

Optimal Use of Blood Component

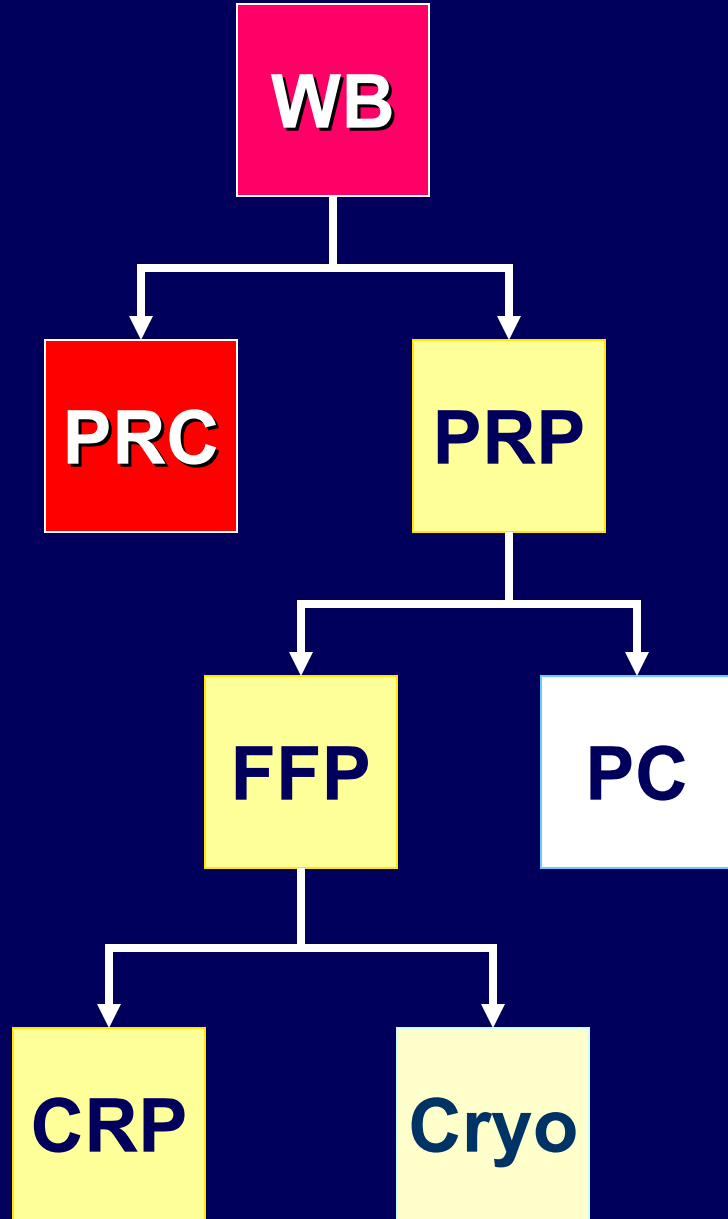
วิชาการสัญจร โรงพยาบาลลำปาง

วันที่ ๑๖ มกราคม พ.ศ.๒๕๕๖

ยิ่งยง ชินธรรมมิตร

ภาควิชาอายุรศาสตร์ คณะแพทยศาสตร์ศิริราชพยาบาล

ถ่านหินลือชา รถม้าลือลั่น เครื่องปั้นลือนาม
งามพระธาตุลือไกล ฝึกช้างให้ลือโลก



WB = Whole blood

PRC = Pack Red Cell

PRP = Platelet-rich plasma

FFP = Fresh frozen plasma

PC = Platelet concentrate

**CRP = Cryo-removed plasma,
FFP with cryo.-removed**

Cryo. = Cryoprecipitate

ข้อใดห้ามเก็บในตู้เย็นเด็ดขาด

1. Whole blood
2. Pack red cell
3. Fresh frozen plasma
4. Platelet concentrate
5. Cryoprecipitate
6. Red wine

Blood Component

	Vol (ml)	Storage	Shelf life
WB	500	1-6°C	35 d [CPDA-1]
PRC	180-200	1-6°C	21[ACD,CPD], 35, 42 d [AS-1,-3,-5]
FFP	200-280	≤-18°C	1 yr
PLT conc	50	20-24°C	5 days
Cryo.	10-15	≤-18°C	1 yr

