Ref



History

Transfusion Therapy

Coagulation Cascade

Components

Testing

Massive Transfusion Protocol



Oklahoma Association of Nurse Anesthetists



Richard Wilson, DNAP, CRNA, FAANA DreamMaker Anesthesia Services, LLC

Disclosure Statement

• I have no financial conflicts of interest to disclose

• I will not be discussing off-label medication use



Objectives

At the end of this presentation the learner will be able to:

- 1) Identify basic concepts of hematology.
- 2) Discuss the coagulation cascade.
- 3) Recognize common coagulation laboratory tests.
- 4) Discuss interpretation of common laboratory test results.
- 5) Discuss primary uses for the different blood components.
- 6) Discuss massive transfusion protocols.

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Richard Wilson, DNAP, CRNA, FAANA DreamMaker Anesthesia Services, LLC History

History

1628 - 1667

- British physician William Harvey discovers the circulation of blood
- The first recorded successful blood transfusion occurs in England (dogs)
- Successful transfusion from sheep to humans

1818

 Successful transfusion from human to human



History

1901-1907

- Blood groups identified
- Crossmatching for safety is recommended

1939 - 1948

- Rh group is discovered
- National blood collection program established for military
- Red Cross begins national blood collection program for civilians

1964

Plasmapharesis is introduced

History

History

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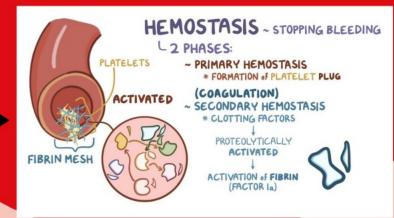
Coagulation Cascade

Procoagulant vs. Anticoagulant

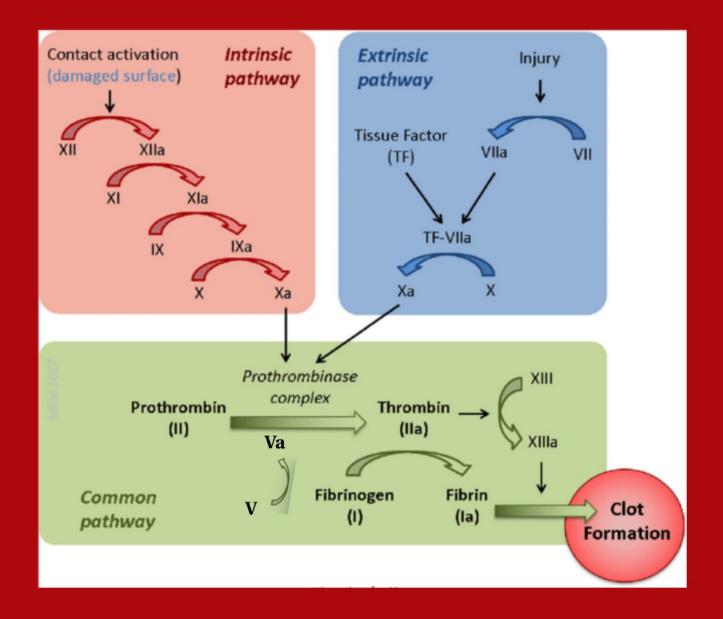


Coagulation Cascade









Mnemonics

Intrinsic

Factors IX-XII 12, 11, 9, 10

Extrinsic

Factors III, VII, & X 3 + 7 = 10

Common

Factors I, II, V & 10 $1 \times 2 \times 5 = 10$

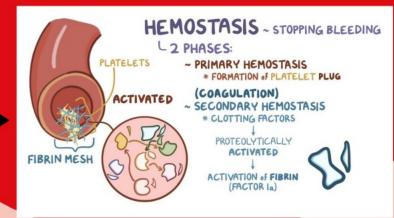
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Coagulation Cascade







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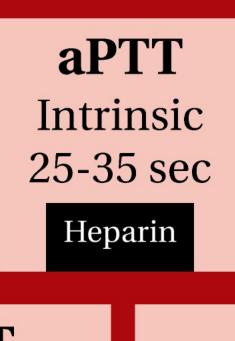
Hemostasis Lab Tests







TEG



PT
Extrinsic
12-15 sec

Warfarin

INR

Ratio

<1.2

Hemostasis Lab Tests







TEG

Activated Clotting Time

Time for clot to form

Quicker results than aPTT

Evaluates intrinsic (VIII, IX, XI & XII) and common pathway (V, X, prothrombin and fibrinogen)

Normal = 70-120 seconds Heparin = 180-240 seconds CPB = > 400 seconds

Hemostasis Lab Tests







TEG

Thromboelastogram (TEG)

