



Optimal Use of Blood Component

Wichai Prayoonwiwat

Blood Donor

- Normal healthy adults 18-25 years
- Pregnant & lactating women are not accepted
- Volumes of blood taken
 - $<1/10$ of total blood volume
 - <420 mL
- Blood 500 mL ~ Iron 250 mg

Blood Donor

- Male Hb > 13.5 g/dL
Female Hb > 12.5 g/dL
- Donors are not bled more than twice a year without replacement
- FeSO₄ 0.4 g daily for 30 days
- BP > 200/110 mmHg is not bled.

Hazards of Blood Donation

- **Fainting**
- **venous spasm**
- **Hyperventilation, tetany**
- **Bruising**
- **Infection**

Clinically important blood group systems

Systems	Frequency of antibodies	Cause of haemolytic transfusion reaction	Cause of haemolytic disease of newborn
ABO	Very common	Yes (common)	Yes (usually mild)
Rh	Common	Yes (common)	Yes
Kell	Occasional	Yes (occasional)	Yes
Duffy	Occasional	Yes (occasional)	Yes
Kidd	Occasional	Yes (occasional)	Yes (occasional)
Lutheran	Rare	Yes (rare)	Yes (occasional)
Lewis	Occasional	Yes (rare)	No
P	Occasional	Yes (rare)	No
MN	Rare	Yes (rare)	Yes (rare)
Li	Rare	Unlikely	Yes (rare)
			No