หญิง ๒๒ ปี เหนื่อยเวลาออกกำลังกาย ๒ เดือน

- ประจำเดือนมา ๗ วัน/รอบมา ๖ เดือน ชอบกินผัก ไม่ชอบกินเนื้อสัตว์
- BP 100/60, P 90, R 16
- **Pale**, no dyspnea, **glossitis** systolic ejection murmur at Lt.2nd parasternal area, **koilonychia**, no edema
- Hb 5.8 g/dL, Hct 17.5%, MCV 52, Wbc ปกติ, Plt 520,000

Plan of Rx

1. PRC + FeSO₄
2. WB + FeSO₄
3. LPB + FeSO₄
4. FeSO₄ alone
5. IV iron
6. EPO + iron

ช ๖๕ ปี ถ่ายดำปนแดง ๓๐ นาที

- โรคเดิม : DM HTN ไตเสื่อม
หลอดเลือดหัวใจตีบ
- BP 90/60, P 120, R 18
- Pale, drowsy, no dyspnea,
no murmur, PR - blood +
melena
- Hb 9, Hct 27%, MCV 101,
wbc ปกติ, Plt 150,000

Initial Rx

1. NSS + PRC
2. NSS + WB
3. NSS + LPB
4. NSS alone
5. EPO + NSS

RBC Transfusion

- Symptomatic & supportive rather than definitive Rx for anemia.
- **Anemia \neq RBC transfusion**
- Use only if **no definitive Rx** or significant symptomatic anemia not able to wait for effects of definitive Rx

ช ๒๕ ปี หนาวสั่นมากหลังได้รับเลือด

- โรค HbH with CS dis
ได้รับเลือดเฉพาะช่วงมีไข้
ไม่สบาย มีอาการหนาวสั่น
มากทุกครั้ง บางครั้งมีแน่น
หน้าอก หายใจลำบาก
ความดันต่ำ
- Lab: Ig A deficiency

Best choice of rbc

1. PRC
2. LPB
3. Irradiated rbc
4. Washed rbc
5. Frozen rbc
6. Prestorage filter rbc

ญ ๔๕ ปี มะเร็งเต้านม ซีด

- โรคมะเร็งเต้านมได้รับยาเคมีบำบัดหลายครั้ง ต่อมาซีดลงมาก ต้องการรับเลือดจากน้องสาวตนเองเท่านั้น
- Lab: Hct 15%, MCV 95, wbc 3400, plt 90,000

Best choice of rbc

1. PRC
2. LPB
3. Irradiated rbc
4. Washed rbc
5. Frozen rbc
6. Prestorage filter rbc

Red Blood Cell Components

Component	Character	Indications
WB	High vol; good flow	Combined RBC & Volume deficit (massive hemorrhage, blood exchange)
PRC	Lower vol; higher Hct	Red cell deficit
Leukocyte-reduced rbc	Good flow in AS-1	↓febrile reaction, ↓CMV, ↓EBV, ↓alloimmunization (prestorage filter)

Red Blood Cell Components

Component	Character	Indications
Washed rbc	plasma depleted, use within 24 hr	↓severe allergic reactions, ↓anaphylaxis in IgA def
Frozen rbc [glycerol]	Long-term storage [10 ⁺ y]; plasma & wbc depletion	Rare donor unit storage; autologous storage for postponed surgery
Irradiated rbc	25-30 Gy, expired 28 d after irradiation	↓TA-GVHD : neonate, congenital immunodef, donor = relative, stem cell transplant, fludarabine

TABLE 19.3 ABO Group Selection for RBC Transfusion

Patient ABO Group	RBC Containing Component ABO Group			
	1st Choice	2nd Choice	3rd Choice	4th Choice
AB	AB	A	B	O
A	A	O		
B	B	O		
O	O			

Whole Blood

- 1-6°C → platelet dysfunction, decayed coagulation factors over time
- Less use in practice
- Fresh WB in military settings
- Advantage
 - Colloid osmotic pressure
 - Not expose to rbc and plasma from different donors

PRC

- 1 unit \rightarrow \uparrow Hct \sim 3%
- Acute blood loss
 - \leq 10% \rightarrow no replacement therapy
 - 11-20% \rightarrow crystalloid solutions
 - $>$ 25% \rightarrow PRC + crystalloid / colloid solutions
- Perioperative & ICU: Hb 7-8 g/dl may be trigger level.