Time necessary for initial fibrin formation

Rapidity of fibrin deposition

Clot consistency

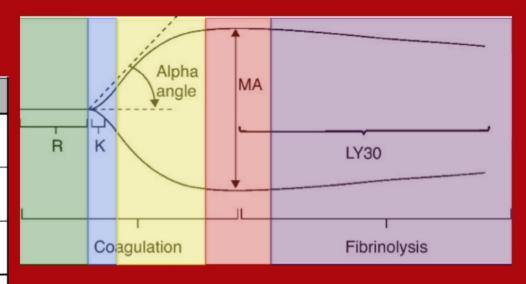
Rate of clot formation

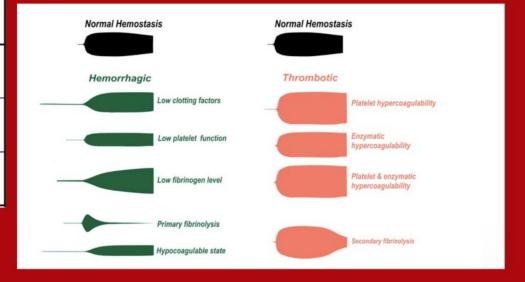
Times required for clot retraction and lysis

TEG 5

TEG 5 Results

TEG Value	Normal*	Description	Measures
TEG-ACT (rapid)	80 - 140 sec	"Activated clotting time" to initial fibrin formation	clotting factors (extrinsic/intrinsic pathways)
R time (conventional)	5.0 - 10.0 min	"Reaction time" to initial fibrin formation	clotting factors (intrinsic pathway)
K time	1.0 - 3.0 min	"Kinetic time" for fibrin cross linkage to reach 20 mm clot strength	fibrinogen, platelet number
α angle	53.0 - 72.0 degrees	Angle from baseline to slop of tracing that represents clot formation	fibrinogen, platelet number
MA	50.0 - 70.0 mm	Maximum amplitude of tracing	platelet number and function
G value	5.3 - 12.4 dynes/cm ²	Calculated value of clot strength	entire coagulation cascade
LY 30	0 - 3%	Clot lysis at 30 minutes following MA	fibrinolysis





Thromboelastogram (TEG)

Time necessary for initial fibrin formation

Rapidity of fibrin deposition

Clot consistency

Rate of clot formation

Times required for clot retraction and lysis

TEG 5

Hemostasis Lab Tests







TEG

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Blood Component Therapy What You Give Matters!

Oklahoma Association of Nurse Anesthetists



Richard Wilson, DNAP, CRNA, FAANA DreamMaker Anesthesia Services, LLC Component Therapy

Indicators

- Hemoglobin/Hematocrit
- Assessment of Vital Organ Perfusion
- Anticipated Course of Case
- HOTN/Tachycardia
- Mixed Venous Saturation
- Arterial Oxygen Delivery
- Lactate Levels

 $ABL = EBV \times 20\%$

ABL = EBV X Initial Hct - Accepted Hct
Average Hct

Recommendations/ Studies

Benefit of Component vs Whole Blood Therapy

Treat a specific deficiency

Avoid volume overload

Minimize reactions to blood products that are not needed

Component Therapy

Indicators

- Hemoglobin/Hematocrit
- Assessment of Vital Organ Perfusion
- Anticipated Course of Case
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- Arterial Oxygen Delivery
- Lactate Levels

 $ABL = EBV \times 20\%$

ABL = EBV X Initial Hct - Accepted Hct
Average Hct

Recommendations/ Studies

Recommendations

1980: The National Institutes of Health

1984: The American College of Obstetricians and Gynaecologists (ACOG)

1990: The Transfusion Practices Committee of the American Association of Blood Banks (coronary artery bypass surgery)

1992: The American College of Physicians (ACP)

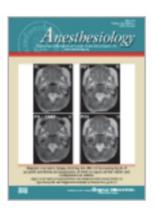
1994: The College of American Pathologists (CAP) - fresh frozen plasma (FFP), cryoprecipitate and platelet transfusion

1994: The American Association of Blood Banks

1996: American Society of Anaesthesiologists – Task Force on Blood Component Therapy

2006: An Updated Report by the American Society of Anesthesiologists Task Force on Perioperative Blood Transfusion and Adjuvant Therapies.[1]

Volume 105, Issue 1 July 2006



Practice Guidelines for Perioperative Blood Transfusion and Adjuvant Therapies:

An Updated Report by the American Society of Anesthesiologists Task Force on Perioperative Blood Transfusion and Adjuvant Therapies

B. Purpose of the Guidelines

The purposes of these Guidelines are to improve the perioperative management of blood transfusion and adjuvant therapies and to reduce the risk of adverse outcomes associated with transfusions, bleeding, or anemia. In addition, these Guidelines provide an update on the relative risks that cause morbidity and mortality associated with blood transfusion and adjuvant therapies.

