PedHemOnc-PMK

Blood Transfusion

—— Make it safe & easy ——

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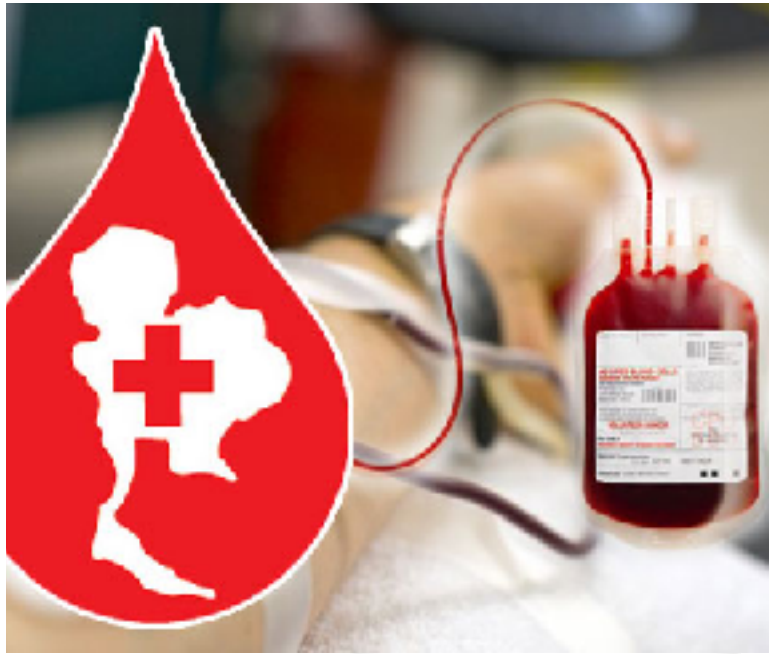
Contents

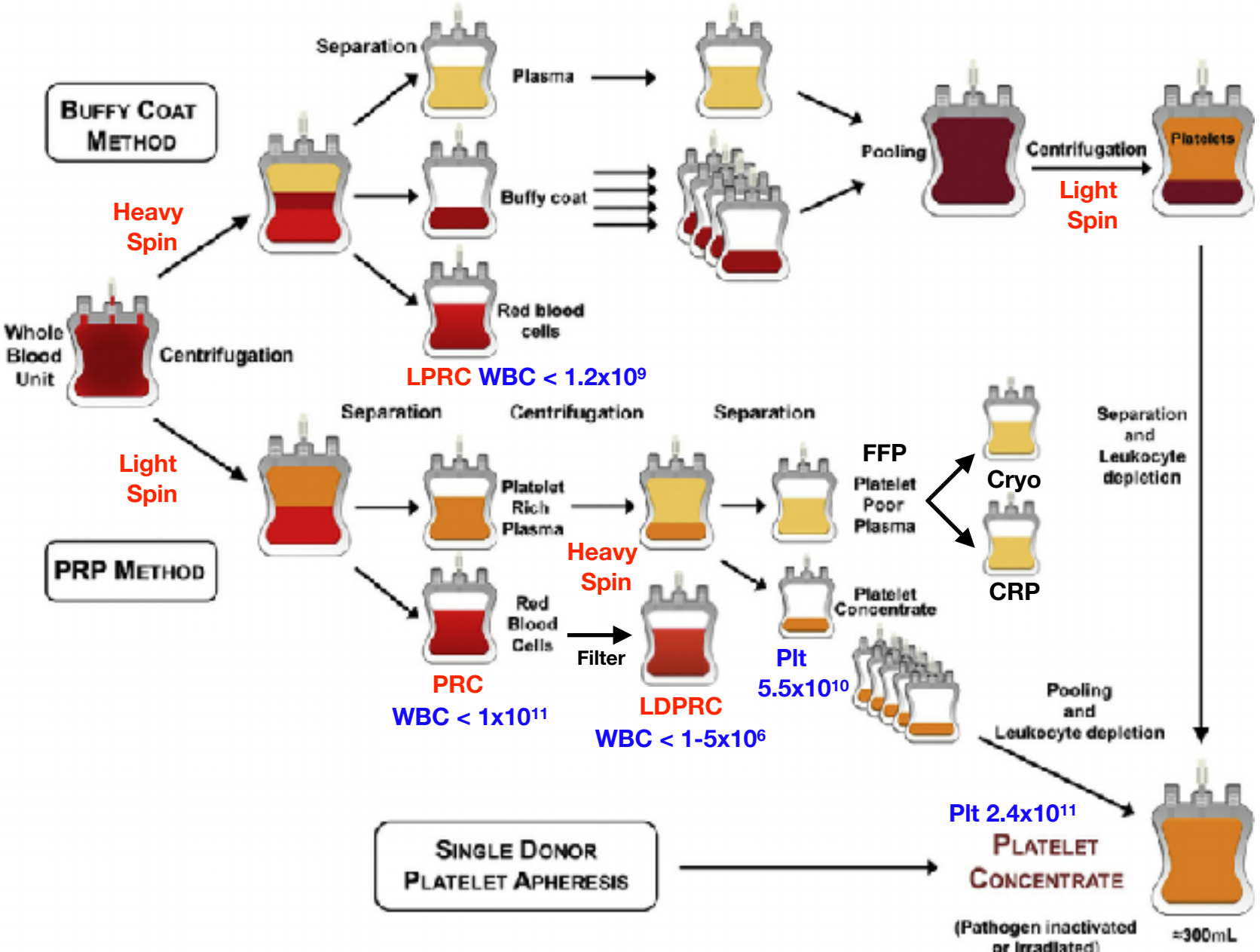
- **Blood component preparation**
- Compatibility Testing
- Special Conditions
- Transfusion-related reactions
- Conclusions

PedHemOnc-PMK

Introduction



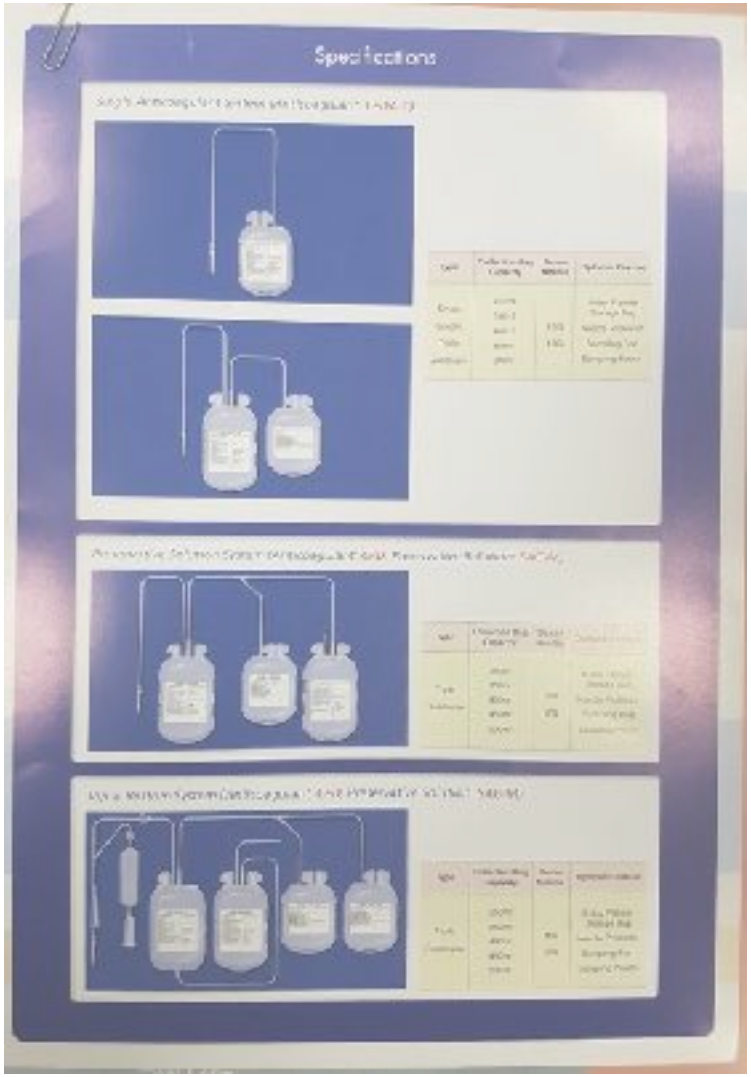
Preparation



Available Blood Products

Red Blood Cells	Whole blood
	Pack red cells
	Red cells in additive solution
	Leukocyte poor red cells/ Leukocyte poor blood
	Leukocyte depleted blood/ Pre-storage filtered blood
	Two unit red cells (apheresis)
Platelets	Platelet concentrate (random donor platelets)
	Leukocyte poor pooled platelets
	Single donor platelets (apheresis)
Plasma	Fresh frozen plasma
	Cryo-removed plasma
	Cryoprecipitate
	Jumbo plasma (by apheresis donation)

Anticoagulant in blood product



CPDA-1 (Citrate / Phosphate / Dextrose)
+ Adenine
Shelf life : ***35 days***

CPD (Citrate / Phosphate / Dextrose)
Shelf life : ***21 days***
+
SAG-M (Preservative solution)
Extended to ***42 days***

PedHemOnc-PMK

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Let's survey

cross-matched LPRC

Group-matched LPRC

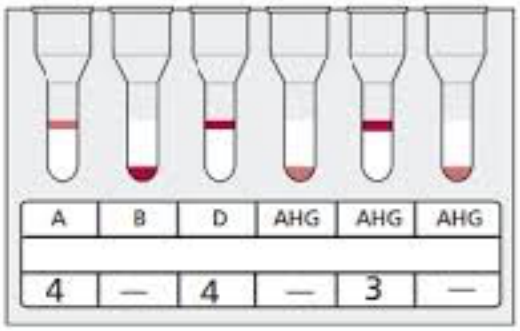
ไม่ LPRC เลย

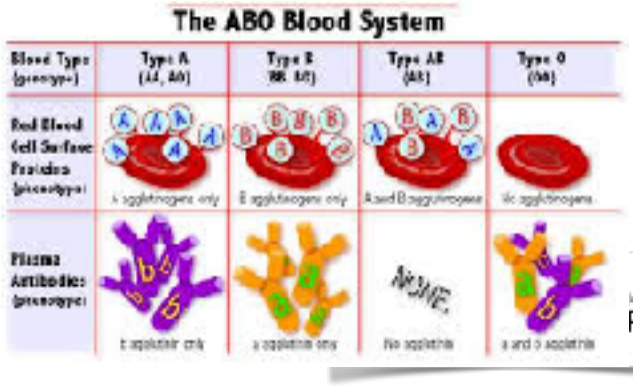
What is “Crossmatching” or “G/M”