ญ ๒๒ ปี จำเขียวที่ขา ๑ สัปดาห์

- มีจุดเลือดออก และจำเขียวที่ขา
สองข้าง ประจำเดือนปกติ ไม่
กินยาใด ไม่มีไข้
- BP 100/60, P 70, R 14
- Not pale, **petechiae &
ecchymoses** at legs, others
unremarkable
- Hb 13, Hct 39%, wbc ปกติ,
Plt 5,000 [0-1/OF, giant plt]

Plan of Rx

1. PLT conc [PC]
2. PC + steroid
3. Steroid
4. PC + FFP
5. FFP

หญิง ๓๒ ปี ปวดหัวอาเจียนมา ๒ ชม.

- เป็นโรค ITP มา ๒ ปี ขาดยา ๔ เดือน เป็นหวัด ๓ วันหายแล้ว ปวดหัวอาเจียนมา ๒ ชม.
- BP 160/90, P 60, R 12
- Not pale, petechiae at legs, alert, no organomegaly
- Hb 12, Hct 36%, wbc ปกติ, Plt 6,000 [0-1/OF, giant plt]
- CT: acute frontal hematoma

Rx : IVIg and ...

1. PLT conc [PC]
2. PC + steroid
3. Steroid
4. PC + FFP + steroid
5. FFP + steroid

ช ๕๒ ปี ไข้ สับสน จำเี่ยวที่ขา

- ไข้ต่ำๆ ๑ สัปดาห์ อ่อนเพลีย
สับสนบางช่วง จำที่ขา ๓ วัน
- T 38, BP 120/80, P 70, R 14
- **Pale, confused, ecchymosis**
at legs, no focal neuro. sign
- **Hb 7, Hct 21%**, MCV 97,
wbc ปกติ, **Plt 7,000** [0-1/OF]
, **schistocyte 3+**, spherocyte
1+, Coombs negative,
coagulogram - normal

Rx : PRC and....

1. PLT conc [PC]
2. PC + steroid
3. Steroid
4. PC + FFP
5. FFP
6. Cryoptt.

Platelet Products

- WB donations → Platelet concentrates
- Apheresis → Single donor platelets (SDPs)

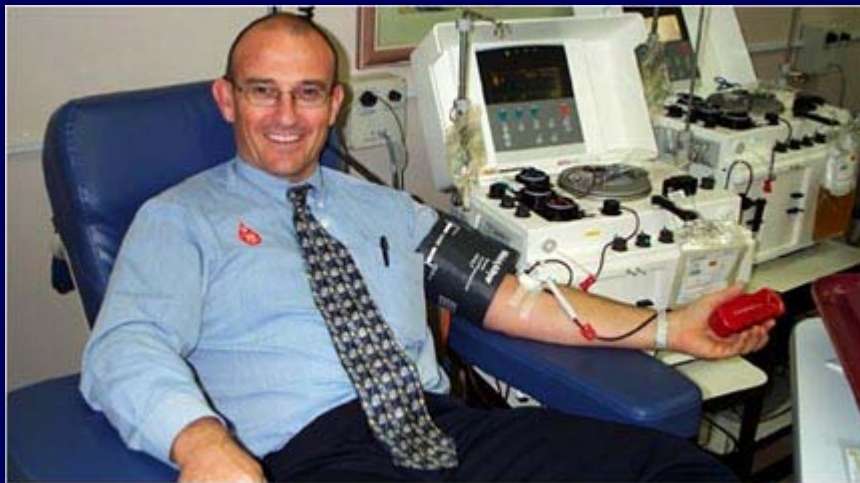
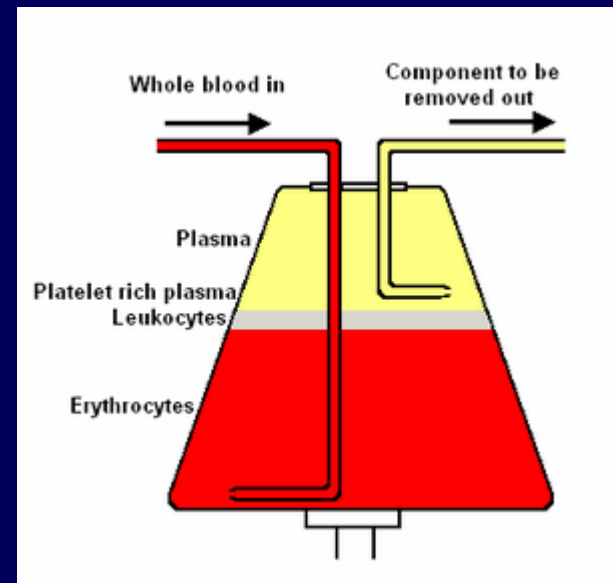


