL
  - Designed as a non-inferiority trial
TRICC trial - NEJM 1999

- No difference in mortality between strategies
TRICC trial - NEJM 1999

- Improved survival

More severely injured patients
Younger patients

![Graphs showing survival rates for patients with APACHE II Score ≤20 and patients younger than 55 years.](image)
Restrictive Blood Transfusion

- Caveats
  - ACTIVE Myocardial disease
  - Symptomatic from anemia - SOB, dizzy
  - Ongoing blood losses

- Avoiding transfusion decreases complications
Erythropoetin

- Licensed for chronic anemia and periop to assist with autologous donation
  - 1302 patients given 40K units a week x 3
  - 10% reduction in PRBC given
  - NO outcome benefit
  - EPO cost $1000 to save 1u PRBC ($400)
- Newer data, EPO might save lives in trauma, esp. neurotrauma patients
IX. Thrombocytopenia and HIT
Platelets

- Thrombocytopenia (<100k)
  - Occurs in about 1/3rd of ICU admissions
  - Predictive of mortality

- After massive transfusion dilution, most common causes are SEPSIS and HIT
  - In sepsis pts develop EDTA IgG ab and plts clump—so there just not appreciated
Transfusion Triggers for Platelets

- Stable HemOnc – 10K
- Complicated HemOnc – >20K
- Minor surgery – 25 - 50K
- Major Surgery – >50K
- Neurosurgery – 100K
- Platelet dysfunction
  - Acquired or congenital
Contraindications for Platelet Transfusion

- **Absolute**
  - TTP
- **Relative**
  - HIT
  - Glanzmann’s Thrombasthenia
    - Novoseven
  - DIC
Platelet Transfusion Ineffective

- ITP
- Highly HLA alloimmunized patients
- Massive splenomegaly
<table>
<thead>
<tr>
<th>4Ts Category</th>
<th>2 Points</th>
<th>1 Point</th>
<th>0 Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thrombocytopenia</td>
<td>Platelet count falls &gt;50% from baseline OR platelet nadir ≥10-19×10⁹/L.</td>
<td>Platelet count falls 30-50% from baseline OR platelet nadir 10-19×10⁹/L.</td>
<td>Platelet count falls &lt;30% from baseline OR platelet nadir &lt;10×10⁹/L.</td>
</tr>
<tr>
<td>Timing of platelet count fall.</td>
<td>Clear onset between days 5 and 10 OR platelet count falls ≤1 day (Heparin exposure within 30 prior days)</td>
<td>Fall in platelet counts consistent with onset between days 5 and 10, but timing is not clear OR onset after day 10 of heparin exposure OR fall in platelet counts ≤1 day with prior heparin exposure between 30 and 100 days prior</td>
<td>Platelet count falls &lt;4 d without recent heparin exposure.</td>
</tr>
<tr>
<td>Thrombosis or other sequelae</td>
<td>New thrombosis, skin necrosis, or acute systemic reaction after unfractionated heparin exposure.</td>
<td>Progressive/recurrent thrombosis or unconfirmed but clinically suspected thrombosis.</td>
<td>No thrombosis or thrombosis preceding heparin exposure.</td>
</tr>
<tr>
<td>Other causes of thrombocytopenia</td>
<td>None apparent.</td>
<td>Possible other causes present.</td>
<td>Probable other causes present.</td>
</tr>
</tbody>
</table>
X. Management and Reversal of Anticoagulant and Antiplatelet agents
Reversal of Warfarin

● Prothrombin Complex Concentrates
  ■ Profilnine or Bebulin

● Weight based dosing
  ■ Profilnine 25u/kg if INR <5 (can redose)
  ■ 50u/kg if INR >5
  ■ REMEMBER to give Vitamin K

● Use FFP if remains high after PCC
Reversal of Warfarin

- Fresh Frozen Plasma
- Best when volume also required e.g. active hemorrhage
- Slower than PCC
- Risk of TRALI
Reversal of anti-platelet agents

- Platelet transfusion – unknown efficacy
- DDAVP, Cryoppte also used
- Easiest to wait for 7-10 days prior to surgery
Reversal of dabigatran (Pradaxa)

- NO ANTIDOTE
- FFP, Cryo, PCC – ALL INEFFECTIVE
- Dialysis only option
  - Removes 60% of activity within 2 hrs
  - Rivaroxaban CAN be reversed with PCC
XI. Transfusion-associated complications
Complications of Transfusion

- Hemolytic transfusion reaction
- Febrile non-hemolytic transfusion reaction
- Allergic reactions
- Bacterial / Viral / Prion contamination
- Fluid overload
- TRALI
- Post-transfusion purpura
Hemolytic Reactions

- **Acute or immediate**
  - Within 24 hours of transfusion
  - Generally Intravascular
- **Delayed**
  - Between 1-10 days
  - Generally Extravascular
- **Incidence** 1:12,000 - 25,000
- **Mortality** 1:650,000
## Hemolytic Reactions