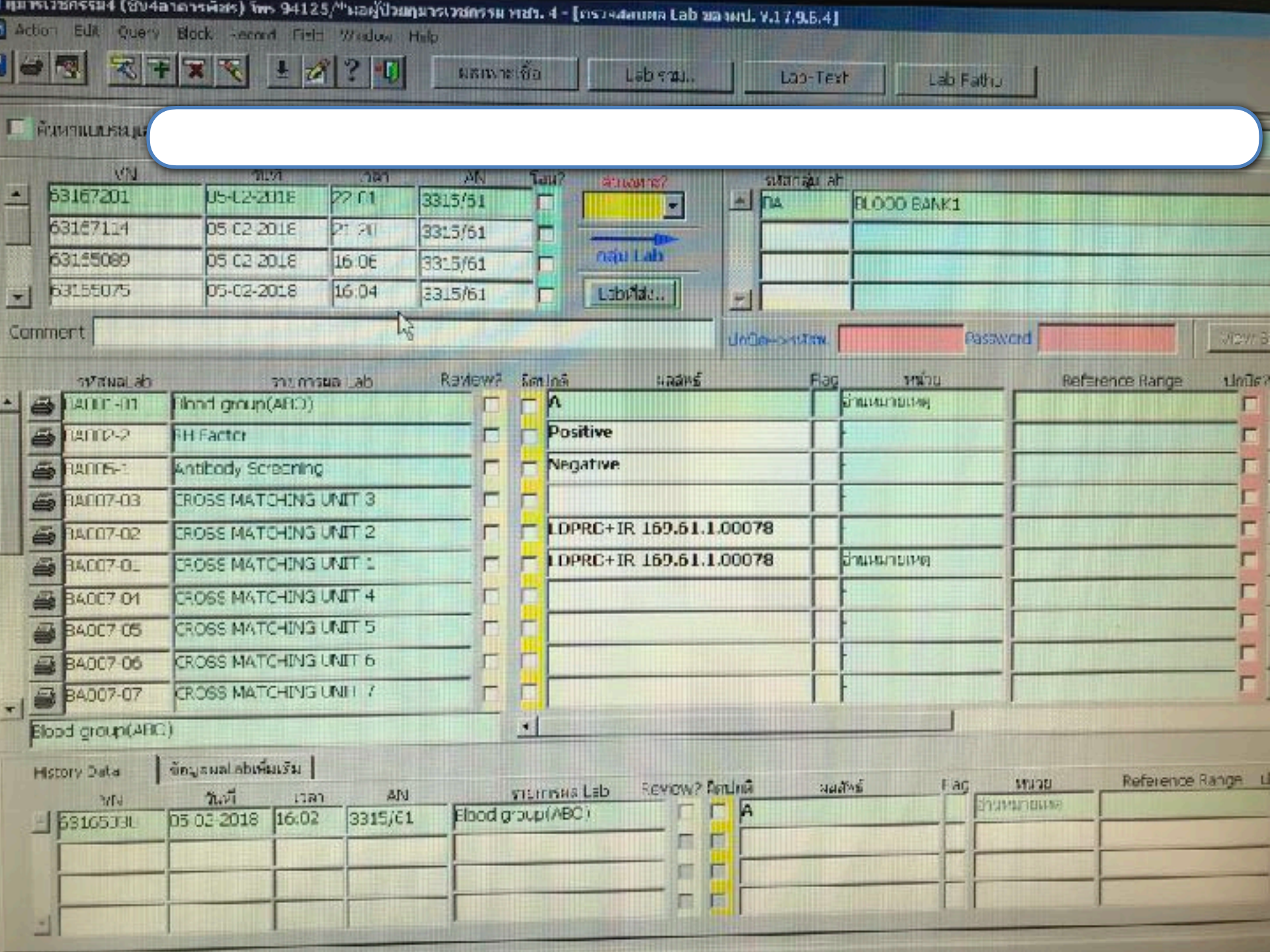
Crossmatching

Group-matched

Compatibility testing



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Lab รวม..
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Blood group(ABC)
Rh Factor
Antibody Screening
CROSS MATCHING UNIT 3
CROSS MATCHING UNIT 2
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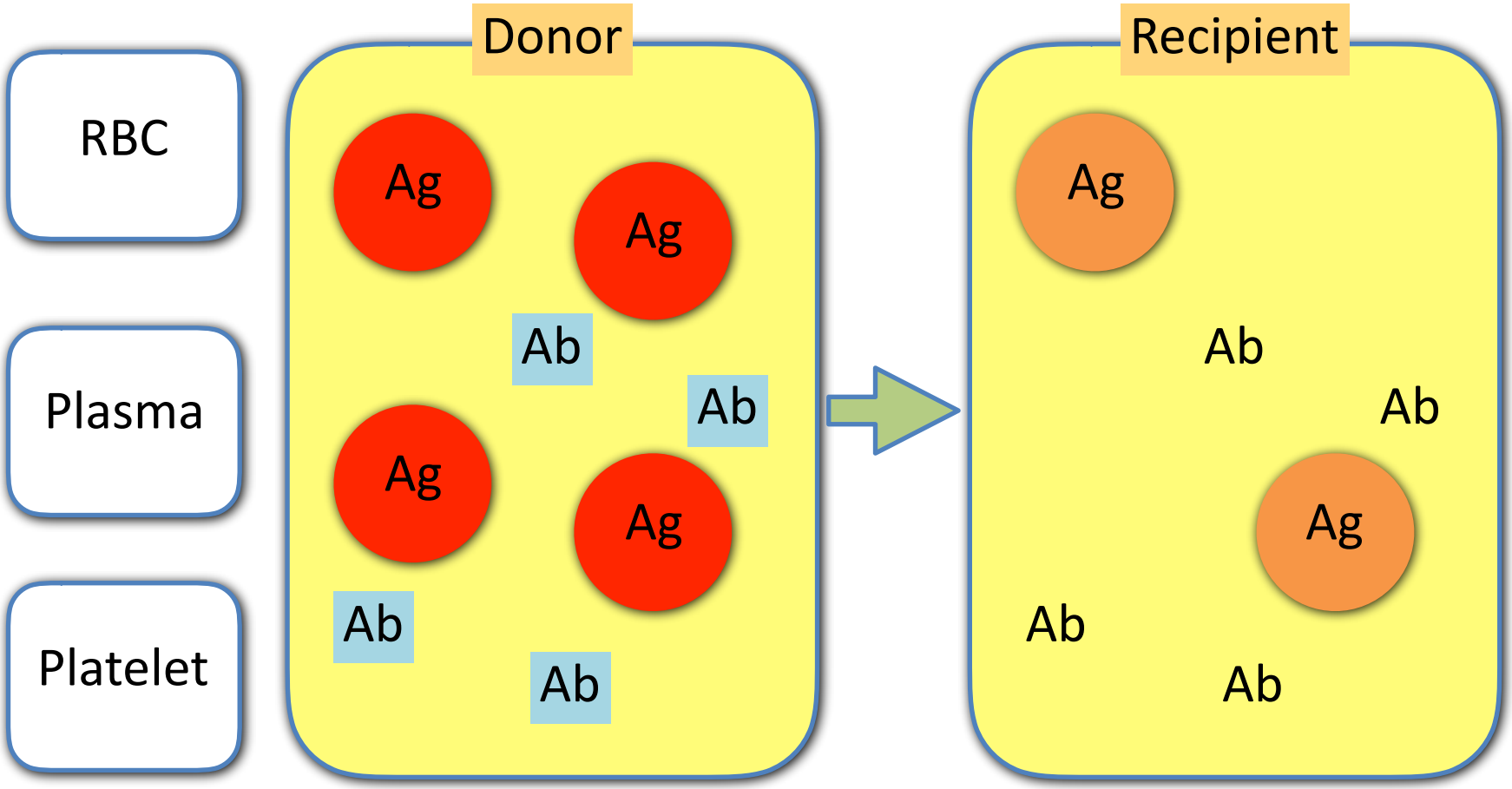
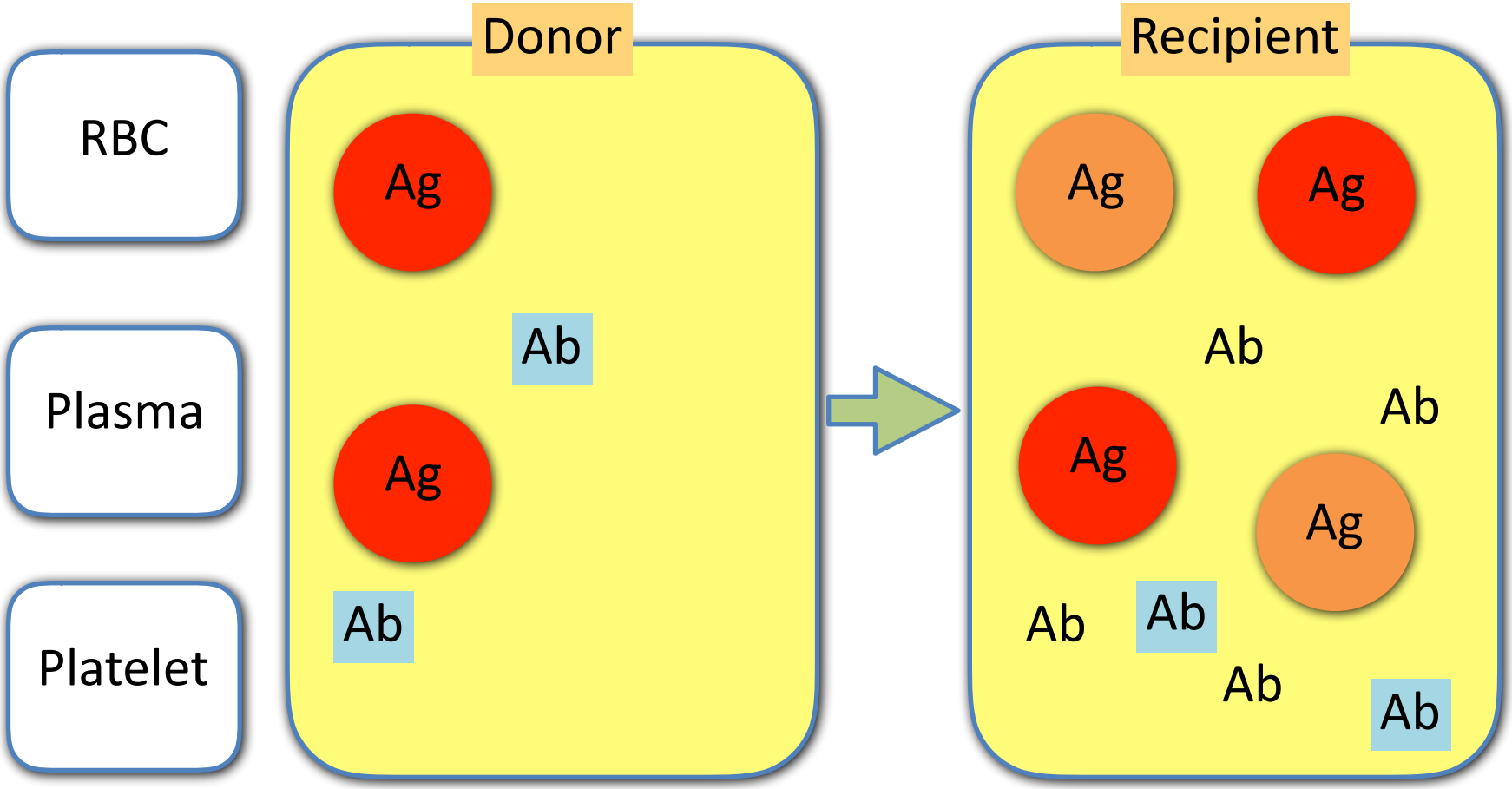
CROSS MATCHING UNIT 5
CROSS MATCHING UNIT 6
CROSS MATCHING UNIT 7
A
Positive
Negative
LDPRC+IR 169.61.1.00078
LDPRC+IR 169.61.1.00078
BLOOD BANK1
History Data

