Massive blood Transfusion

Massive transfusion protocol (MTPs)

- Established to provide rapid blood replacement in a setting of severe hemorrhage
- Early optimal blood transfusion is essential to sustain organ perfusion and oxygenation

What is Massive transfusion?

10 units of red cells in 24 hours

Total blood volume is replaced within 24 hours

Three units over one hour

50% of total blood volume is replaced within 3 hours

Massive Transfusion-Clinical Settings

- Trauma
- Surgery (e.g. Liver, Cardiovascular)
- Less frequent
  - abdominal aortic aneurysm
  - liver transplant
  - obstetric catastrophes
  - GI bleeding

- **Cardiac surgery** — Most common cause of massive transfusion
- **Obstetric hemorrhage** — Gravid and parturient women are hypercoagulable with compensatory hyperfibrinolysis.
- **Liver disease** —
  - leads to the reduced production of normal coagulation factors
  - production of abnormal factors

Types of Shock

- Cardiogenic – MI, cardiomyopathy
- Obstructive – Tamponade, PE
- Distributive – Sepsis, Anaphylaxis
- **Hypovolemic – Hemorrhage**

Challenges

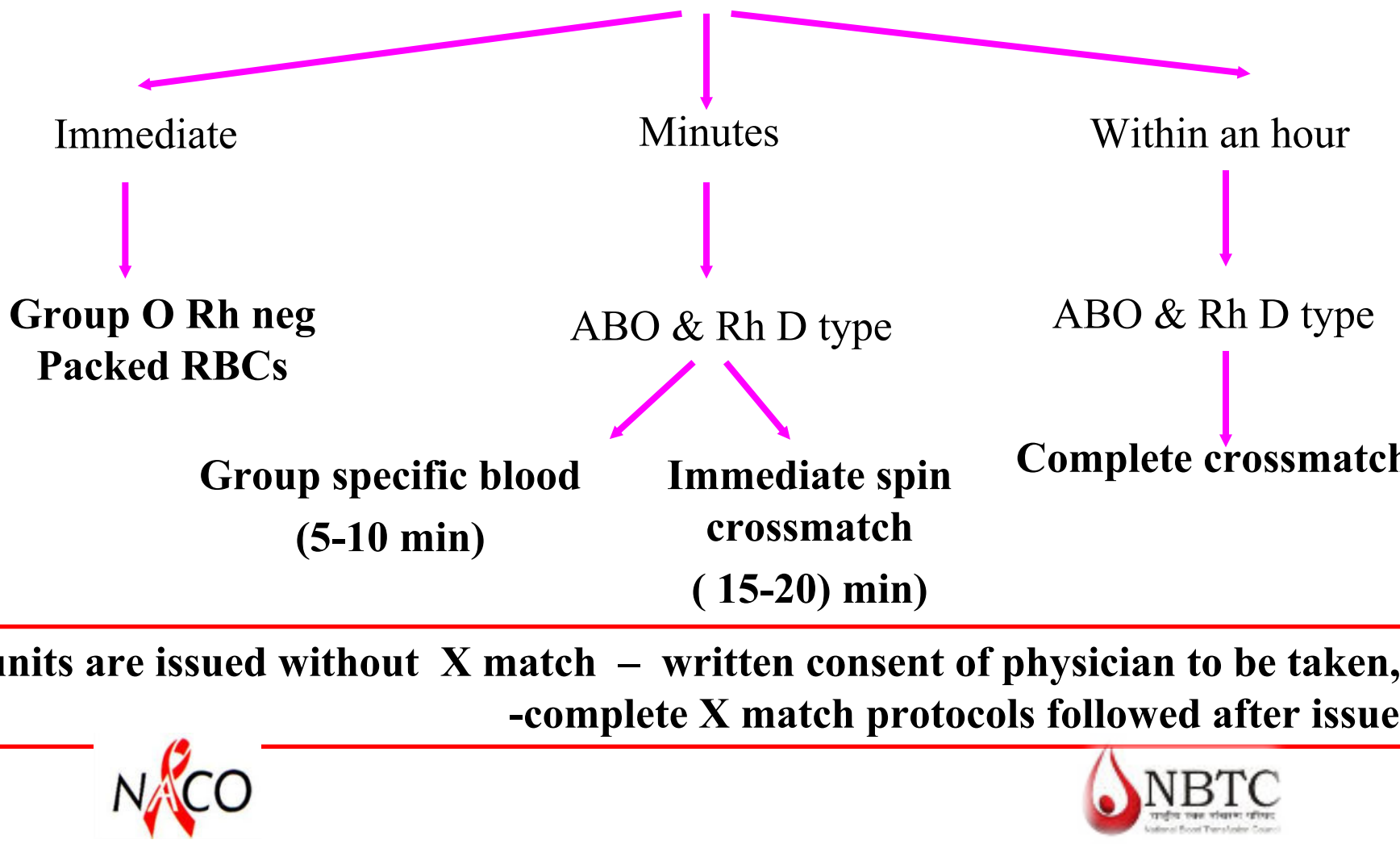
- Types of components to be administered
- Selection of the appropriate amounts