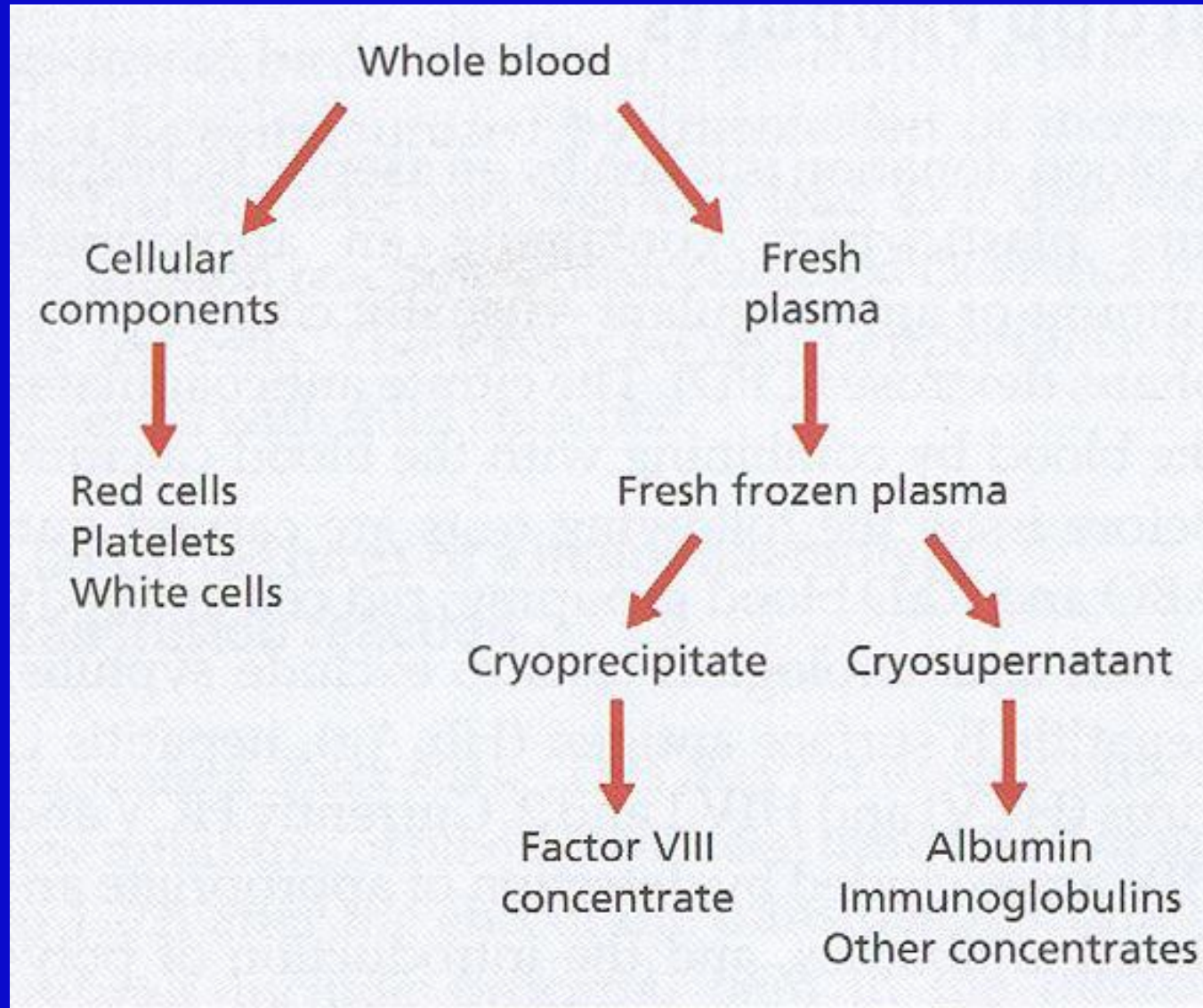
Modern Transfusion Practice

- Blood is separated into various components
- Individual component
....need of the patient
- Superior to whole blood
 - concentration
 - increasing efficacy
 - minimizing volume
- Donated blood to maximal and optimal use

Optimal Use

- **Indication**
- **Efficacy**
- **Complication**

Blood Components



Fresh Whole Blood

1,800 cpm 7 min

Packed Red Cell

Store at 4 °C

Plasma + Platelets

3,000 cpm 10 min

Plasma Platelet Concentrate

Store at -20 °C 24 h

Store at 22 °C

Fresh Frozen Plasma with Cryoprecipitate

FFP Cryoprecipitate

Store at -20 °C for 1 y

Blood Components

- Red blood cells
- Platelets
- Plasma and derivation
- Granulocytes

Red Blood Cells

- Homologous packed RBC
- Leukocyte-poor RBC
- Washed RBC
- Frozen RBC
- Neocytes
- Directed donor RBC
- Autologous RBC



Platelets

- Random donor
- Single-donor
- Leukocyte-poor
- HLA-matched



Plasma and derivatives

- Fresh frozen plasma
- Cryoprecipitate-poor plasma
- Cryoprecipitate



Granulocytes

- Stimulated leukapheresis

Measures to Protect the Recipient

- **Viral hepatitis:**
HBV, HCV, Non-A Non-B
- **HIV**
- **CMV**
- **Syphilis 4°C 4 days**
- **Malaria 4°C 3 weeks**

The Storage of Blood

- Heparin 24 Hours
- ACD 21 Days
- CPD 21 Days
- Adenine 17 mg to 1 unit of blood 1-2 weeks longer

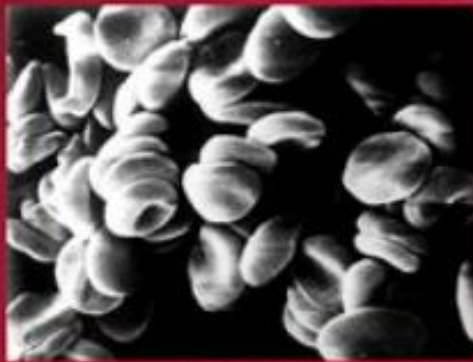
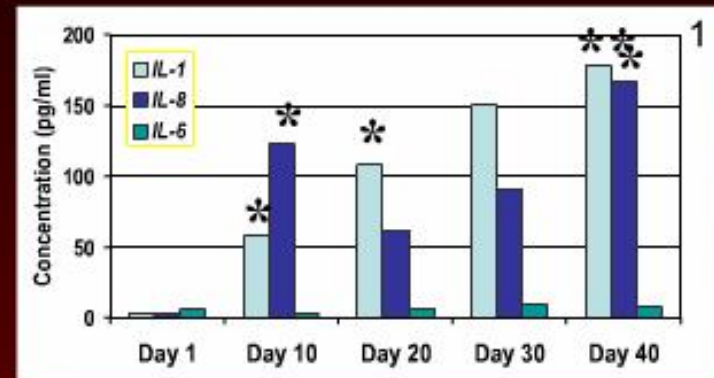
Some of the Changes Occurring in Blood Stored in ACD Solution at 4°C