Compatibility Testing

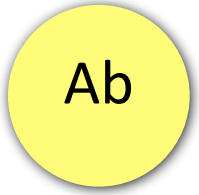


Compatibility Testing

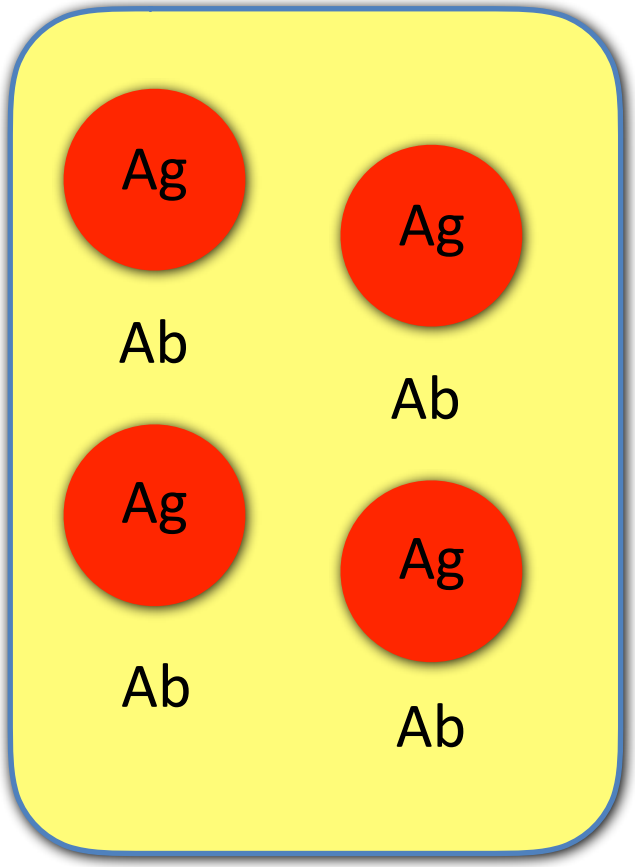


ABO Grouping

- Cell grouping and serum grouping
- Verify ABO group with previous record



	Red cell		Serum/Plasma		
group	cell grouping		serum grouping		
Reagent	Anti-A	Anti-B	A cells	B cells	O cells
A	+ A	-	-	+ Anti-B	-
B	-	+ B	+ Anti-A	-	-
AB	+ A	+ B	-	-	-
O	-	-	+ Anti-A	+ Anti-B	-



Rh D Typing

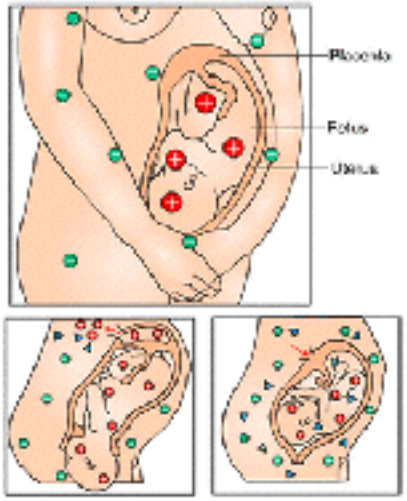
Test for presence of D Antigen

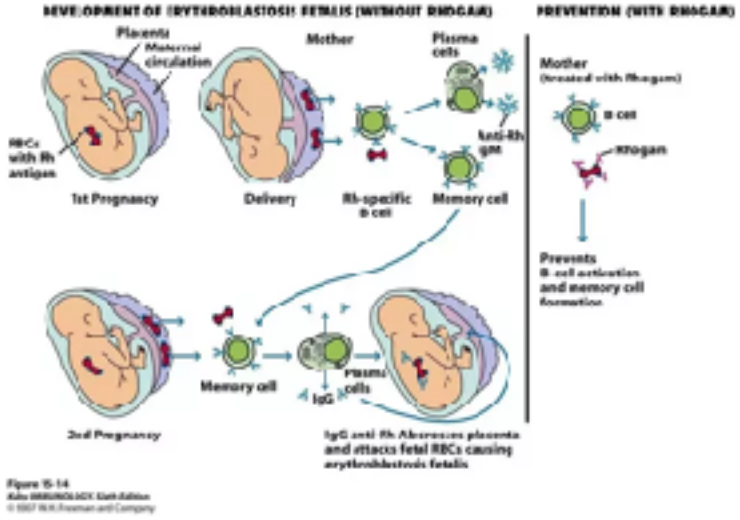
- **D Antigen (+)** —> Rh D Positive — 99.7% of Thais
- **D Antigen (-)** —> Rh D Negative — 0.3% of Thais

Rh D Antigen : ***Potent immunogenicity*** that cause of severe hemolytic disease of fetus and newborn ***(HDFN)***

To prevent of anti-D formation

- Rh D negative - should receive RhD Neg PRC/PLT
- Rh D negative pregnant woman without anti-D should receive anti-D immunoglobulin





Rh D Typing

1. Different RBC antigens between father(RhD+) and mother(RhD-)

2. Antigens on fetal red cells inherited form father →blood group incompatibility between a fetus(RhD+) and mother(RhD-)

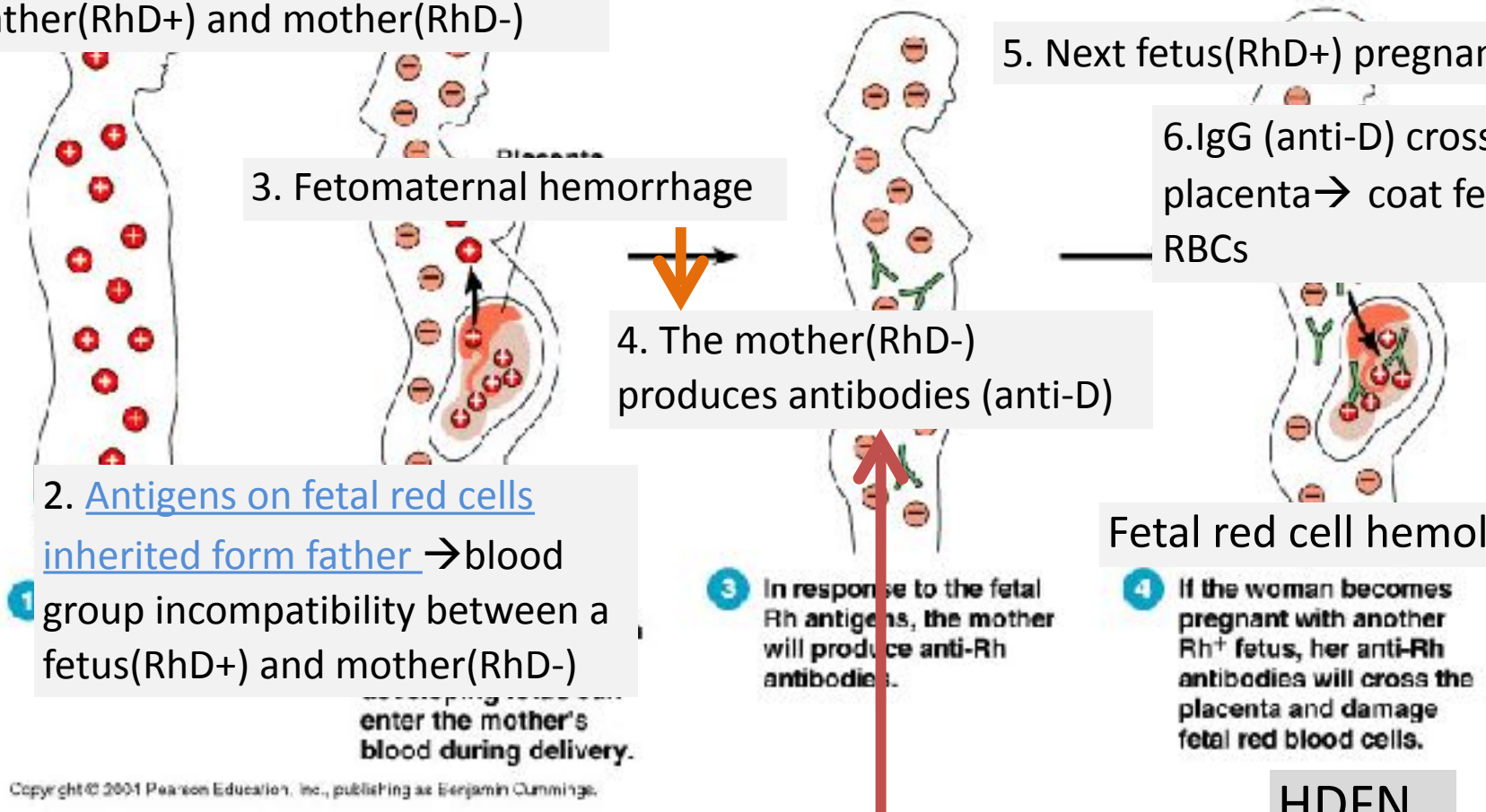
3. Fetomaternal hemorrhage

4. The mother(RhD-) produces antibodies (anti-D)

5. Next fetus(RhD+) pregnancy

6.IgG (anti-D) cross placenta→ coat fetal RBCs

Fetal red cell hemolysis



The mother received RhD+ red blood cell transfusion

HDFN

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Antibody screening

Detection pf antibody to other blood groups :

