

Transfusion in Trauma



Jack CF Chong, MD

ATLS® Instructor

Shin Kong Memorial Hospital

Aim of Treatment

- Blood volume
 - Blood composition within safe limits
 - Haemostasis
 - Oxygen carrying capacity
 - Oncotic pressure
 - Biochemistry
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Sequence of Components

Crystalloid



Colloid



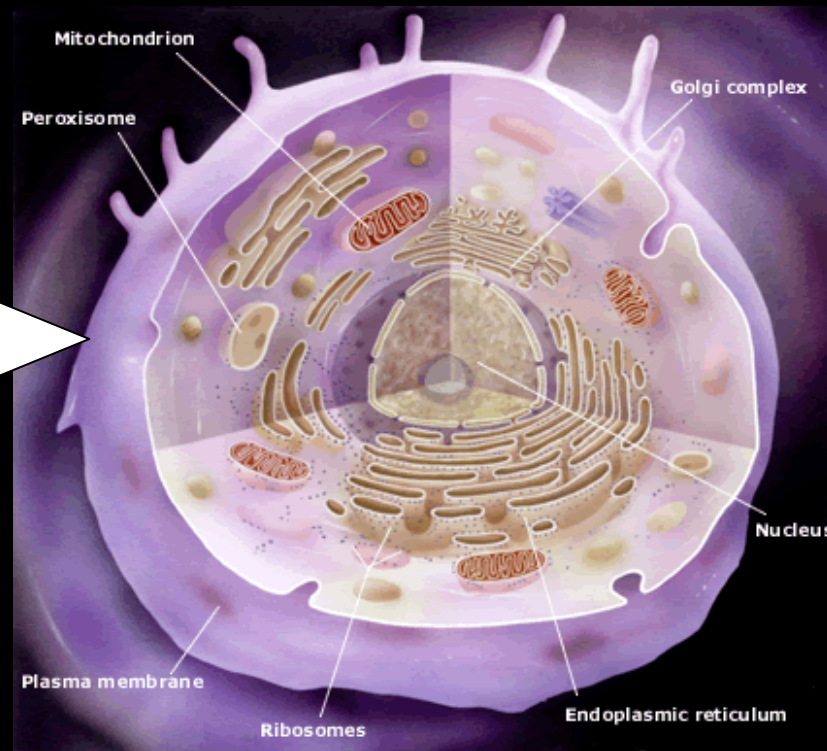
Red cells

- Initial red cell replacement is in the form of packed red cells
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Crystalloids / Colloids

- Crystalloids
- Colloids

Semipermeable
membrane



BES

- Balanced electrolyte solutions
 - Isotonic crystalloids
 - Ringer's lactate (RL)
 - Normal saline (NS)
 - After 1 hour,
 - BES → 1/3 intravascular (333 cc of 1 L)
 - D5W → 1/15 intravascular (67 cc of 1 L)
-

Pitfall

- Fluid management in trauma
 - Physicians → Inadequate or slow
 - Surgeons → Fluid overload
- 1:3 rule
 - 1 L blood loss → 3~4 L RL



Classification of Shock

Class	I	II	III	IV
Blood loss	?	?	?	?
PR	?	?	?	?
RR	?	?	?	?
Capillary refill	?	?	?	?
BP	?	?	?	?
Mental	?	?	?	?
U/O	?	?	?	?
Crystalloid (2L or 20ml/kg)	?	?	?	?
Transfusion	?	?	?	?