DAYS STORED		0	7	14	21	28
%Red cells destroy within 24 h of Tx.		0	5	10	20	33
Plasma	pH	6.9-7		6.8	6.7	6.6
	6.5					
Plasma	K (mM)	3-4	12	24	32	40
Plasma	Na (mM)	150	148	145	142	140
Plasma	Hb (g/dL)	0-0.1		0.25	0.5	1.0
	1.5					
2-3 DGP					10-20%	
(Add Adenine = 70%)						

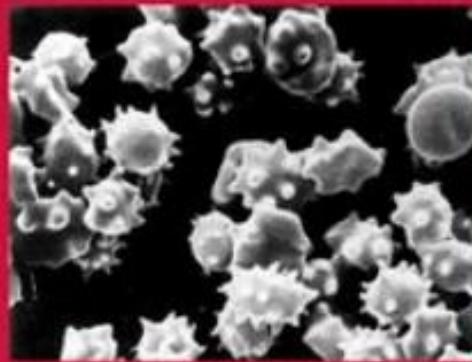
Storage Defects and Microvascular Perfusion



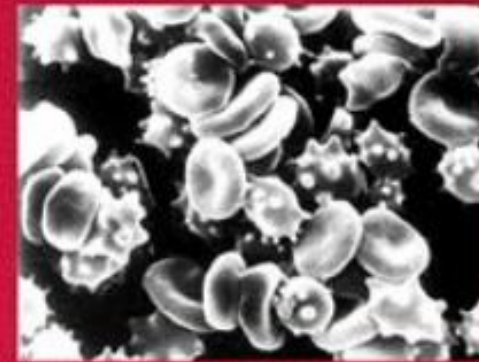
- Build-up of cytokines, free Hgb, K+, debris (BRMs) ^{1,2}
- Decreased 2,3- DPG, ADP, NO
- Poor deformability³



Day 1



Day 21



Day 35

¹ Kristiansson, ActaAnesthScand 1996;40

² Fransen, Chest 1999;116

³ Hovav, Transfusion 1999; 39

Storage of Other Constituents of Blood

Platelets 4°C

24 h 5% of original plts. are viable

48 h 0% “-----”

Factor VIII

12 h 50% “-----”

Factor V

not survive or storage



Indications (RBC)

- **Chronic hypoproliferative anemia**
- **Acute blood loss**
- **High-risk patients**
- **Hemolytic anemia**
- **Sickle cell anemia**
- **Perioperative transfusion**

Un acceptable indication

- **Enhance a patient's general sense of well being**
- **Promote wound healing**
- **Expand vascular volume**

Perioperative transfusion

- Non cardiac surgery
.....Hb > 7-8 g/dL
- No risk factors for MI
..... > 7-8 g/dL
- Elderly patient Hb
..... > 9 g/dL
- **Hb < 10 g/dL**

Acute blood loss

- Healthy young person generally tolerates 500-1,000 mL of ABL
- ABL 1,000-2,000 mL
... volume replacement alone
- ABL > 2,000 mL
... required RBC transfusion
- ABL intraoperative > 500 mL
- Burn...volume depletion

High-Risk Patients

- Impairs ability to increase
 - intravascular volume
 - heart rate
 - stroke volume
 - blood flow
- Older patient
- Coronary artery disease
- Vascular disease

Hemolytic anemia

- Symptomatic hemolytic anemia
- ABO & Rh match least degree of in vitro hemolysis
- Blood warmer for cold antibody

RBC Transfusion

When? How much?