Practice Guidelines for Perioperative Blood Transfusion and Adjuvant Therapies: An Updated Report by the American Society of Anesthesiologists Task Force on Perioperative Blood Transfusion and Adjuvant Therapies. Anesthesiology 2006; 105:198–208 doi: https://doi.org/10.1097/00000542-200607000-00030

2006 ASA Recommendations (PRBCs)

- I. A close watch on assessment of blood loss during surgery and assessment of tissue perfusion is to be maintained.
- II. Transfusion is rarely indicated when the haemoglobin concentration is greater than 10 gm/dl, and is almost always indicated when it is less than 6 gm/dl.
- III. For intermediate haemoglobin concentrations (6–10 gm/dl), justifying or requiring RBC transfusion should be based on the patient's risk for complications of inadequate oxygenation.
- IV. Use of a single haemoglobin "trigger" for all patients and other approaches that fail to consider all important physiologic and surgical factors affecting oxygenation are not recommended.
- V. When appropriate, preoperative autologous blood donation, intraoperative and postoperative blood recovery, acute normovolemic hemodilution and measures to decrease blood loss (deliberate hypotension and pharmacologic agents) may be beneficial.
- VI. The indications for transfusion of autologous RBCs may be more liberal than for allogeneic RBCs because of the lower (but still significant) risks associated with the former.

2006 ASA Recommendations (Platelets)

- I. Prophylactic platelet transfusion is ineffective and rarely indicated when thrombocytopenia is due to increased platelet destruction (e.g. idiopathic thrombocytopenic purpura)
- II. Prophylactic platelet transfusion is rarely indicated in surgical patients with thrombocytopenia due to decreased platelet production when the platelet count is greater than 1,00,000/cucc and is usually indicated when the count is below 50,000/cucc. The determination of whether patients with intermediate platelet counts (50–100,000/cucc) require therapy should be based on the risk of bleeding.
- III. Surgical patients with microvascular bleeding usually require platelet transfusion if the platelet count is less than 50,000/cucc and rarely require therapy if it is greater than 100,000/cucc. With intermediate platelet counts (50–100,000/cucc), the determination should be based on the patient's risk for more significant bleeding, type of surgery and site of operation, e.g. closed space like brain or eye.
- IV. Platelet transfusion may be indicated despite an apparently adequate platelet count if there is known platelet dysfunction and microvascular bleeding.

2006 ASA Recommendations (FFP)

Recommendations: Latest recommendations for use of FFP are:

- I. Urgent reversal of warfarin therapy
- II. Correction of known coagulation factor deficiencies for which specific concentrates are unavailable
- III. Correction of microvascular bleeding in the presence of elevated (>1.5-times normal) prothrombin time (PT) or partial thromboplastin time (PTT)
- IV. Correction of microvascular bleeding secondary to coagulation factor deficiency in patients transfused with more than one blood volume and when PT and PTT cannot be obtained in a timely fashion
- V. FFP should be given in doses calculated to achieve a minimum of 30% of plasma factor concentration
- VI. FFP is contraindicated for augmentation of plasma volume or albumin concentration
- VII. FFP should not be used to reconstitute packed RBCs
- VIII. FFP should not be used as a source of proteins or routinely after cardiopulmonary bypass

2006 ASA Recommendations (Cryo)

- I. Prophylaxis in non bleeding perioperative or peripartum patients with congenital fibrinogen deficiencies or von Willebrand's disease unresponsive to 1-desamino-8-D-arginine vasopressin (DDAVP).
- II. Bleeding patients with von Willebrand's disease
- III. Correction of microvascular bleeding in massively transfused patients with fibrinogen concentrations less than 80–100 mg/dl (or when fibrinogen concentrations cannot be measured in a timely fashion)

Damage control resuscitation using blood component therapy in standard doses has a limited effect on coagulopathy during trauma hemorrhage

Results: One hundred six patients who received at least four PRBC units were included. Thirty-four patients (32 %) required a massive transfusion. On admission 40 % of patients were coagulopathic (ROTEM CA5 \leq 35 mm). This increased to 58 % after four PRBCs and 81 % after eight PRBCs. On average all functional coagulation parameters and procoagulant factor concentrations deteriorated during hemorrhage. There was no clear benefit to high-dose FFP therapy in any parameter. Only combined high-dose FFP, cryoprecipitate and platelet therapy with a high total fibrinogen load appeared to produce a consistent improvement in coagulation.