- **Rh** (c,C,D,e,E), **Duffy** (Fy^a, Fy^b), **Kidd** Jk^a,Jk^b), **Kell** (K,k), **MNS (M,N,S**,s), **Mia, Lewis (Le^a, Le^b), P (P_1)**, and **Diego** (Di^a, Di^b)

*Blue - IgM, Black - IgG

Landsteiner in Stockholm in 1930

Table 1 The 30 systems of blood group

ISBT No.	Name	Symbol	No. of antigens	ISBT No.	Name	Symbol	No. of antigens
1	ABO	ABO	4	16	Landsteiner-Wiener	LW	3
2	MNS	MNS	46	17	Chido / Rodgers	CH / RG	9
3	P1PK	P1PK	2	18	Hh	H	1
4	Rh	RH	52	19	Kx	XK	1
5	Lutheran	LU	20	20	Gerbich	GE	11
6	Kell	KEL	32	21	Cromer	CROM	16
7	Lewis	LE	6	22	Knops	KN	9
8	Duffy	FY	5	23	Indian	IN	4
9	Kidd	JK	3	24	Ok	OK	3
10	Diego	DI	22	25	Raph	RAPH	1
11	Yt	YT	2	26	John Milton Hagen	JMH	6
12	Xg	XG	2	27	I	I	1
13	Scianna	SC	7	28	Globoside	GLOB	1
14	Dombrock	DO	7	29	Gill	GIL	1
15	Colton	CO	4	30	RHAG	RHAG	3

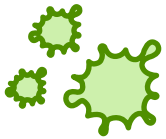
Ref : Daniels G, Bromilow I. Essential Guide to Blood Groups. Oxford, 2007

Antibody screening

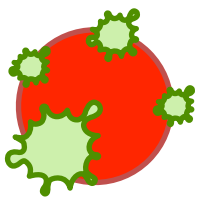
Immediate spin at room temp → **Incubate at 37 Celcius for 30 mins** → **Indirect Antiglobulin Test (IAT)**

O1, O2, O3 red cells

gr.O red cell containing all other minor bl.gr. antigen



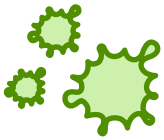
Patient's Serum



Agglutination IgM

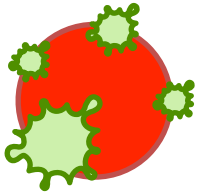
Direct Agglutination

Patient's Serum



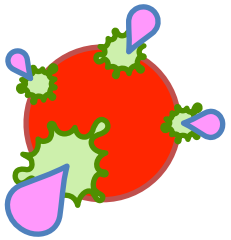
O1, O2, O3 red cells

Coated RBC IgG



Washed 4 times Then added ***coombs' reagent***

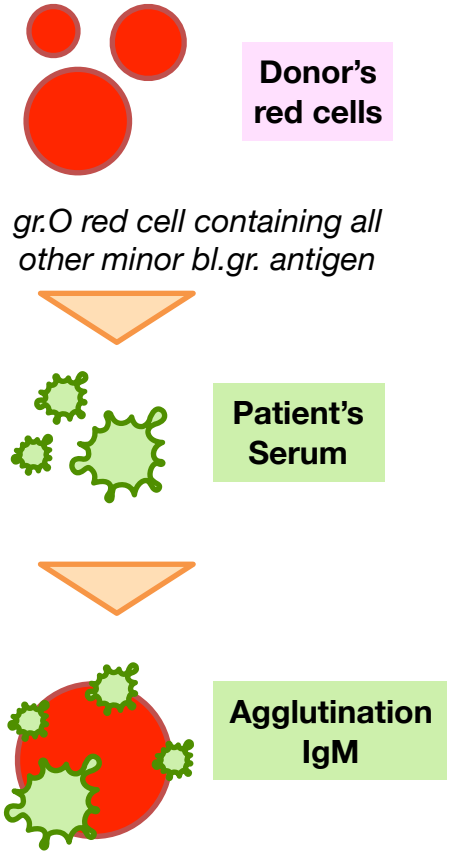
Agglutination IgG



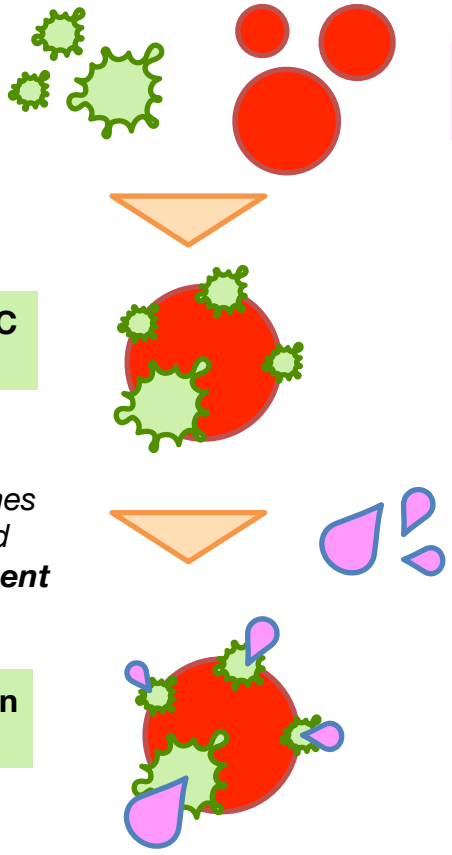
Direct Antiglobulin Test

Crossmatching

Immediate spin at room temp → **Incubate at 37 Celcius for 30 mins** → **Indirect Antiglobulin Test (IAT)**