- **No single Hb threshold**
- **Clinical status > Hb level**
- **Hemodynamic instability**
- **Symptoms and signs of impaired organ function**
- **Rate of blood loss**
- **Response to transfusion**
- **Anemia ÷ platelet dysfunction**

RBC

O₂ carrying capacity

Chronic anemia

Heart failure

Old aged

↑ Hb before surgery

PRC + NSS

Leukocyte Poor Blood

- ให้ผู้ป่วยที่มี febrile reaction
เช่น ผู้ป่วยที่ให้เลือดบ่อย ๆ
pregnancy

Frozen red blood cell
Washed red blood cell



Platelet Concentrate

- Thrombocytopenia $< 20 \times 10^9/L$
- Bleeding

Choice of Platelet Product

- **Underlying condition**
 - **acute, reversible,**
chronic thrombocytopenia
 - **local availability of supplies**

Pooled random donor platelet

Single-donor platelets

- Correction of severe thrombocytopenia**
- Platelet dysfunction**
- Massive bleeding**
- Cardiopulmonary bypass**

Single-donor platelets

- Decrease exposure to infections agents**

Leukocyte-poor platelets (filtered or irradiated)

- Prevent alloimmunization to HLA antigen inpatients requiring repeated platelet transfusions**

HLA-matched platelets

- Treat bleeding associated with thrombocytopenia in patients who are refractory to platelet transfusion due to HLA sensitization**

Alternative to Platelet Transfusions

- DDAVP
- Transamine
- Estrogen
- RBC transfusion
- Erythropoietin

FFP, Cryoprecipitate

- **Coagulation factor deficiency**
 - **Prevention**
 - **Bleeding**
- **Replacement therapy**

Indication of FFP

- **Correct of factor deficiency**
- **Liver disease**
- **DIC**
- **Vitamin K deficiency**
- **Warfarin overdose**
- **Massive bleeding**

Indication of FFP

- Antithrombin deficiency
- Severe protein-losing
- Severe C1 esterase inhibitor deficiency with life-threatening angioedema
- TTP/HUS

Plasma Exchange Therapy

- Cryoglobulinemia
- Goodpasture syndrome
- Guillain-Barre syndrome
- Homozygous familial hypercholesterolemia
- Posttransfusion purpura
- TTP

Plasmapheresis

- **Chronic inflammatory demyelinating polyneuropathy**
- **Cold agglutinin disease**
- **Autoimmune thrombocytopenia**
- **Rapidly progressive glomerulonephritic**
- **Systemic vasculitis**

Plasma Requirements

- **ABO-type-specific FFP**
- **Appropriate dose of FFP**
 - **plasma volume of patient**
 - **the desired increase in factor activity**
 - **the expected half-life of the factors**

Cryoprecipitate: Indication

- **Severe hypofibrinogenemia (100 mg/dL)**
- **Uremia with severe bleeding unresponsive to dialysis and DDAVP**
- **Topical fibrin glue**
- **F XIII deficiency**
- **vWD**

WBC Concentrate

Good prognosis

Fever (infection) fail antibiotic

WBC: Neutrophil $< 0.5^9/L$

ABO & HLA matched



Complications

- Hemolytic transfusion reactions
- Reaction due to WBC & platelet Abs
- Allergic & anaphylactic reactions
- Circulatory overload,
thrombophlebitis, air embolism
- Reaction due to bacterial pyrogens
and bacteria

Complications

- **Complication of massive transfusion**
- **Disease transmitted by blood transfusion**
- **Transfusion hemosiderosis**
- **Immunological sensitization**

Pseudothrombolytic transfusion reaction

Recipient cell hemolysis

- **Drugs : Penicillin, quinidine**
- **Hemolytic anemia**
- **Infections : Malaria**
- **Large hematoma**
- **Mechanical trauma :**
Prosthesis heart valve

Donor cell hemolysis

- Thermal extremes
- Cardiopulmonary bypass
- Bacterial infected blood
- Drugs administration
- Hypotonic solution

Noncardiogenic Pulmonary Edema

- Pulmonary hypersensitivity reaction
- Allergic pulmonary edema
- Transfusion-related acute lung injury

Intravascular RC Destruction

- Lumbar pain
- Feeling of constriction in the chest
- Tachycardia & BP ↓
- Anaesthetized patient
1st sign = bleeding at a previously dry operative site