- TIME

Blood Products

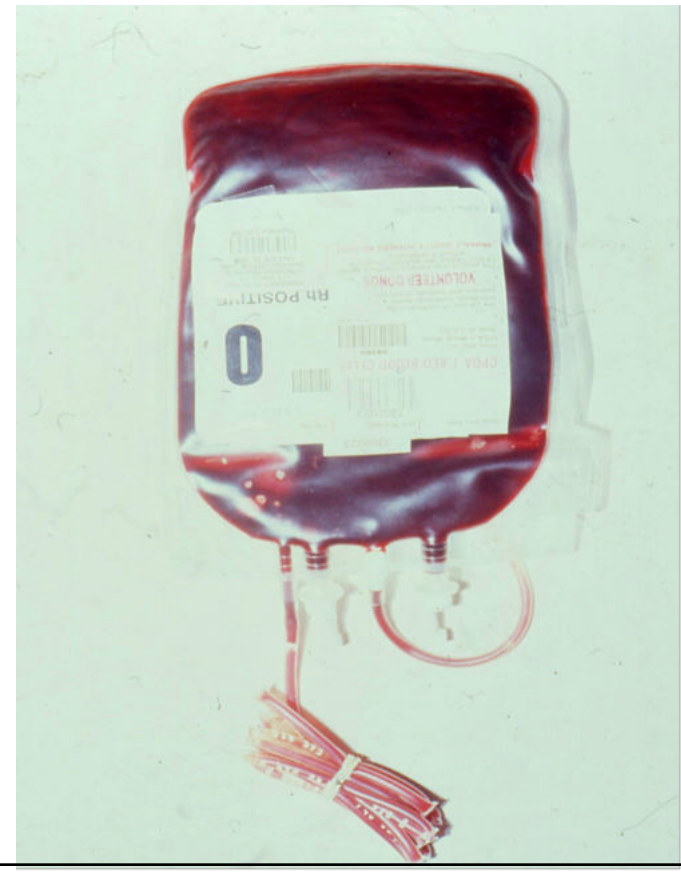
- RBC
- Plasma
- Platelets
- Cryoprecipitate

Emergency blood issue



Emergency Release Blood - Universal Donor

- O, RhD neg/pos RBCs – 5 min
- AB or A Plasma/Platelets



Recommendations

- “Damage control” approach
- Improved survival when the ratio of transfused Fresh Frozen Plasma (FFP, in units) to platelets (in units) to red blood cells (RBCs, in units) approaches 1:1:1

Holcomb JB, Jenkins D, Rhee P, et al. Damage control resuscitation: directly addressing the early coagulopathy of trauma. J Trauma 2007; 62:307.

Important

At the onset - aggressive fluid replacement and bleeding control can reduce the tissue injury, inflammation, and hypoperfusion

Untimely or incomplete control of massive bleeding- systemic consumptive coagulopathy with hemodilution and endothelial damage

If uncorrected, concurrent hypothermia and acidosis can further exacerbate coagulopathy and lead to irreversible multiorgan failure (MOF).