Figure 2: Apheresis Donor



Platelet Products

	Platelet conc	Single Donor PLT
Platelets	5.5×10^{10}	3×10^{11}
One adult dose	6 donors	1 donor
cost	less	more
Indications	Prophylactic, therapeutic	PLT alloantibody [crossmatched plt] , neonatal alloimmune thrombocytopenia

ABO group selection for PLT transfusion

ABO of Recipient	ABO of Donor (in order of preference)
O	O, A, B, AB
A	A, AB (O after plasma removal and resuspension in additive solutions or negative for high-titer anti-A/A,B)
B	B, AB (O after plasma removal and resuspension in additive solutions or negative for high-titer anti-A/A,B)
AB	AB (A, B, O after plasma removal and resuspension in additive solutions or negative for high-titer anti-A/A,B)

Platelet level & Bleeding

- $> 100,000/\text{mm}^3$ No bleeding tendency
- $< 100,000/\text{mm}^3$ Bleeding time prolongation
- $< 50,000/\text{mm}^3$ Bleeding after trauma , surgery
- $< 1-20,000/\text{mm}^3$ Spontaneous bleeding
- $< 5,000/\text{mm}^3$ High risk for spontaneous CNS bleeding

Thrombocytopenia & Bleeding

- Platelet level
- Platelet function : aspirin, clopidogrel
- Anemia
- Local problem : ulcer, surgical wound, artery injury
- Coexisting coagulopathy

Prophylaxis in thrombocytopenia

Condition	Threshold
Chronic <u>stable</u> thrombocytopenia (underproduction e.g. aplastic anemia)	<5,000 <u>or</u> No
Post-chemo <u>stable</u> patient	<10,000
<u>Unstable</u> (fever or infection or coagulopathy or platelet dysfunction)	<20,000
Invasive procedures, surgery	<50,000
Neurosurgery, ocular Sx	<100,000

Therapeutic Platelet Transfusion

- **Low platelet \neq Platelet concentrates**
- Symptomatic & supportive Rx
- NOT definitive Rx (อย่าลืมแก้สาเหตุเกิดเลือดต่ำ และเหตุเลือดออกอื่นๆ เช่น varice, arterial bleed)
- Consider in actively bleeding with PLT. $<50,000/uL$ or PLT. dysfunction
- Contraindication: TTP, HIT

Adverse Effects of PLT Transfusion

- **Infectious risks:** virus, **bacteria**
- **Allergic & febrile** nonhemolytic transfusion reactions: **more plasma** more risk
- **ABO & Hemolytic reactions** esp. O-donor to A -recipient
- Transfusion-related acute lung injury (**TRALI**): more plasma more risk
- **Rh(D) sensitization** from rbc: PC 1 unit ~ rbc 0.5 ml, SDP 1 bag ~ rbc 5 ml [rbc 1 ml needs Anti-D 20 ug]

Rh immune globulin = IgG Anti-D

TABLE 35.1 RhIg Vial Size and the Corresponding Amount of Whole Blood or RBCs Neutralized

Vial size	IU	Whole blood (ml)	RBCs (ml)
50 μg	250	5	2.5
120 μg	600	12	6
300 μg	1500	30	15
1000 μg	5000	100	50

Perinatal Rh Ig Use in D-negative mother

- At **GA=28 wk** → **300 ug**
- **At delivery**, if neonate is D-positive, weak-D positive, or D untested → **300 ug**
- Following **perinatal events** associated with FMH eg, abortion, ectopic preg, amniocentesis, CVS, abdominal trauma, antepartum hge → **300 ug** + dose by fetomaternal hemorrhage (FMH) test if GA >20 wk [50 ug if GA<12 wk]