Classification of Shock

Class	I	II	III	IV
Blood loss	< 15% (< 750cc)	15-30% (750-1500cc)	30-40% (1500-2000cc)	40% (> 2000cc)
PR	< 100 /min	100-120 /min	120-140 /min	> 140 /min
RR	14-20 /min	20-30 /min	30-40 /min	> 35 /min
Capillary refill	< 2 sec	> 2 sec	> 2 sec	> 2 sec
BP	NP	NP	Decreased	Decreased
Mental	Anxious	Irritable	Confused	Lethargic
U/O	> 30 cc/h	20-30 cc/h	5-15 cc/h	Negligible
Crystalloid (2L or 20ml/kg)	Rapid response	Transient response	Transient response	No response
Transfusion	No	Probable	Urgent	Immediate

Pitfall

- Large amount of NS may cause hyperchloremic (non-AG) metabolic acidosis
 - Inadequate tissue perfusion
 - Ketoacidosis



Electrolytes

■ Normal saline

■ Na	154 mEq/L
■ Cl	154 mEq/L

■ Ringer's lactate

■ Na	130 mEq/L	
↓ ■ Cl	109 mEq/L	
■ Lactate	28 mEq/L	⇨ 14 mEq/L HCO ₃ ⁻
■ K	4 mEq/L	
■ Ca	3 mEq/L	



Pitfall

- Large amount of RL may cause severe lactic acidosis in patients with severe liver disease




Electrolytes

■ Normal saline

■ Na	154 mEq/L
■ Cl	154 mEq/L

■ Ringer's lactate

■ Na	130 mEq/L
■ Cl	109 mEq/L
■ Lactate	28 mEq/L  14 mEq/L HCO ₃ ⁻
■ K	4 mEq/L
■ Ca	3 mEq/L

Pitfall

- RL should not be infused with or in the same iv tubing as bank blood



Electrolytes

■ Normal saline

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■ Cl	154 mEq/L

■ Ringer's lactate

■ Na	130 mEq/L
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Colloids

- Plasma colloid oncotic pressure (COP)
 - Normal COP = 28 mmHg
 - Colloids
 - ↑ Intravascular volume
 - ↓ Interstitial edema
 - ↑ Tissue O₂ delivery
 - ↑ Wound healing
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Dextran

- Sucrose –(Bacteria)→ Glucose polymer
 - Types
 - D-40: MW 10,000~80,000
 - D-70: MW 40,000~100,000
 - Beneficial effects
 - Volume: 500 cc D-40 → 750 cc within 1h, 1,050 cc within 2h; may persist up to 8h
 - Improves blood flow in microvasculature
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Pitfall

- Dextran – Adverse effects
 - Increase bleeding from open wounds
 - ↓ Plt adhesiveness, ppt coagulation factors if > 20 cc/kg/d
 - Difficulty with typing and cross-matching of blood
 - Should inform the blood bank
 - Anaphylactoid reactions
 - Urticaria, rash, nausea, bronchospasm
 - Acute renal failure in oliguric p'ts
 - Precipitate within renal tubules



Albumin

- Molecular weight 65,000
 - Accounts for 80% of plasma COP
 - Synthesis 12~14 g/day in liver
 - Adult: 4~5 g/kg, 30~40% intravascular (3.5~5 g/dL)
 - Body T1/2 = 20~22 days
 - Plasma T1/2 = 12-16 hours
 - Fractionated blood → Heated to 60°C x 10h
 - Preparation: 5% 500 cc; 25% 50cc
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Albumin-Effects

■ Volume expansion

- 5% x 500 cc → Volume ↑ 250~750 cc
- 25% x 100 cc → Volume ↑ 300~600 cc (≈ 450 cc)

■ Other effects

- Binding and inactivating proteolytic enzymes
 - Maintenance of microvascular permeability
 - Scavenging free radicals
-

Pitfall

- Infusion of albumin, especially to hypotensive patients, may rapidly reduce iCa levels and contribute to myocardial failure or shock

- 1 g Albumin \leftrightarrow 0.8 mg Ca
- \downarrow iCa \rightarrow Negative inotropic effect on myocardium



Hydroxyethyl Starch

- Hetastarch (HES, 6% in NS)
 - Derived from amylopectin
 - Volume expansion 100~170%
 - Retention time 12~48 h
 - Serum amylase levels may double
 - >20 mL/kg/day → Prolonged aPTT and BT
 - ↓ Factor VIII
 - ↑ Fibrinolysis
-

Pitfall

- Hetastarch is an effective colloid for expanding blood volume, but excessive use can cause increased bleeding