Patients who have sustained severe traumatic injuries and/or who are likely to require massive transfusion should receive a **1:1:1 ratio** of FFP to platelets to RBCs at the **outset** of their resuscitation and transfusion therapy

- *Borgman MA, Spinella PC, Perkins JG, et al. The ratio of blood products transfused affects mortality in patients receiving massive transfusions at a combat support hospital. J Trauma 2007; 63:805.*
- *Holcomb JB, Wade CE, Michalek JE, et al. Increased plasma and platelet to red blood cell ratios improves outcome in 466 massively transfused civilian trauma patients. Ann Surg 2008; 248:447.*
- *Cotton BA, Au BK, Nunez TC, et al. Predefined massive transfusion protocols are associated with a reduction in organ failure and postinjury complications. J Trauma 2009; 66:41.*
- *Shaz BH, Dente CJ, Nicholas J, et al. Increased number of coagulation products in relationship to red blood cell products transfused improves mortality in trauma patients. Transfusion 2010; 50:493.*
- *Inaba K, Lustenberger T, Rhee P, et al. The impact of platelet transfusion in massively transfused trauma patients. J Am Coll Surg 2010; 211:573.*
- *de Biasi AR, Stansbury LG, Dutton RP, et al. Blood product use in trauma resuscitation: plasma deficit versus plasma ratio as predictors of mortality in trauma (CME). Transfusion 2011; 51:1925.*

Important!

Uncrossmatched group O Rh D negative RBCs /Whole blood

Residual plasma with both antibodies (Anti A & B) can accumulate when large quantities are transfused

Repeat the blood group and do antibody titres before resuming transfusion of RBCs of the patient's own blood group.

Fibrinogen concentrate

- European guidelines recommend fibrinogen concentrate when the level falls below 1.5g
- Cost of fibrinogen concentrate is much more than cryoprecipitate
- Availability

Cryoprecipitate

- Most common blood product used to replace fibrinogen
- Contains approximately 200–250 mg of fibrinogen per unit
- Standard dose of two 5-unit pools should be administered **early** in major **obstetric haemorrhage**.
- Subsequent **cryoprecipitate** transfusion should be guided by fibrinogen results, aiming to keep levels above 1.5 g/l.

Platelet Transfusion

- It becomes necessary after two volumes of blood loss.
- 10 to 12 units of transfused RBCs- 50 percent fall in the platelet count
- Platelet concentrates should be transfused as 1 pack/10 kg body weight.

Massive Transfusion Protocol
Regional West Medical Center

Immediately prepare first transfusion "package" :	• **Six units RBC's** • **Four units FFP** • **Deliver first "package" within 35 minutes of the initial order.**
Have second "package" ready within 35 minutes of issue of first "package".	• **Six units RBC's** • **Four units FFP** • **One Single Donor Platelet or one "six-pack" random platelets**
Have third "package" ready within 35 minutes of issue of second "package."	• **Six units RBC's** • **Four units FFP** • **One "ten-pack" pooled Cryoprecipitate**

Important Contact Numbers:

PSBC Physician On-Call
206-292-6525 (option 3)

Hospital Laboratory:
#####

Hospital Blood Bank:
#####

Rapid Response Team:
#####

Code Blue Activation:
#####

Transfusion Guidelines

Initial transfusions may begin empirically

If No Lab Values:
- Consider transfusing all components in OBH pack on arrival from lab.
- If suspect DIC, prioritize transfusion of 2 cryo pools

General Ratio Guidelines:
- Every 1 RBCs, give 1 Plasma
- Every 6 RBCs, give 1 Apheresis Platelet and 1-2 Cryo pools