Red Cells Lysed

↓
Thromboplastin-like substances

↓
Hemoglobinemia
Hemoglobinuria

↘
Fibrin Clot

- ↓
- Acute defibrination Syndrome
 - Thrombocytopenia
 - Hypofibrinogenemia
 - Fibrinolysis

↓
Oliguria Anuria

↓
MAHA

Immediate HTR

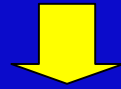
- **Most dangerous type**
- **Due to antibodies**
- **Rate of destruction**
 - **Potency and type of Ab**
 - **Strength of Ag**
 - **Quantity of incompatible RC**

Immediate HTR

- Preventable
 - Personal errors
 - Incorrect labeling
 - Failure to check the labels
 - Errors of identification of the patients

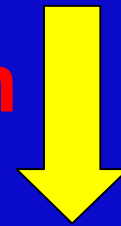
Febrile Non-Hemolytic Transfusion Reaction

Multiple Transfusion



Leukoagglutinin

Blood transfusion with WBC



Leukocyte lysis



Pyrogen



Fever, Chill, N-V, Hypotension
Headache, Myalgia

Reaction Due to WBC & Platelet Antibodies

Febrile Reactions

- Ab in plasma against Ag on WBC & Platelets
- Onset 0.5 - 3 h
- BT 38-40°C $\xrightarrow{< 8 \text{ h}}$ normal
- Chill & headache
- Blood pressure normal



ให้เลือดแล้วมีไขขึ้น

- ผู้ป่วยมีไขเพียงอย่างเดียว
- การให้เลือดอาจไม่จำเป็นต้องหยุดทันที
- ให้เลือดให้ช้าลง
- เก็บตัวอย่างเลือดจากผู้ป่วยตรวจ

Antiglobulin test → negative

→ ให้เลือดต่อ

- ดู free hemoglobin → No free Hb

Reaction Due to WBC & Platelet Antibodies

Treatment :

- **ASA before transfusion**
- **Slow rate of transfusion**
- **Antihistamine intravenous**

Allergic Transfusion Reaction

- Anaphylactoid
- Urticaria
- พบประมาณ 3%
- Ig A deficiency → severe anaphylaxis
- **Rx** WASHED RED BLOOD CELL

Post Transfusion Purpura

- Male > Female
- Occur **1** week posttransfusion
- Spontaneous recover 1-6 weeks
- Rx exchange transfusion, plasmapheresis
corticosteroid, platelet conc.
- Anti BaK^a, Anti PIA², Anti GP 120,
Anti GP IIB
- Anti PIA1

Post-transfusion purpura

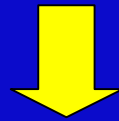
- 7-14 days post PRC or platelet transfusion
- Severe thrombocytopenia ($< 10 \times 10^9/L$)
- Lab: Anti-HPA antibody, HPA typing (National blood center)
- Avoid transfusion if possible, IVIg, plasma exchange

Volume Overload

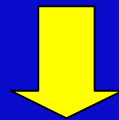
- Elderly people with degenerative vascular disease
- The first warning signs
 - Dry Cough
 - ↑ Jugular venous pressure
 - Acute pulmonary edema
- Severe chronic anemia c CHF
 - Partial exchange transfusion
 - PRC 200 mL
- Treatment as treat CHF

Bacterial contamination

Cold growing bacteria Gram-ve



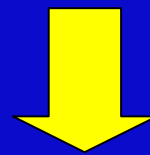
Endotoxin



Pyrexia, Hemoglobinuria, Renal failure
Shock, DIC

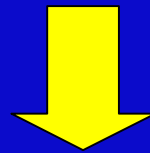
Pharmaceutical incompatibility

Transfusion of Heavily Infected Blood



immediated reaction

BT^oC prostration peripheral
circulatory failure persistent
hypotension



Acute Defibrination Syndrome

Reactions Due To Bacterial Pyrogens and Bacteria

- **Fever from pyrogens → almost never nowadays**
- **Reaction due to infected blood**
 - **Very serious complication**
 - **Worse than ABO incompatibility**
 - **Often fatal outcome**
 - **Gram-ve bacteria**