Perinatal Rh Ig Use in D-negative mother

- At **GA=28 wk** → **300 ug**
- **At delivery**, if neonate is D-positive, weak-D positive, or D untested → **300 ug**, further dosing by fetomaternal hemorrhage (FMH) testing [if neonate is D-negative, no use of Rh Ig]
- Following **perinatal events** associated with FMH eg, abortion, ectopic preg, amniocentesis, CVS, external cephalic version, abdominal trauma, antepartum hge → **300 ug** + dose by FMH test if GA >20 wk [50 ug if GA <12 wk]

PLT Refractoriness

Nonimmune

- Fever
- Sepsis
- Drug eg, amphotericin
- Active bleeding
- Splenomegaly
- DIC
- Venooclusive dis

Immune

- Anti-HLA antibodies
- Anti-HPA antibodies
- ABO mismatch
- Autoantibodies
- Drug eg, heparin

PLT antibody



Cross-matched PLT

Corrected Count Increment

$$\text{CCI} = \frac{\text{Body surface area (m}^2\text{)} \times \text{platelet count increment} \times 10^{11}}{\text{Number of platelets transfused}}$$

Example: If 5×10^{11} platelets are transfused to a patient whose body surface area is 2.0 m^2 and the increase in post-transfusion platelet count is $30,000/\mu\text{l}$, then:

$$\begin{aligned}\text{CCI} &= \frac{2.0\text{m}^2 \times 30,000/\mu\text{l} \times 10^{11}}{5 \times 10^{11}} \\ &= 12,000 \text{ platelets} \times \text{m}^2 / \mu\text{l}\end{aligned}$$

PLT Refractoriness

- Corrected Count Increment (CCI)
at 1 hr $<7,500$ (5,000-10,000) or
at 18-24 hr $<4,500$
- If 1-hr CCI is good, but plt count falls back to baseline by 18-24 hr \rightarrow likely nonimmune cause
- If 1-hr CCI is poor \rightarrow likely immune cause

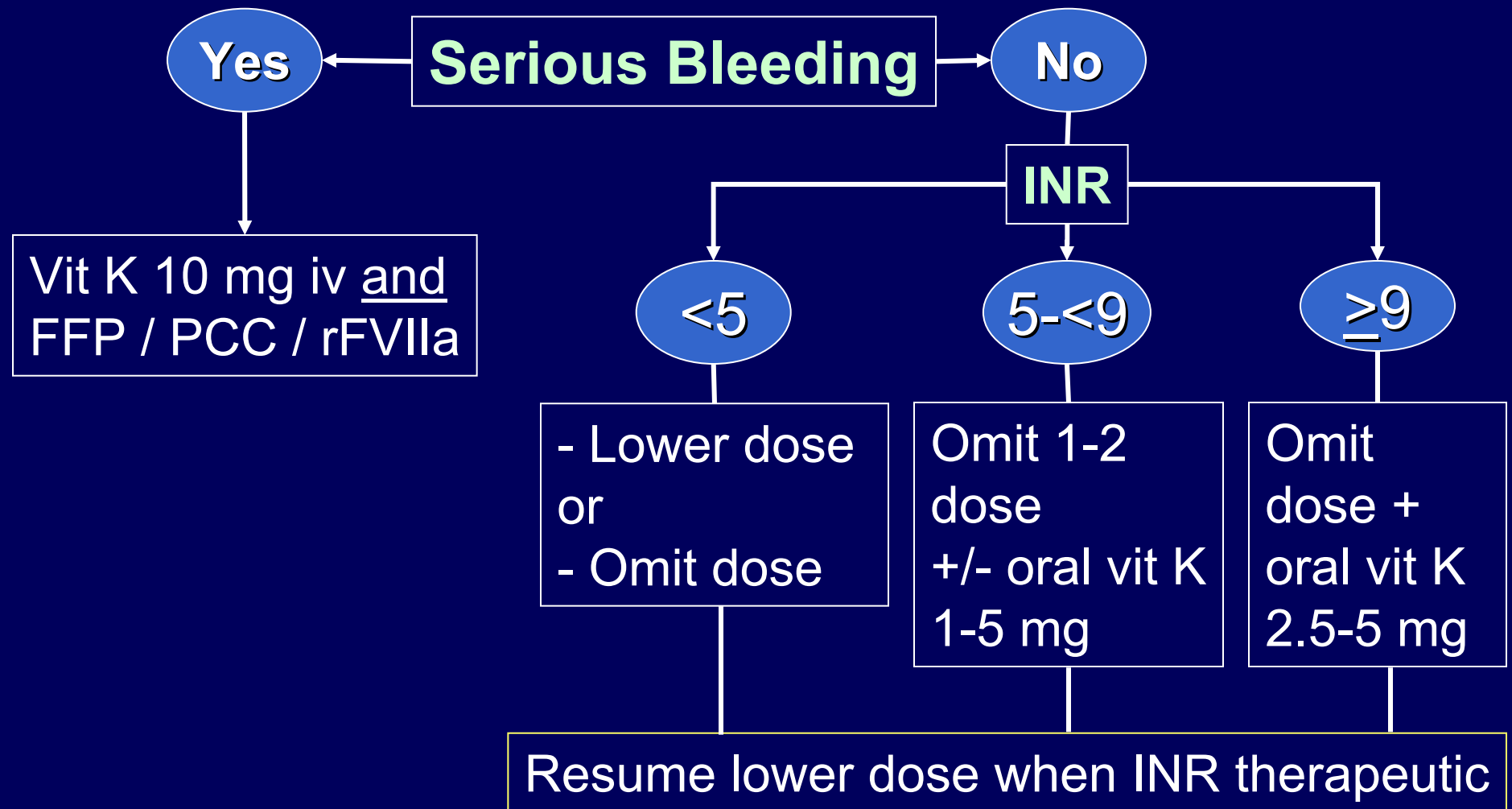
ช ๖๒ ปี ปวดหัวอาเจียนมา ๒ ชม.