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<thead>
<tr>
<th></th>
<th>Intravascular</th>
<th>Extravascular</th>
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</thead>
<tbody>
<tr>
<td>Fever, chills</td>
<td>80%</td>
<td>55%</td>
</tr>
<tr>
<td>Renal Failure</td>
<td>35%</td>
<td>5%</td>
</tr>
<tr>
<td>Pain</td>
<td>15%</td>
<td>2.5%</td>
</tr>
<tr>
<td>N and V</td>
<td>10%</td>
<td>-</td>
</tr>
<tr>
<td>↓ BP, ↑ HR</td>
<td>12%</td>
<td>-</td>
</tr>
<tr>
<td>DIC</td>
<td>10%</td>
<td>5%</td>
</tr>
<tr>
<td>Jaundice</td>
<td>-</td>
<td>10%</td>
</tr>
</tbody>
</table>
Complications of Transfusion

- Febrile reactions
  - Common 1:100-1:200
  - ? Due to non-toxic immune complexes
  - Can be treated with Benadryl / Tylenol
- Allergic reactions (urticarial)
  - Relatively common - 1:200
  - Treat as above and stop transfusion

- ALWAYS REPORT TO BLOOD BANK
Infectious risks

- HIV 1 in 2.6 million
- Hepatitis C 1 in 2.6 million
- Hepatitis B 1 in 600,000
- Bacterial Very rare
- West Nile Possible, risk not known
- NvCJD Not yet described
- Rabies Not known
Circulatory Overload

- Clinically under-recognized (1:700)
- Symptoms develop within hours
- Elderly with poor cardiopulmonary status
- More likely with Autologous transfusion
- Transfuse slowly – over 4 hours
- Consider pre or post diuresis
- Intubation for severe pulmonary edema
Transfusion Related Acute Lung Injury

- Incidence: 1 in 1700-5000
- Life threatening
  - No. 1 cause of transfusion related deaths
  - Leading cause of morbidity
- Onset during or within 6 hrs
- Plasma-containing product transfusion
  - FFP > Platelets > Red Cells > CRYO > IVIG
Proposed Criteria for TRALI

- Acute onset - during or within 6 hrs of Tx
  - Hypoxemia
    - $O_2$ sat <90% at room air
    - Ratio of $PaO_2/FiO_2$ <300 mm Hg
  - Bilateral infiltrates on Chest X-ray
  - No evidence of Left Atrial Hypertension

- No preexisting Acute Lung Injury before Tx
- No temporal relationship to alternative risk for ALI
Other Findings Associated with TRALI

- Dyspnea
- Tachypnea, tachycardia, cyanosis, fever
- Hypotension (85%)
- Froth in endotracheal tube
- Laboratory findings:
  - Transient acute leukopenia
  - High titer HLA or HNA antibodies in implicated donor
Mechanism of TRALI

- Generally donor plasma contains implicated Ab
  - Multiparous women
  - HLA or Neutrophil specific Ab
- Neutrophil aggregation
- Complement activation
- Endothelial damage – leak
- ?Neutrophil priming lipids
  - Lysophosphatidylcholine
- Cytokines
Two-event Model of TRALI

Endothelial cells

L-Selectin

E-Selectin

HLA / HNA Ab

Cytokines

Capillary Leak, Edema, and Acute Lung Injury
Treatment of TRALI

- Oxygen support
- Intubation
- Pressors for hypotension
- Steroids — probably no role but given anyway
- 80% survive with normal lung function
- Future Transfusion
  - Not a problem
FFP most commonly implicated

<table>
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<tr>
<th>Blood Product</th>
<th>FY05</th>
<th>FY06</th>
<th>FY07</th>
<th>FY08</th>
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<td>RBC</td>
<td>5</td>
<td>5</td>
<td>12</td>
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<tr>
<td>Plasma*</td>
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<tr>
<td>Multiple Products</td>
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</tbody>
</table>
Importance of Reporting to BB

- Identify donor
- Test donor and recipient
- Defer donor
- Who are the worst donors?
- Multi-parous females
- In UK – only male plasma collected!
- American Red Cross – same idea
Post Transfusion Purpura (PTP)

- Rare occurrence
- 5-10 days after transfusion of any blood component
- Normal baseline platelets but develop sudden and severe thrombocytopenia
- Multiparous or multitransfused
- Can bleed profusely
PTP - Management

- Stop transfusion
- **DO NOT** give platelets to correct thrombocytopenia
- If life threatening bleeding: transfuse with HPA1a (-) platelets
- IVIG
- Plasmapheresis: No longer
- Gets better within 7-14 days
QUESTIONS?

"Whoa! That was a good one! Try it, Hobbs — just poke his brain right where my finger is."