Fibrinogen <150:
Transfuse 2 Pooled Cryo units *prioritize

INR ≥ 1.6:
Transfuse 4-6 Plasma units

Platelets <100,000 u/L:
Transfuse 1 Aph. Platelets

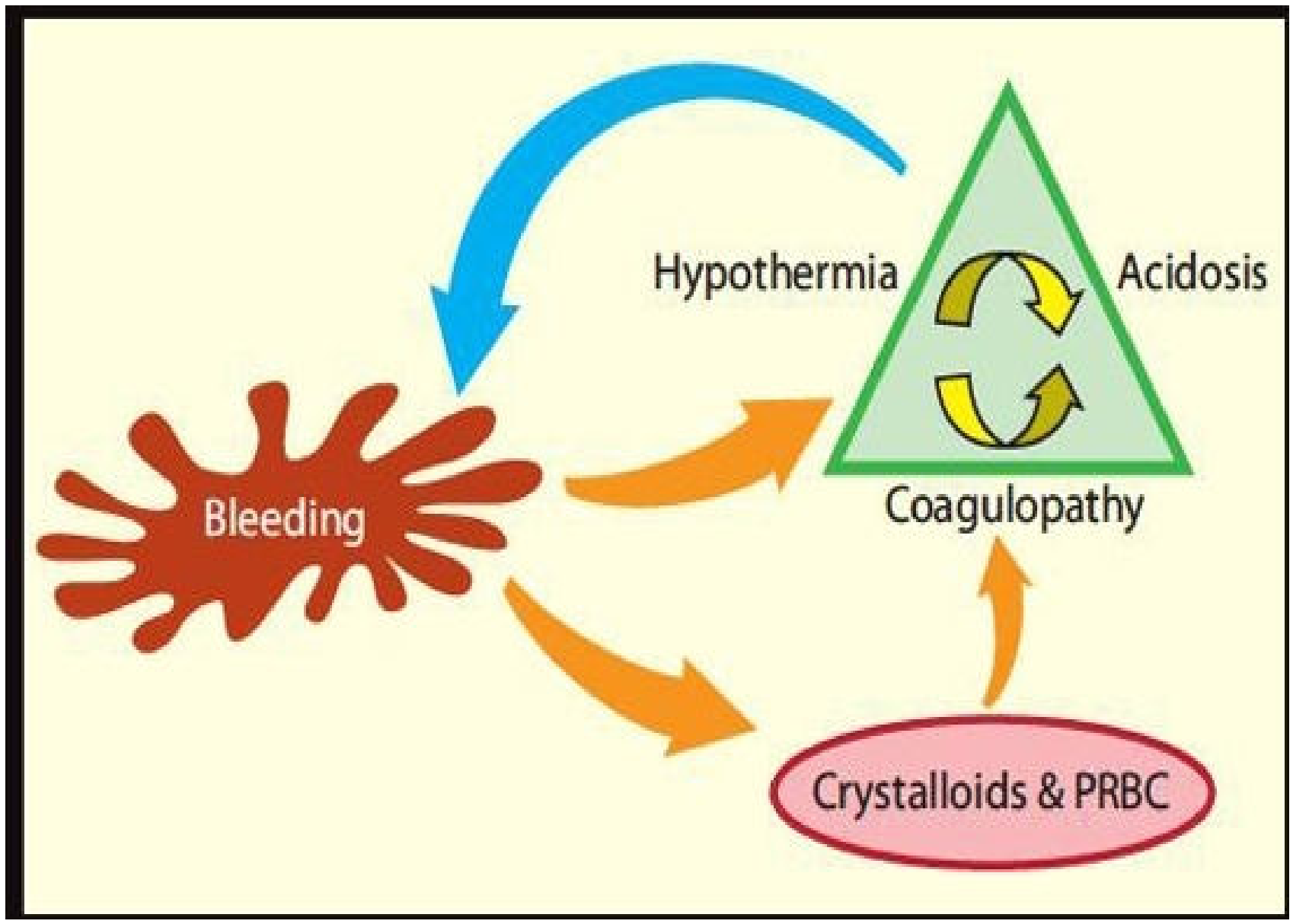
Transfuse 1-6 RBC Units consistent with clinical condition of patient

Order STAT and q30 minutes:
Emergency Hem Panel:
(includes) Hct, Platelet PT/INR, and Fibrinogen
and
Ionized Calcium
Magnesium
ABG
Type and Crossmatch
(one time only)

Goals:
Core Temp > 35.9C
pH > 7.3

Complications of Massive Transfusion

- Hypothermia
- Acid/base derangements
- Coagulopathy
- Citrate toxicity
- Electrolyte abnormalities
  - hypocalcemia
  - hypomagnesemia
  - hypokalemia
  - hyperkalemia
- Transfusion-associated acute lung injury



Acidosis and hypothermia

- Acidosis
  - Interferes with formation of coagulation factor complexes
- Hypothermia
  - Reduces enzymatic activity of coagulation factors
  - Prevents activation of platelets

Hypothermia

10 units of cold blood products and an hour of surgery can lead to a 3°C drop in core temperature and hypothermic coagulopathy

RBCs that are stored at 4C are transfused rapidly

Lowers the recipient's core temperature and further impairs haemostasis.

Reduces the metabolism of citrate and lactate

Increases the likelihood of hypocalcaemia, metabolic acidosis and cardiac arrhythmias.