FFP

■ Indication

- Multiple coagulation deficiencies

■ Transfusion

- Use filter
 - Give within 2 hours of thawing
 - ABO matched
 - Compatibility testing not required
-

Crystalloids

Shock → Shrinkage of ECF

PE less likely due to rapid equilibration with ECF
Colloids may cross leaky pulmonary capillaries

Free from anaphylactoid reaction

Colloids (except FFP) affects coagulation

Colloids 10~100 x more expensive

Colloids

Shock → Loss of intravascular volume

Volume of crystalloids must be 3~4 x loss
Crystalloids reduces COP

< 0.05% risk



Anxiom

- Successful resuscitation is primarily dependent on the adequacy of fluid replacement and not the composition of fluid itself



Blood Transfusion

■ Transfusion requirements

$$\text{O2 delivery} = \text{CO} \times \text{Hb} \times \text{SaO2} \times 1.34$$

- Hb >10g/dl → Transfusion rarely indicated
 - Hb <7g/dl → Transfusion usually necessary
 - Hb 7~10 g/dl → Transfusion guided by clinical status
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Hematocrit

- Keep Hct $>20 \sim 25\%$
 - Young, healthy
 - Normal blood volume and cardiac output
 - $\text{SaO}_2 > 90\%$
 - Keep Hct $>30 \sim 35\%$
 - Critically ill
 - Major/multiple trauma
 - Keep Hct $>35 \sim 40\%$
 - Severe sepsis
 - Severe cardiopulmonary dysfunction
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Anxiom

- Young healthy individuals can do well with a Hb of 7.0 g/dL if they are hemodynamically stable and their bleeding is controlled



Blood Types

- Type O blood
 - No cellular antigens
 - Anti-A and Anti-B antibodies
 - O-positive blood
 - O-negative blood
 - Type-specific blood
 - ABO and Rh D typing
 - 10~15 min
 - Fully cross-matched blood
 - ABO, Rh-D, and compatibility tests, Ab screen
 - 30~45 min
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Type O Blood

- Un-typed, un-cross-matched type O blood in extreme emergencies
 - O-negative blood for women of child-bearing age
 - Large amount → Transfusion reactions (minor)
 - If > 8 U → Complicate subsequent cross-matching
-

Pitfall

- If physicians give type O un-cross-matched blood when it might be possible to delay infusion for 5~10 min by using other fluids, they greatly increase the risk of complications



Extreme Emergencies

- ① Group O blood
 - Women → Rhesus D negative blood
 - ② Type specific blood
 - ABO and Rh D matched, available in 10~15 min
 - ③ Cross-matched blood
 - Use original serum sample
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- If an Ab screen -ve and more than one blood volume has been administered
 - No need for compatibility tests
 - Should only exclude ABO mismatches
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Massive Transfusion

- Replacement of a patient's total blood volume in less than 24 hours
 - Acute administration of $>50\%$ of the patient's estimated blood volume per hour
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Massive Transfusion

- Patients who require massive transfusion of >20 U of blood within 24 hours \rightarrow Mortality $\sim 50\%$
 - Risks
 - SBP <80 mmHg for >30 min
 - Pre-existing disease
 - Age >65 yr
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Complication (1)

- Dilutional thrombocytopenia
 - $> 1.5 \times$ blood volume

Complication (2)

- Coagulation Factor Depletion
 - Supervening DIC
 - Stored blood contains all coagulation factors except V and VIII
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Tips

- Simple test

- 2~3 cc blood in test tube for 5~10 min

- Sample collection

- Should not be drawn from an indwelling catheter



Complication (3)

- Oxygen Affinity Changes
 - Stored blood → High O₂ affinity
 - 2,3 DPG levels rise rapidly following transfusion
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Complication (4)

■ Hypocalcaemia

- Citrate = 1.5 g/unit
- Liver will metabolize 3g citrate every 5 min
- Citrate toxicity → Hypocalcemia (tetany, BP↓)
 - > 12-20 units at rate > 2 unit every 5 min
 - Impaired liver function