- ผ่าตัด mitral valve และมี AF มา ๒ ปี กินยา **warfarin** ทุกวัน ปวดหัวอาเจียนมา ๒ ชม.
- BP 140/90, P 80, R 12
- Not pale, **ecchymoses** at legs, alert, no organomegaly
- CBC normal, **INR 9.0**
- **CT: acute subdural hematoma**

Rx

1. WB
2. FFP
3. Cryoprecipitate
4. Vit K 10 mg IV
5. 2+4
6. 3+4

Warfarin reversal

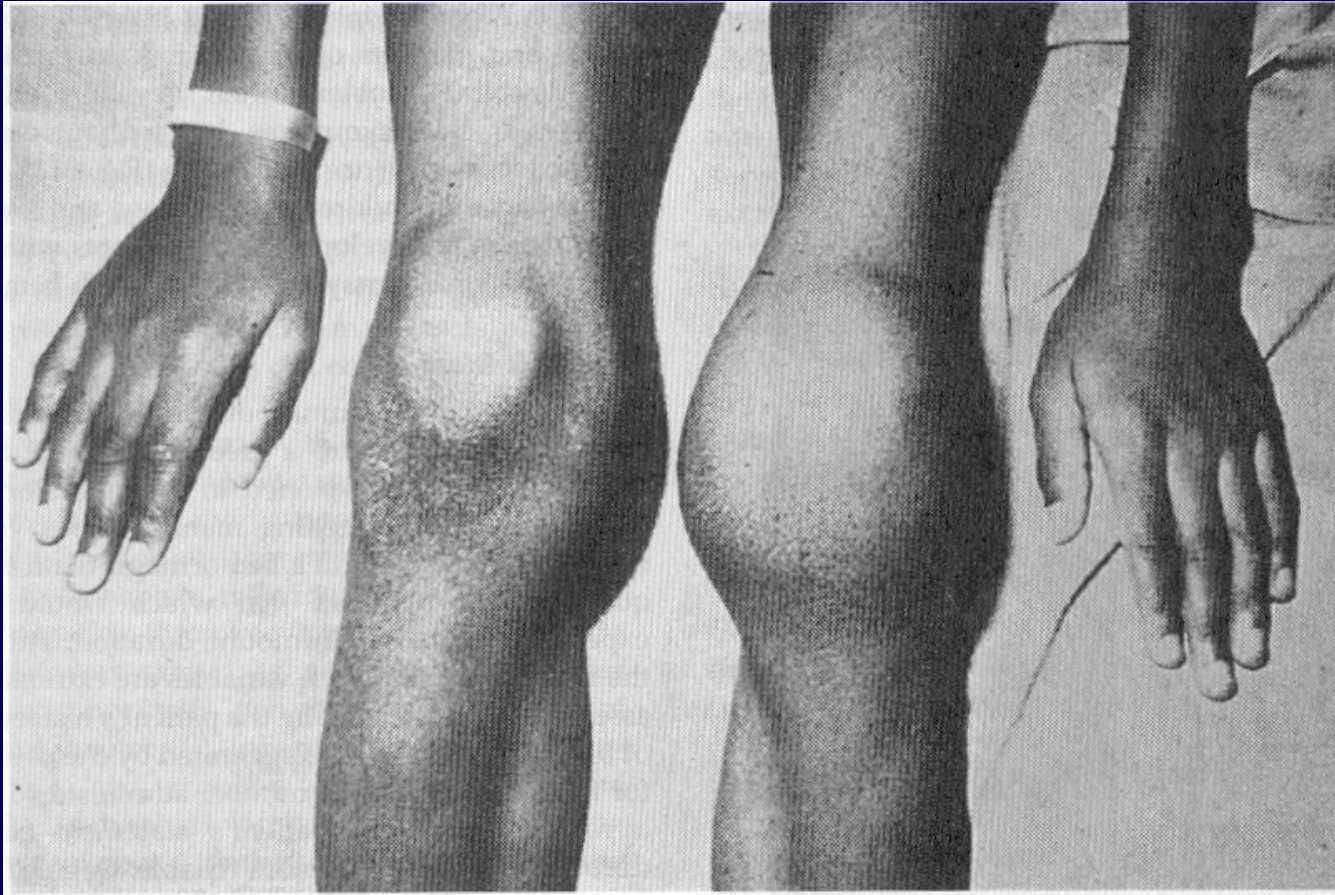


ช ๑๖ ปี ปวดบวมข้อเท้าขวา ๒ ชม.

- เป็นโรค **hemophilia A** และมี **blood group B** ปวดบวมข้อเท้าขวา ๒ ชม. ไม่มี trauma
- not pale, **swelling+warm+tenderness at Rt. ankle joint**

Best Rx

1. FFP gr AB
2. CRP gr O
3. FFP gr B
4. Cryoprecipitate gr O
5. Joint aspiration



HEMARTHROSIS AND HEMOPHILIC ARTHROPATHY

Hemophilia A

- Factor VIII concentrates
- Cryoprecipitate
- FFP
- DDAVP



vWD

- DDAVP
- F VIII concentrates
- Cryoprecipitate
- FFP

Hemophilia B

- Prothrombin complex concentrate (PCC)
- FFP
- Cryo. Removed Plasma
- F IX concentrates

Rx of Bleeding episodes in Hemophilia

Site	Initial Level (%)	Rx Length
Joint	40	1-2 days
Muscle	40	2-3 days