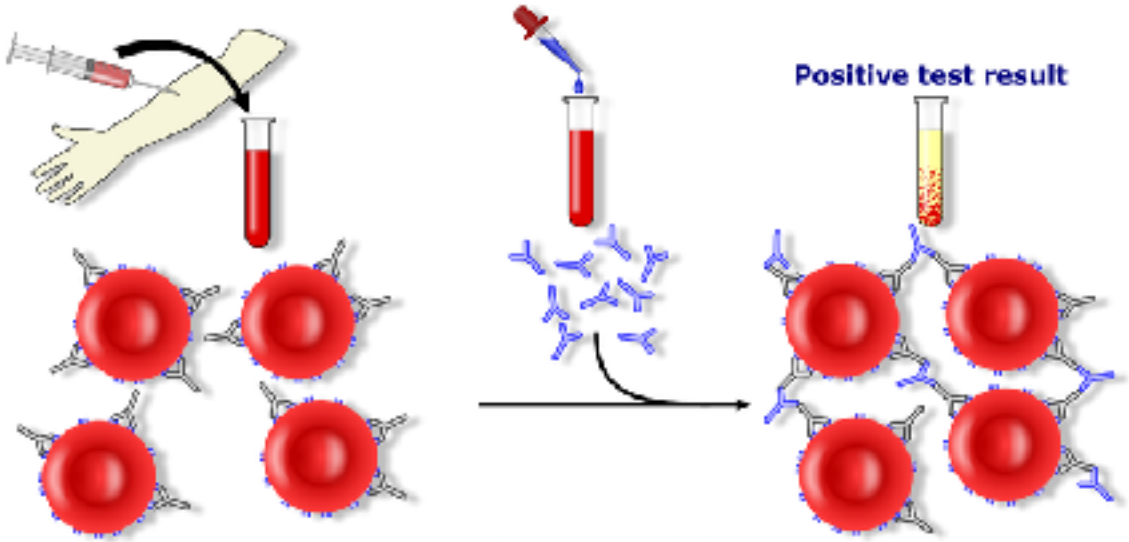


Direct Agglutination



Direct Antiglobulin Test

Direct Coombs test / Direct antiglobulin test

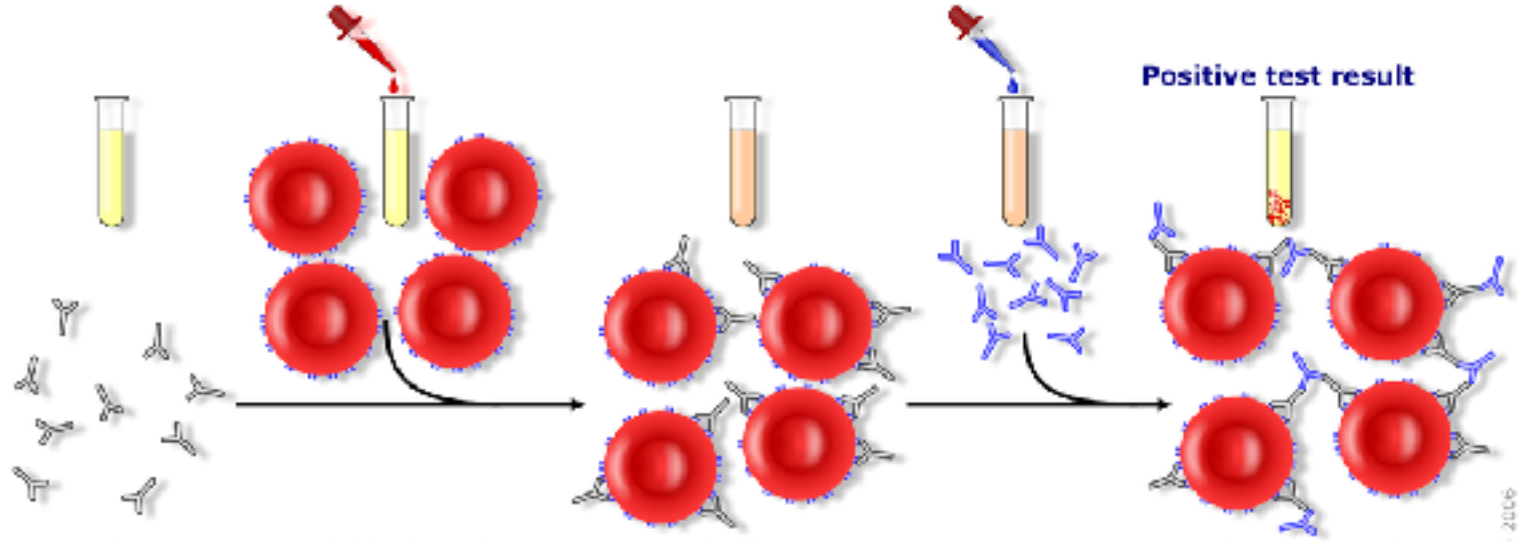


Blood sample from a patient with immune mediated haemolytic anaemia: antibodies are shown attached to antigens on the RBC surface.

The patient's washed RBCs are incubated with antihuman antibodies (*Coombs reagent*).

RBCs agglutinate: antihuman antibodies form links between RBCs by binding to the human antibodies on the RBCs.

Indirect Coombs test / Indirect antiglobulin test



Recipient's serum is obtained, containing antibodies (Ig's).

Donor's blood sample is added to the tube with serum.

Recipient's Ig's that target the donor's red blood cells form antibody-antigen complexes.

Anti-human Ig's (*Coombs antibodies*) are added to the solution.

Agglutination of red blood cells occurs, because human Ig's are attached to red blood cells.

Compatibility Testing

RBC

- ABO grouping
- RhD grouping
- Antibody screening
- Crossmatching

Plasma

- ABO grouping

Platelet

- ABO grouping
- RhD grouping*
  (Rbc in product)

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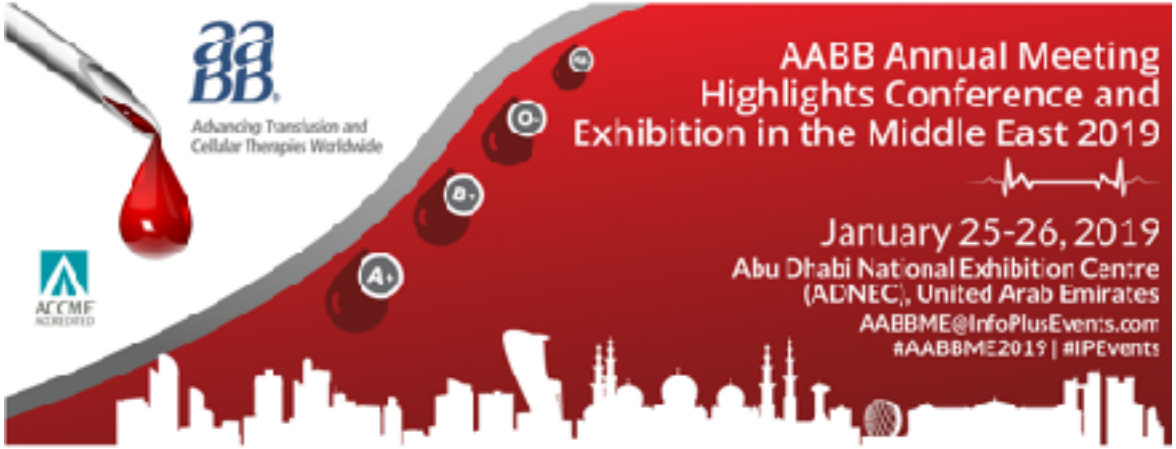
Blood request

Emergency ***-uncrossmatched-***	***0 mins***	PRC “O” in ad-sol
Urgency ***-ABO matched-***	***5 mins***	ABO grouping RhD grouping
Immediate ***-Immediate spin-***	***10-15 mins***	Antibody screening Crossmatching
Routine ***-full crossmatched-***	***30-60 mins***	
Type and screen	***60 mins***	Antibody screening

Compatibility testing

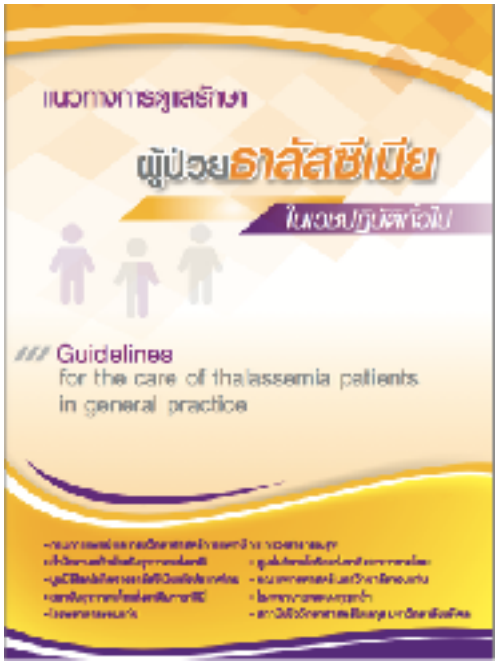
- Extended red cell antigen typing at least ***C, c, D, E, e, and Kell***, though preferably a full red cell phenotype/genotype panel.
- If the patient is already transfused, ***antigen typing*** can be performed using ***molecular*** rather than ***serologic testing***.
- All patients with thalassaemia should be transfused with ***ABO and Rh(C, c, D, E, e) and Kell compatible blood*** in order to avoid alloimmunisation against these antigens

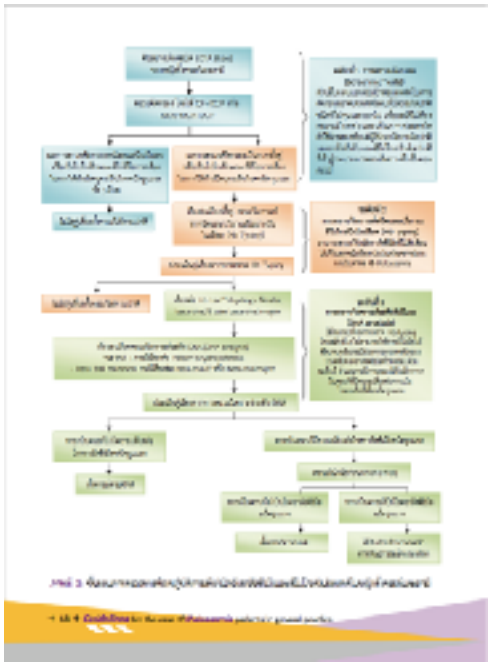


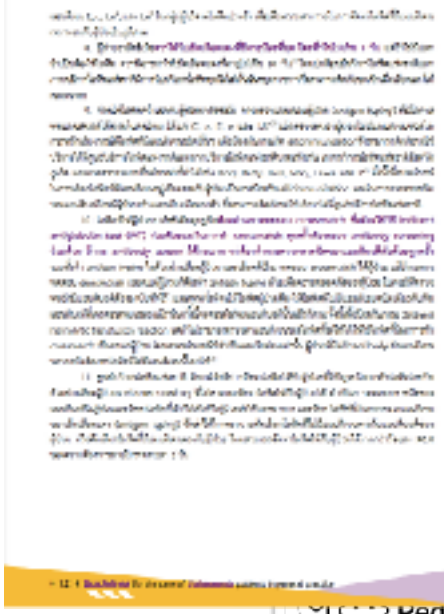
Ref : AABB guidelines

Compatibility testing

- Extended red cell antigen typing at least ***C, c, D, E, e, and Mi^a*** according to high prevalence in Thai population.
- Others antigen typing including; ***Kidd, Duffy, Kell, MNS, Lewis and P***
- All patients should perform ***antibody screening*** in every crossmatch
- All patients with thalassaemia should be transfused with ***ABO and Rh(C, c, D, E, e) compatible blood*** in order to avoid alloimmunisation against these antigens