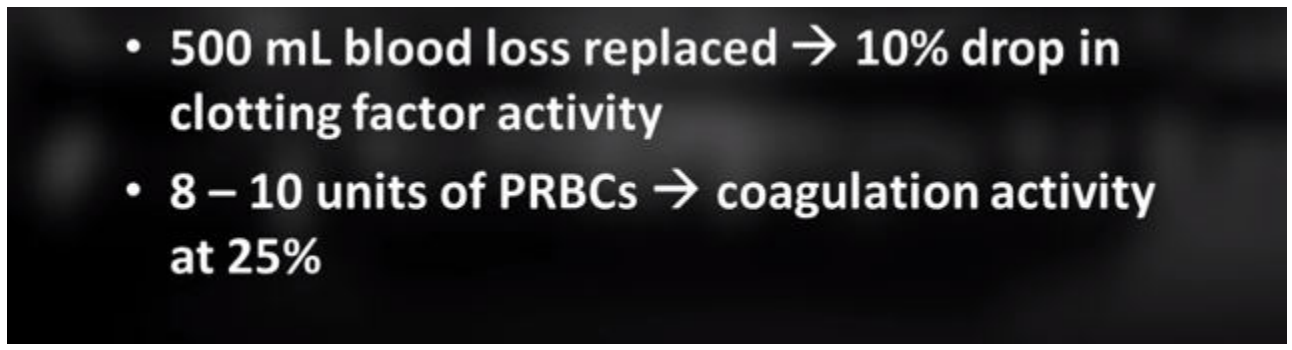
Shifts the oxyhaemoglobin dissociation curve to the left, reducing tissue oxygen delivery

Prevention of hypothermia

- A high capacity commercial blood warmer should be used to warm blood components

Coagulopathy

- Dilutional coagulopathy
- Disseminated intravascular coagulation.
- Consumption of platelets and coagulation factors



ALTERATIONS IN HEMOSTASIS

- Acute DIC
- microvascular oozing
- prolongation of the PT and aPTT in excess of that expected by dilution
- significant thrombocytopenia
- low fibrinogen levels
- increased levels of D-dimer

Hypocalcaemia

- Citrate binds calcium
- Results in hypotension, small pulse pressure, flat ST-segments and prolonged QT intervals on the ECG.
- Slow i.v. injection of calcium gluconate 10%

Hyperkalaemia

- The potassium concentration of blood increases during storage, by as much as 5–10 mmol u1 .
- Hyperkalaemia rarely occurs during massive transfusions unless the patient is also hypothermic and acidotic

Monitoring recommendations

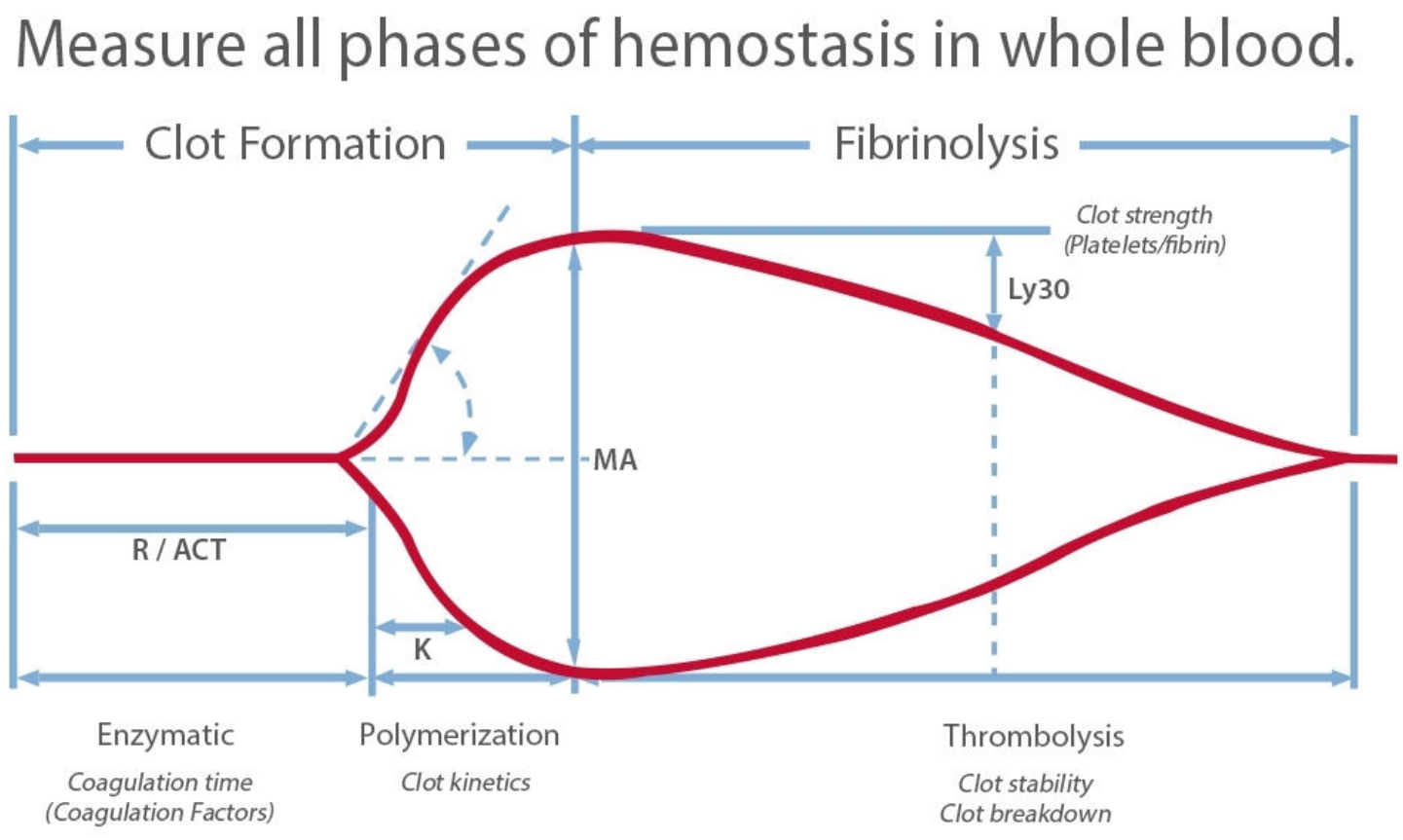
- PT, aPTT
- Platelet count
- Fibrinogen
- Electrolytes
- Viscoelastic test
  - after the administration of every five to seven units of red cells.