Hematuria	50	3-5 days
Retroperitoneal	80-100	5 days
GI	80-100	7-14 d
Neck	80-100	7-14 d
Intracranial	80-100	14-21 d

Hemophilia A with hemarthrosis

- 60 kg.
- Raise F VIII to 40 %
- **1 u/kg raise 2%**
- F VIII half life = 12 hr
 - Raise 40% -> 20 u/kg = 20x60 = 1200 u
 - Cryo. 12 bags (cont. → 6 bags q 12 hr)

Hemophilia B with hemarthrosis

- 60 kg.
- Raise F IX to 40 %
- **1 u/kg raise 1%**
- F IX half life = 24 hr
 - Raise 40% -> $40 \text{ u/kg} = 40 \times 60 = 2400 \text{ u}$
 - FFP 2400 ml. (cont. → 1200 ml. q 24 hr)

FFP

- Contain all soluble coagulation factors, albumin, hormones, vitamins
- After thawing, the activities of clotting factors decrease esp. labile factors (V,VIII)

FFP: Indications

- Multiple **acquired coagulation factor deficiency** eg, Liver disease, Massive transfusion, DIC
- Rapid **reversal of warfarin** effect
- Plasma infusion or exchange for **TTP**
- **Congenital coagulation defect**
- **C1-esterase inhibitor deficiency** – acute episodes & prophylaxis of angioedema