Reactions Due To Bacterial Pyrogens and Bacteria

Prevention >>> Treatment

- All blood should be kept at 2-6°C
- One unit should be issued at time
- ห้ามเก็บเลือดไว้ที่ room temperature
- เปลี่ยน set ให้เลือด ทุก 8 ชั่วโมง

Diagnosis :

- **Culture at 4°C, 20°C, 37°C**

Treatment :

- **Maintain BP & broad spectrum antibiotics**



Massive Transfusions

- ให้เลือด > total blood volume in 24 h
- Cardiac irregularities, ventricular fibrillation, arrest
- Cause
 - excess citrate in the blood
 - low temperature
 - biochemical changes
- Excess citrate \longrightarrow $\text{Ca}^{2+\downarrow}$
- Citrate $\xrightarrow{\text{Liver}}$ HCO_3

Massive Transfusions

- Blood 1 L + 1 g calcium
- Low pH NaHCO_3 44.6 mEq/blood 2.5 L
- ↓ Platelet, coagulation factor

Recommend

- ให้เลือด < 10 days
- 20% ของเลือด ควรเป็น fresh blood
- After 2.5 L of blood + NaHCO_3

UTHSC-H MT Guideline

Adult Trauma Massive Transfusion Guidelines

FFP	<p>As soon as the need for massive transfusion is recognized.</p> <p>For every 6 RBCs, give 6 FFP (1:1 ratio)</p> <p>NOTE: 1 Jumbo FFP = 3 FFP</p>
Platelets	<p>As soon as the need for massive transfusion is recognized.</p> <p>For every 6 RBCs, give 1 dose of platelets (1:1 ratio)</p> <p>NOTE: 1 dose of platelets are equal to either 6 Random-Donor plt units or 1 apheresis plt unit</p>
Cryoprecipitate	<p>After first 12 RBCs, check fibrinogen level. If <100 mg/dL, give 10 units cryo. Repeat as needed, depending on fibrinogen level, and request appropriate amount of cryo.</p> <p>NOTE: FFP also contains fibrinogen and thus cryoprecipitate may not be frequently needed.</p>

rVIIa in Trauma- Summary

- rVIIa is a wonder drug, but...
 - rVIIa will not stop surgical bleeding
 - rVIIa does not replace the need to correct the cause of the bleeding & coagulopathy
 - › Shock
 - › Acidosis
 - › Hypothermia
 - › DIC
 - › “Substrate”- vitamin K, platelets, FFP, cryo
 - › Continued mechanical source of bleeding
 - It is a temporary plug, at best
- Patient selection, timing and dosing are the billion dollar questions

Diseases Transmissible by Blood Transfusion

Syphilis ... 1°C - 6°C เชื้อตาย

**Fresh blood & platelet conc.
(22°C)** นำเชื้อนี้ได้

Diseases Transmissible by Blood Transfusion

Parasites

African trypanosomiasis

Kala-azar

Chagas disease

Microfilaria

Toxoplasmosis

Virus

Post Transfusion Hepatitis

- Most common
- Asymptomatic → Dead
- Hepatitis B, C, non-A non-B
- Incubation period 15-18 days
- NANB 90% incubation period 4-10 weeks

Virus

Post Transfusion Hepatitis

WBC conc. เสี่ยงที่สุด

Frozen red cell ปลอดภัยที่สุด

กลุ่มเสี่ยง **Immunocompromised host,**

Exchange transfusion,

Massive transfusion,

Infant,

Open heart surgery

Virus

Human Parvovirus Infection

- Aplastic crisis**
- F VIII concentrate**

Other Disease

- Herpes virus
- Infectious mononucleosis
- Brucellosis
- Typhus
- Measles
- Salmonellosis

Other Reactions

- **Thrombophlebitis**
- **G-6-PD deficiency**
- **Hemochromatosis**
- **Air embolism**
- **Isoimmunization**

Optimal Use

- **Indication**
- **Efficacy**
- **Complication**

Thank you