Ref : แนวทางการวินิจฉัยและรักษาโรคโลหิตจางธาลัสซีเมีย Nov 2018

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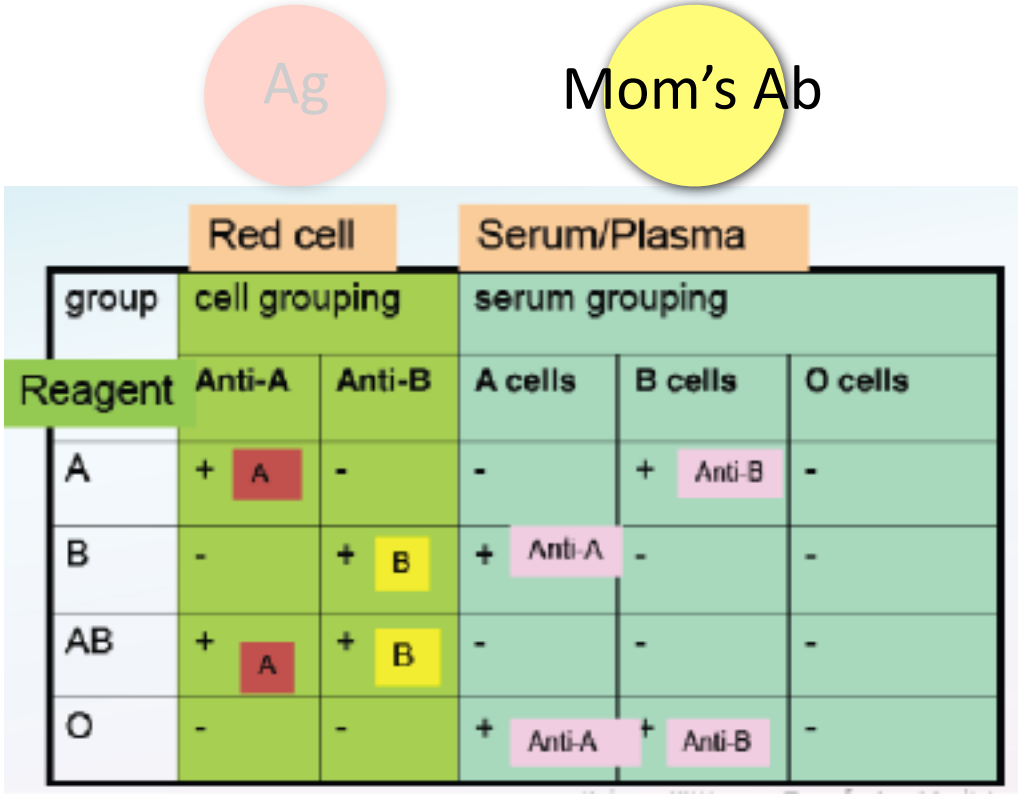
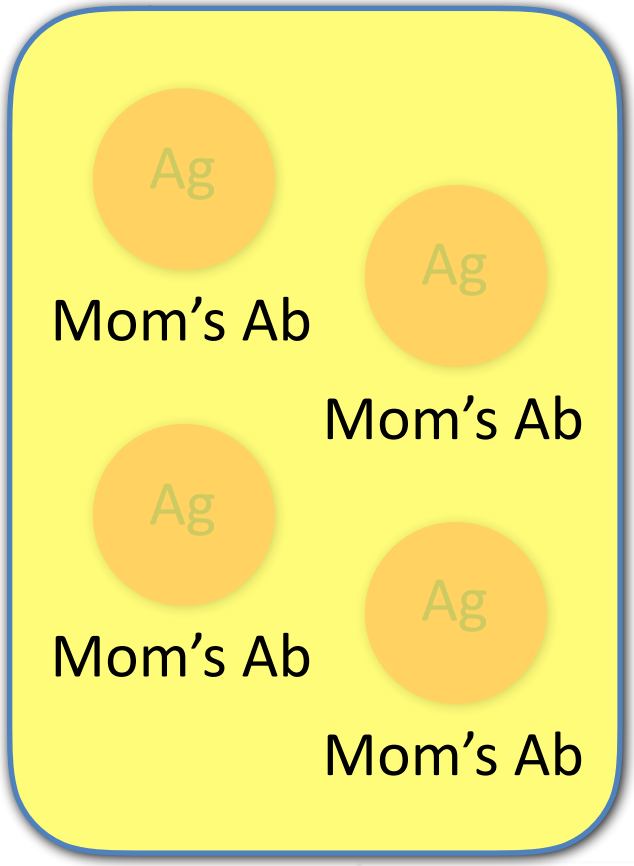
ABO Grouping - Newborn

- Maternal blood : Cell grouping + serum grouping
- Neonatal blood : only cell grouping



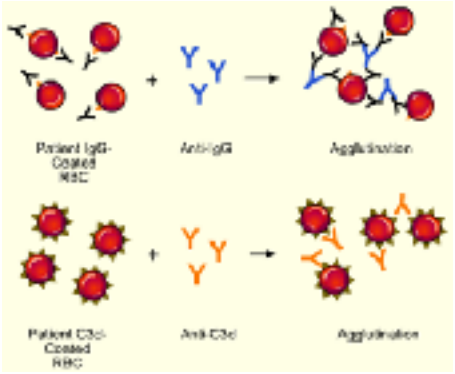
	Red cell		Serum/Plasma		
group	cell grouping		serum grouping		
Reagent	Anti-A	Anti-B	A cells	B cells	O cells
A	+ A	-	-	+ Anti-B	-
B	-	+ B	+ Anti-A	-	-
AB	+ A	+ B	-	-	-
O	-	-	+ Anti-A	+ Anti-B	-



ABO Grouping - Newborn

- A serum grouping test to detect IgG-classed anti-A and anti-B
- ***IgG > detected in IAT phase***
- Test in neonate's blood to detect maternal anti-A/anti-B (IgG)

ABO incompatibility HDN (group O mother VS group A baby)					
	anti-A	anti-B	A cell	B-cell	
Maternal	-	-	+	+	Group O
Neonatal	+	-	+ at IAT	+ at IAT	Group A with IgG-classed anti-A anti-B from mother



IAT A cell	RT	37 C	IAT
Neonate's plasma with A cell	-	-	+

ABO-incompatibility

Only 10% develop HDFN

1st child is at risk.

- Anti-A and anti-B are ***natural-occurring antibodies***

Only group O mother

- ***IgG (anti-A,B)***

Fetal anemia extremely rare.

- A and B antigens are not fully developed on fetal RBCs
- Hemolysis in newborn > jaundice

Maternal blood group	Maternal Antibodies	Incompatible infant
O	Anti-A, anti-B, anti-A,B (IgG)	A, B
A	Anti-B	A, AB
B	Anti-A	B, AB
AB	-	-

ABO Grouping - Newborn

แม่	ลูก	IAT to A/B cell	PRC	FFP
O	A	**พบหรือไม่พบ** Anti-A	O *serum แม่มี Anti-A,B*	A, AB
O	B	**พบหรือไม่พบ** Anti-B	O *serum แม่มี Anti-A,B*	B, AB
A	AB	**พบ**Anti-B	A	AB
		ไม่พบ Anti-B	AB	AB
B	AB	**พบ**Anti-A	B	AB
		ไม่พบ Anti-A	AB	AB
A	B	**พบ**Anti-B	O	B, AB
		ไม่พบ Anti-B	B	B, AB
B	A	**พบ**Anti-A	O	A, AB
		ไม่พบ Anti-A	A	A, AB

Compatibility testing - Newborn

< 4 Months	> 4 Months
No need of compatibility test & ABO & D if… • Antibody screening is negative • Transfused RBCs are group O, ABO identical • Transfused RBCs are either D negative or same D as the patient	**Same as adult AABB standard**
Waving of repeat ABO & D and antibody screening if… • Same hospitalization • Until neonate reaches 4 months	

Ref : AABB guidelines

Pediatric Cancer & Hematologic Disorder
PedHemOnc-PMK

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Transfusion-related reaction

Immediate	Delayed
Immune process	
Immediate hemolytic transfusion reaction	Delayed hemolytic transfusion reaction
Febrile nonhemolytic transfusion reaction	Post transfusion purpura
Urticarial (allergic) reaction	Alloimmunization
Anaphylactic reaction	Transfusion-associated GVHD
Noncardiogenic pulmonary edema	Immunosuppression
Nonimmune process	
Bacterial contamination	Iron overload
Volume overload	
Physical red blood cell damage	
Dilution of coagulation factors or platelets	

Ref : Adverse effects of blood transfusion, Chantrapa S., Et al.
Thai Journal of Hematol and Transfusion Med.; Vol.10, No.4, October 2000

Transfusion-related reaction

ACUTE	FREQUENCY	DELAYED	FREQUENCY
Haemolytic (intravascular)	1/25,000	Alloimmune	1/100
Anaphylactic	1/50,000	Haemolytic (extravascular)	1/2,500
Febrile non-haemolytic	1/100	Graft vs Host Disease	Rare
Allergic (Urticarial)	1/100		
TRALI	1/10,000		

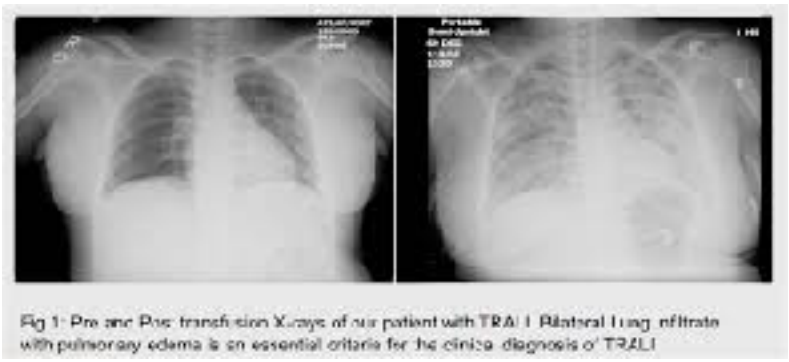


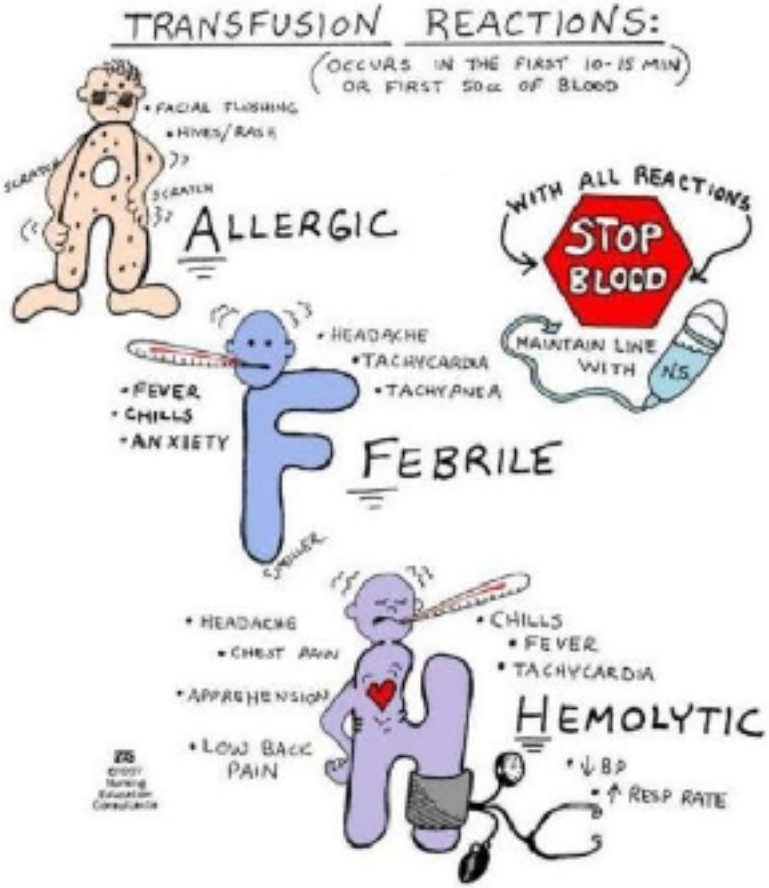
Fig 1: Pre and Post transfusion X-rays of our patient with TRALI Bilateral lung infiltrate with pulmonary edema is an essential criteria for the clinical diagnosis of TRALI