Goals

Investigation	Target value
Haemoglobin	10 gm/dl
Hematocrit	32%
Platelet count	> 50 x 10 9 /l
PT	< 1.5 x control
PTT	< 1.5 x control
Fibrinogen	> 0.8 g/l

Viscoelastic whole-blood assays

- TEG® and ROTEM®
- provide information on the coagulation process through the graphic display of clot initiation, propagation and lysis.
- used to guide transfusion of blood components

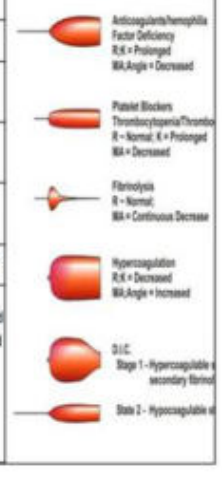


The TEG® hemostasis system continuously measures all phases of hemostasis as a net product of whole blood components

- Costeffective -since it reduces inappropriate transfusions, thus improving transfusion management and patients' clinical outcome

Laboratory Value	Interpretation	Blood Product Transfusion
R less than 4 min	Enzymatic Hypercoagulability	No treatment if bleeding
R between 11-14 min	Low clotting factors	Plasma and RBC's
R greater than 14 min	Very low clotting factors	Plasma and RBC's
a-angle<45 degrees	Low fibrinogen level	Cryoprecipitate/ Fibrinogen /Platelets
MA between 46-54 mm	Low platelet function	Platelets / Cryoprecipitate/ Fibrinogen
MA between 41-45 mm	Very low platelet function	Platelets / Cryoprecipitate/ Fibrinogen
MA at 40 mm or less	Extremely very low platelet function	Platelets / Cryoprecipitate/ Fibrinogen
MA greater than 73 mm	Platelet Hypercoagulability	No treatment if bleeding
LY30 greater than 3%, CI less than 1.0	Primary fibrinolysis	**Tranexamic acid** 1g IV over 10 minutes followed by 1g in 250cc NS infused over 8 hours

QUALITATIVE INTERPRETATION — PATTERN RECOGNITION



- Refer to TEG analysis tree for values outside these ranges

Depletion of fibrinogen and coagulation factors

- PT prolonged – FFP in a dose of 15 ml/kg
- aPTT prolonged – factor VIII/fibrinogen concentrate

Summary and recommendations

- Need to define protocol triggers , an algorithm for preparation and delivery of blood products, including continued support
- The protocol should be updated annually and practised in ‘skills drills’ to inform and train relevant personnel.