FFP: Not Indicated

- Immunodeficiency
- Burns
- Wound healing
- Reconstitution of packed rbc
- Volume expansion
- Source of nutrients
- Bleeding from Heparin/LMWH (consider protamine)

TABLE 19.4 ABO Group Selection of Plasma Component Transfusion

Patient ABO Group	Plasma Containing Component ABO Group			
	1st Choice	2nd Choice	3rd Choice	4th Choice
O	O	A	B	AB
A	A	AB		
B	B	AB		
AB	AB			

Cirrhosis

- FFP 10-15 ml/kg
- Vitamin K 10 mg IV (ineffective in Child C)
- Pitfalls
 - Uncorrected localized bleeding problem e.g. varice, mucosal lesion
 - Overdependence on PT
 - Goal: to correct or prevent bleeding, Not to achieve a normal PT
 - Timing of FFP therapy before an invasive procedure

DIC

- Rx cause
- Bleeding
 - FFP , PLT concentrate
 - Cryoprecipitate raise fibrinogen > 100 mg/dL
:1 bag/5 kg BW raise fibrinogen 100 mg/dL
- Thrombosis
 - heparin : purpura fulminans, acral/dermal ischemia, retained dead fetus syndrome, giant hemangioma, aortic aneurysm without rupture

ช ๖๖ ปี STEMI ปวดหัวอาเจียนหลังฉีดยา SK

- เป็นโรค STEMI & CHF
ได้รับ streptokinase ต่อมา
๓ ชม. ปวดหัวอาเจียนพุ่ง
- Blood group A
- BP 170/90, P 90, R 15
- Alert, not pale, no skin
bleeding, rt.hemiparesis
- CBC ปกติ, PT 18, PTT 50

Best Rx

1. FFP gr AB
2. CRP gr A
3. FFP gr B
4. Cryoprecipitate
5. Vitamin K i.v.

Cryoprecipitate

- FFP thawed in the cold (1-6°C)
- Fibrinogen, F VIII, vWF, F XIII, fibronectin

Cryoprecipitate: Indications

- Hypofibrinogenemia (congenital/acquired)
- Massive transfusion with bleeding
- A component of fibrin glue
- F XIII deficiency
- Reversal of thrombolytic therapy with bleeding
- Hemophilia A
- von Willebrand disease
- Uremic bleeding

Cryoprecipitate: Misuses

- Replacement therapy in patients with **normal fibrinogen level**
- Reversal of **warfarin** therapy
- Rx of bleeding without evidence of hypofibrinogenemia
- Rx of hepatic coagulopathy
- Underuse in massive transfusion with dilutional coagulopathy and bleeding

TABLE 19.2 ABO Selection of Blood Components

Component	ABO Selection of the Component
Whole blood	Identical to the patient
RBCs	Compatible with the patient's plasma
Granulocytes pheresis	Compatible with the patient's plasma
Plasma	Compatible with the patient's RBCs
Platelet pheresis	All ABO groups acceptable; preferable to give components compatible with the patient's RBCs
Cryoprecipitate	All ABO groups acceptable

Rh system: Only RBC-containing components (WB, PRC, PC, SDPs) need to be matched for the D-antigen.

Plasma derivatives: FFP, Cryo.

- No medications added
- Return to blood bank if not use within 30 min
- Most adverse transfusion reactions occur in the first 15 min.
- Time of transfusion – not exceed 4 hr
- Rate in adult (good cardiac condition)
: 200 - 300 mL/hr
- NOT for: volume expansion, protein (alb, glob)
nutrient

Thrombolytic agent & Heparin

- SK (Hf. 18-23 min), rtPA (Hf. 3-8 min)
→ ↓ fibrinogen
- Heparin neutralization
 - Unfractionated Heparin
 - protamine 1 mg : residual UFH 100 u
 - LMWH (enoxaparin) [60% neutralizable]
 - ≤ 8 hr – protamine 1 mg : LMWH 1 mg
 - $> 8-12$ hr – protamine 0.5 mg : LMWH 1 mg
 - F/U aPTT 2-4 hr if prolonged repeat protamine 0.5 mg/ LMWH 1 mg
- rFVIIa for uncontrolled bleeding

ปูจณา... วิถีชนา