Ref : Thalassemia International Federation (TIF). Nicosia, Cyprus; 2013

Transfusion Reaction

- **Fever** and/or chills
- Blood pressure change
- **“Pain”** : infusion site, chest , abdomen, flank
- **Skin change** – rash, urticaria, angioedema
- **Respiratory distress**: dyspnea, wheezing
- **Hemoglobinemia/ Hemoglobinuria**
- Unexplained bleeding/DIC

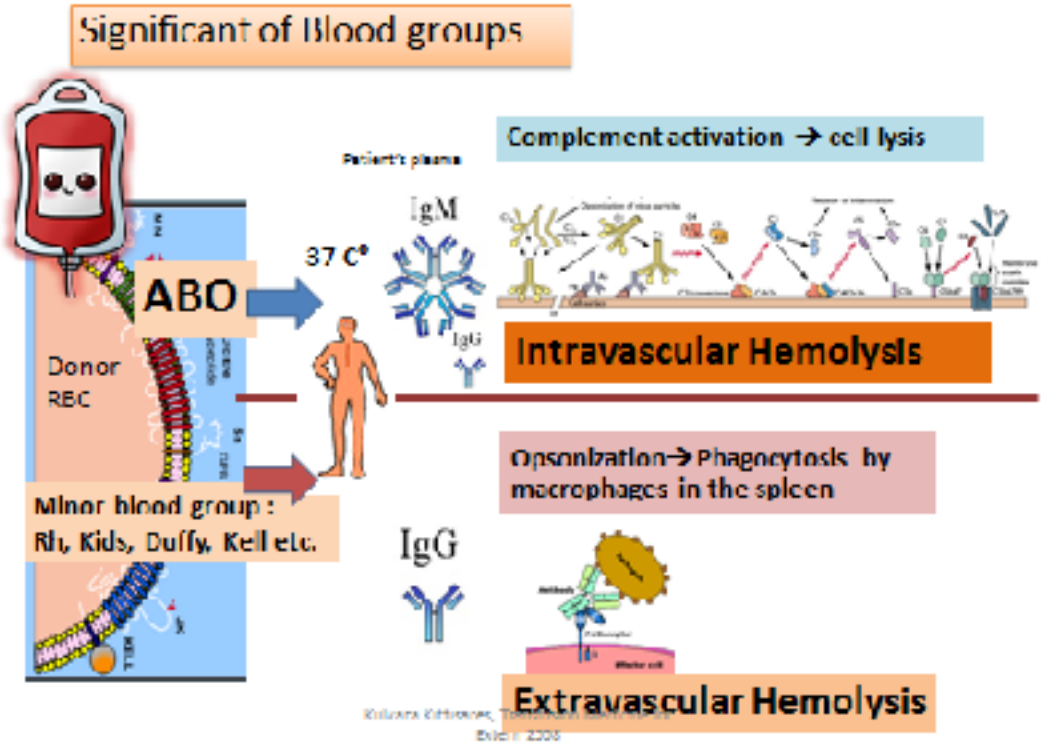
1. Stop transfusion
2. Keep vein open, NSS infusion
3. ประเมิน vital signs, อาการและความรุนแรง
4. Check bedside clerical error (identification, blood group)
5. แจ้งธนาคารเลือดว่าผู้ป่วยเกิด transfusion reaction
6. ให้การรักษาตาม Differential diagnosis



Acute Hemolytic Transfusion Reaction (AHTR)

Etiology - ABO incompatibility

Prevention - Compatibility testing, transfusion procedure



Therapeutic Approach

– Stop the transfusion

– Maintain venous access with NSS infusion

– Hydration and diuresis

- keep renal output > 1 ml/kg/hr
- Renal replacement therapy if indicated

– Bleeding and acute DIC treatment

– ***Notify blood bank for investigation****

Febrile Non Hemolytic Transfusion Reaction (FNHTR)

Etiology

– ***Recipient antibodies attack donor WBCs*** >> cytokine release

– Cytokines produced from donor WBCs during storage

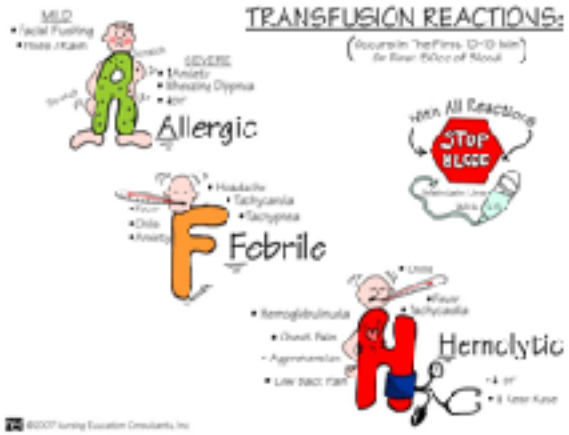
Prevention

– Premedication with acetaminophen for patient with history of reaction

– ***Leukocyte-reduced blood components***

- Leukocyte poor red cells
- Leukocyte depleted red cell (prestoraged filtered)
- Leukocyte poor pooled platelets
- Single donor platelet by apheresis

"Fever-Chill" Reaction



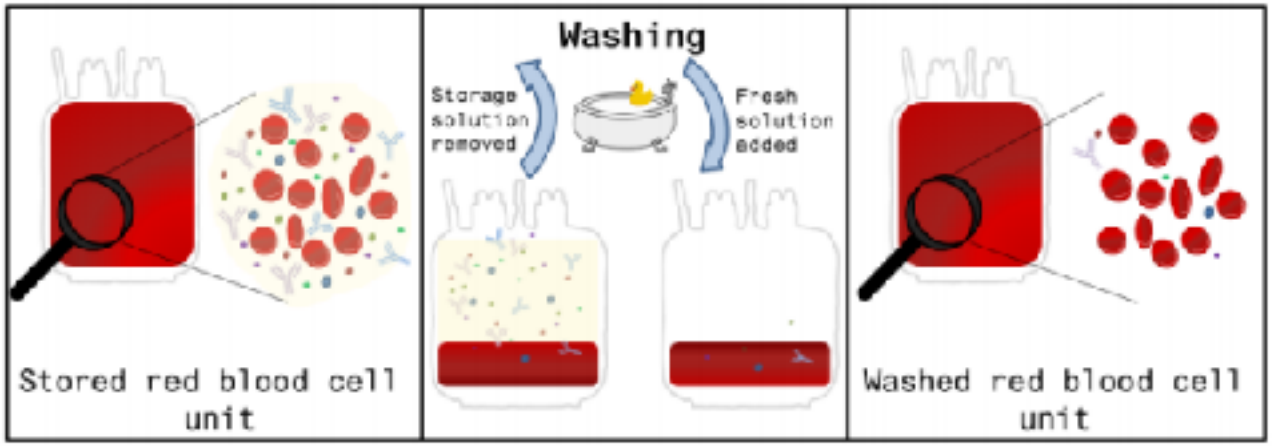
Anaphylaxis

Etiology

- ***Hypersensitivity to DONOR PLASMA PROTEIN***
- Possible allergen: **IgA** in IgA deficiency patient, **haptoglobin** in haptoglobin deficiency patient, **latex , drugs, food** in donors in susceptible patients

Prevention

- **Washed blood component**
- Epinephrine (1:1,000) 0.2-0.5 ml IM/ SQ
- Antihistamines IV



Transfusion Related Acute Lung Injury (TRALI)

Etiology

– **Donor antibodies** react strongly with the **patient's neutrophils and deposit in pulmonary vasculature**

Prevention

– Stop transfusion

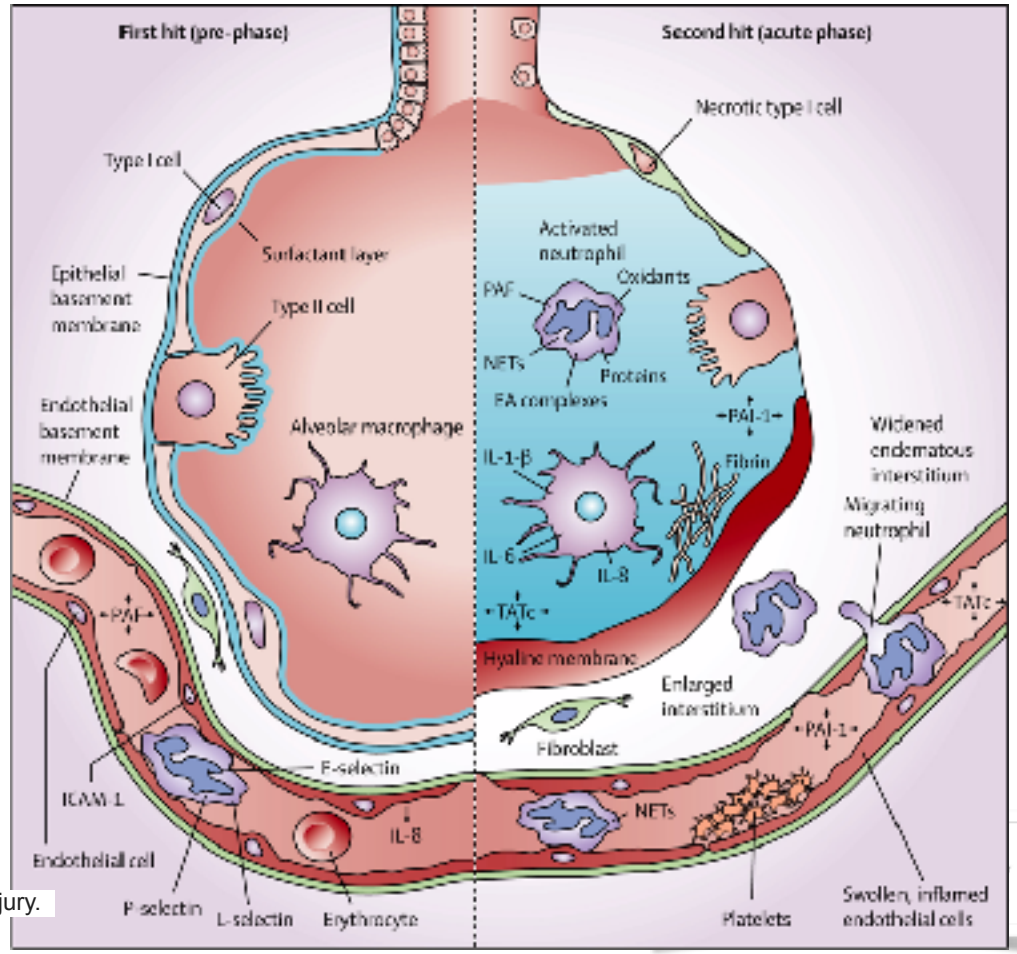
– Implicated ***donor with Ab*** should be deferred from donation