■ Calcium supplement

- Only if there is biochemical, clinical or ECG evidence of hypocalcaemia
-

Complication (5)

■ Hyperkalaemia

- Stored blood K > 30 mEq/L
- Hyperkalaemia if very large amounts of blood are given quickly

■ Hypokalaemia

- More common as red cells begin active metabolism and intracellular uptake of potassium restarts
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Complication (6)

■ Acid/Base Disturbances

- Lactic acid up to 30-40 mmol/L
 - Citrate \rightarrow HCO_3^- \rightarrow profound metabolic alkalosis
 - Final acid/base status being dependent on tissue perfusion, rate of transfusion, and citrate metabolism
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Complication (7)

- Hypothermia ($<35^{\circ}\text{C}$)
 - Reduction in citrate and lactate metabolism \rightarrow Hypocalcaemia and metabolic acidosis
 - Increase in affinity of haemoglobin for oxygen
 - Impairment of red cell deformability
 - Platelet dysfunction
 - Increased tendency to cardiac dysrhythmias
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Complication (8)

■ ARDS

- Etiology as yet not fully understood
 - Risk factors
 - Both under- and over-transfusion are associated with an increased risk of ARDS
 - Albumin < 3 g/dL
 - Blood > 40 U and shock > 30 min
 - Microaggregate filters should be used during massive transfusion except when giving fresh whole blood or platelets
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Correcting Hemostasis

■ Platelet concentrates

- Two units/10kg if platelet $< 50,000$
- Two units of platelet concentrate also provides around 50ml of fresh plasma

■ Fresh frozen plasma

- 12 ml/kg if PT or PTT $> 1.5 \times$ control

■ Cryoprecipitate

- 2-3 units/10kg if fibrinogen $< 0.8\text{g/L}$
-

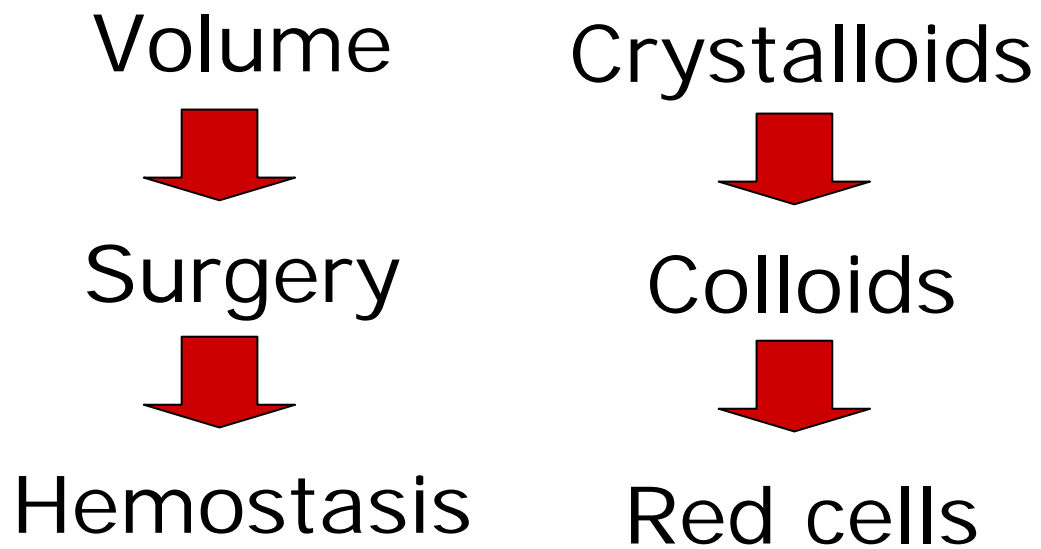
Pitfall

- Massive uncontrolled hemorrhage
 - Highest priority
 - ➔ Definitive surgical hemostasis
 - Lower priority
 - ➔ Correct coagulopathy





Conclusion



Thanks



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