– Respiratory support (oxygen,intubation, ventilation)

– Usually resolve with supportive care within 48 – 96 hours

Occur within 6 hours after transfusion

New onset of ***acute respiratory distress syndrome (ARDS)***



Ref : Popovsky MA, Abel MD, Moore SB. Transfusion-related acute lung injury. American Review of Respiratory Disease. 1983 Jul;128(1):185-9.

Transfusion–associated Circulatory Overload (TACO)

Patients at risk

– Patients with pre-existing congestive heart failure, renal failure, chronic anemia, very old or very young

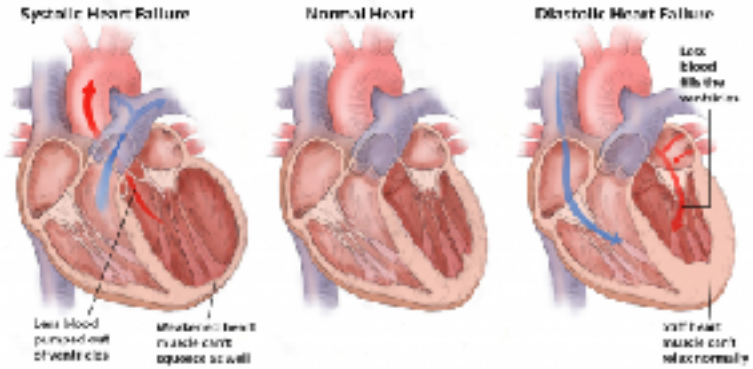
Prevention

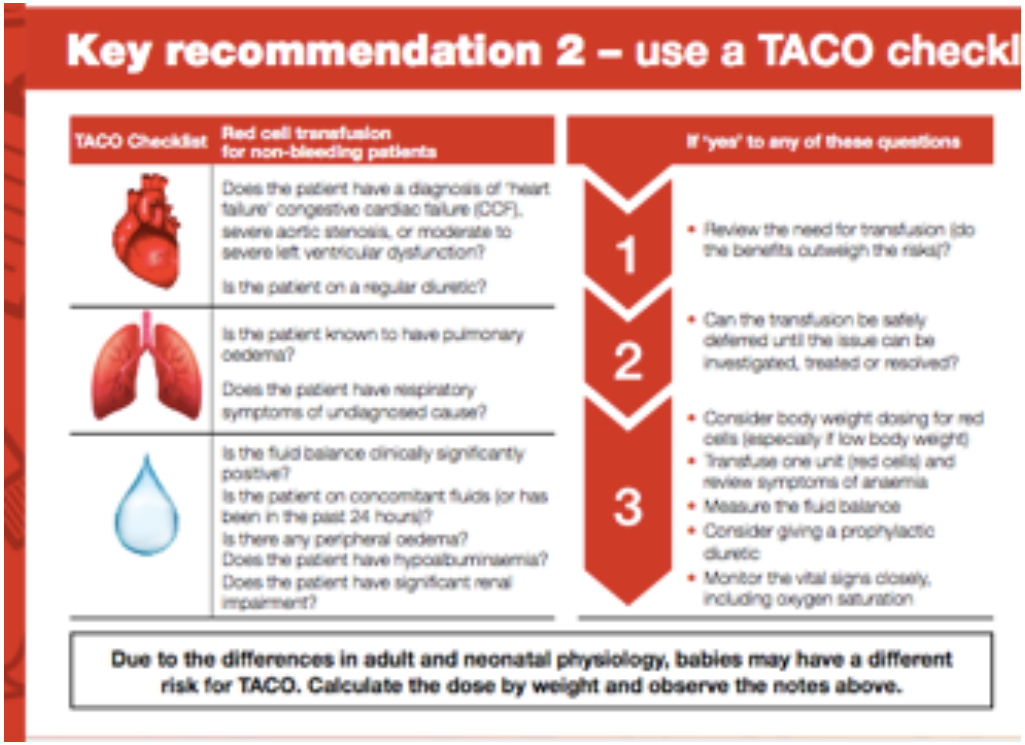
– Control infusion rate

1 ml/kg/hr for red cells

2-4 ml/kg/hr for FFP/platelet

– Especially in patients at risk





Ref : AABB guidelines

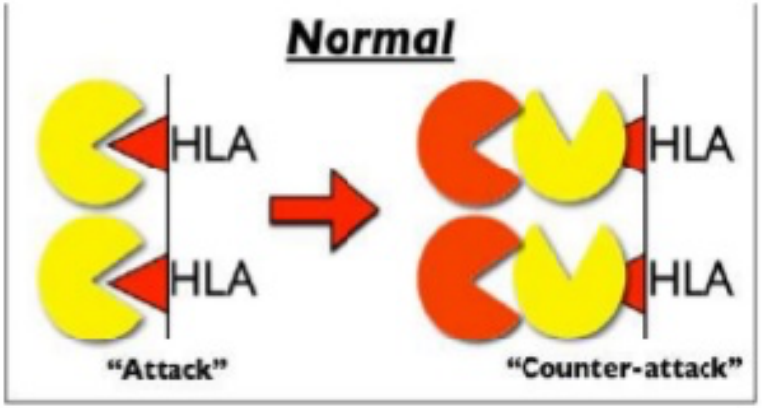
Transfusion–associated Graft vs Host disease (TA-GVHD)

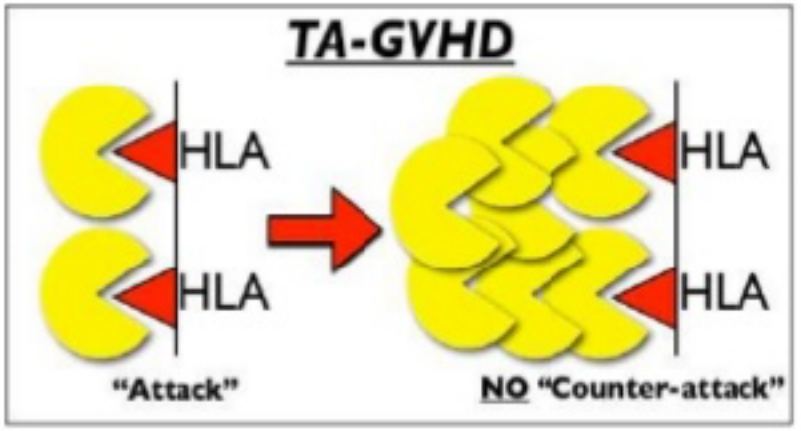
GAMMA IRRADIATION (25Gy or 2,500 cGy) of cellular component

Mechanism : ***Inactivate T-lymphocyte*** functioning and dividing

Patients at risk

- Intrauterine transfusion (IUT) and newborns with IUT
- ***Premature infants*** weight < 1200 g at birth
- Known or suspected cellular immune deficiencies
- ***Significant immunosuppression***
- ***Blood component from relatives***
- HLA matched/ crossmatch compatible platelets





PMK

Transfusion reaction & Prevention

Donor's RBC antigens VS Patient's IgG, IgM >> **Hemolytic transfusion reaction**

- **Compatibility testing**

Donor's WBC antigens VS Patient's IgG, IgM >> **Febrile non hemolytic reaction**

- **Leukocyte reduced blood products**

Donor's Plasma proteins VS Patient's IgE >> **Allergic reaction, Anaphylaxis**

- **Washed blood product**

Donor's Antibodies VS Patient's Neutrophils >> **TRALI**

- **Implicated *donor with Ab* should be deferred from donation**

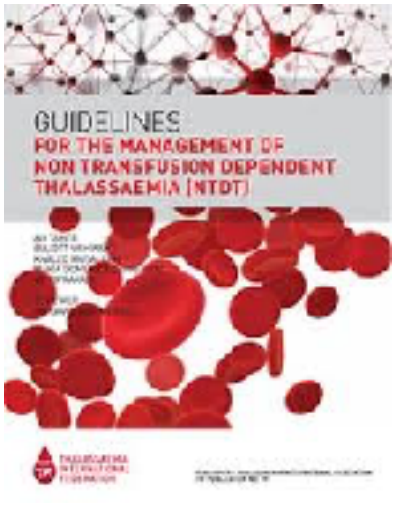
Too much/Too fast >> **TACO**

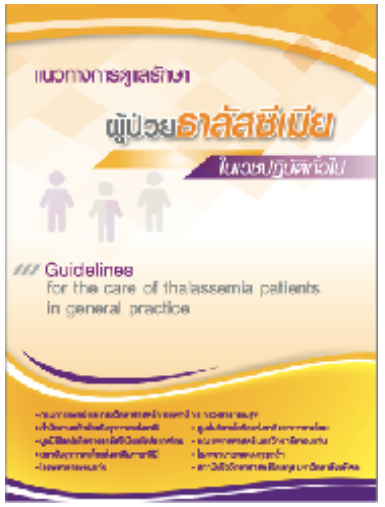
- **Diuretics and supportive**

Donor lymphocytes >> **TA-GVHD**

- **Irradiated blood products**

References





Thank you

Pediatric Cancer & Hematologic Disorder
PedHemOnc-PMK