Khan, S., Davenport, R., Raza, I., Glasgow, S., De'Ath, H. D., Johansson, P. I., Curry, N., Stanworth, S., Gaarder, C., & Brohi, K. (2015). Damage control resuscitation using blood component therapy in standard doses has a limited effect on coagulopathy during trauma hemorrhage. Intensive care medicine, 41(2), 239–247. https://doi.org/10.1007/s00134-014-3584-1



Journal of Surgical Research



Volume 287, July 2023, Pages 193-201

Outcomes of Transfusion With Whole Blood, Component Therapy, or Both in Adult Civilian Trauma Patients: A Systematic Review and Meta-Analysis

Conclusions

Transfusion with WB + COMP is associated with lower 24-h mortality *versus* COMP and transfusion with WB is associated with a lower volume of red blood cells transfused at both 6 and 24 h. Based on these findings, greater utilization of whole blood in civilian adult trauma resuscitation may lead to improved mortality and reduced transfusion requirements.

Micah Ngatuvai, Israel Zagales, Matthew Sauder, Ryan Andrade, Radleigh.G. Santos, Tracy Bilski, Lucy Kornblith, Adel Elkbuli, Outcomes of Transfusion With Whole Blood, Component Therapy, or Both in Adult Civilian Trauma Patients: A Systematic Review and Meta-Analysis, Journal of Surgical Research, Volume 287,2023, Pages 193-201,ISSN 0022-4804, https://doi.org/10.1016/j.jss.2023.02.010.

UTHealth Houston News

Stories from The University of Texas Health Science Center at Houston (UTHealth Houston)

HEALTH

EDUCATION

RESEARCH

COMMUNITY

MEDIA RESOURCES

UTHealth Houston researchers begin five-year study into effectiveness and safety of whole blood transfusion

TROOP trial will enroll 1,200 patients at 12 trauma centers across the United States

Written by: Vinod Hopson, UTHealth Houston School of Public Health | Updated: October 24, 2022



Blood

Y Plasma

Stem Cells

Y Organs & **Tissues**

From whole blood to blood components...and back again!

Transfusion

Blood

Thursday, December 05, 2019 Dr. Geraldine Walsh

Component Therapy

Indicators

- Hemoglobin/Hematocrit
- Assessment of Vital Organ Perfusion
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Recommendations/ Studies Ref



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BLOOD PRODUCTS



BLOOD PRODUCTS

WHOLE BLOOD

platelets

PACKED RED BLOOD CELLS (PRBCs)

PLATELET **TRANSFUSIONS** FRESH FROZEN PLASMA













Platelets



cryoprecipitate

So Many Choices

	Blood Type							
	А	В	AB	0				
Red Blood Cell Type		B	AB					
Antibodies in Plasma	Anti-B	Anti-A	None	Anti-A and Anti-B				
Antigens in Red blood Cell	A antigen	♦ B antigen	A and B antigens	None				

Patient ABO Group	Whole Blood	Red Blood Cells	Platelets	Plasma	Cryoprecipitate
0	0	0	Any (O preferred)	O,A,B,AB	N/A
Α	A	A or O	Any (A preferred)	A or AB	N/A
В	В	B or O	Any (B preferred)	BorAB	N/A
АВ	AB	AB,A,B,orO	Any (AB preferred)	AB	N/A

BLOOD PRODUCTS



BLOOD PRODUCTS

WHOLE BLOOD

platelets

PACKED RED BLOOD CELLS (PRBCs)

PLATELET **TRANSFUSIONS** FRESH FROZEN PLASMA













Platelets



cryoprecipitate

So Many Choices

PRBCs



Contents

CPD A - anticoagulant Phosphate - buffer Dextrose - ATP Adenine - ATP

 $Maximum\ Storage\ Life = 42\ days$ $Mean\ Storage\ Life = 15\ days$

Reduced 2, 3 DPG

Decrease efficacy of clotting proteins

Primary = O_2 carrying capacity

BLOOD PRODUCTS



BLOOD PRODUCTS

WHOLE BLOOD

platelets

PACKED RED BLOOD CELLS (PRBCs)

PLATELET **TRANSFUSIONS** FRESH FROZEN PLASMA













Platelets



cryoprecipitate

So Many Choices

- Given for deficiency in quantity and quality
- Given in concentrates from 6-10 donors (pooled)
- One platelet count per 10kg body weight recommended
- ABO matching preferred (*not required*)
- Transfuse if less than 50 per microliter
- One platelet concentrate will increase count by 5-10 per microliter

Platelets



BLOOD PRODUCTS



BLOOD PRODUCTS

WHOLE BLOOD

platelets

PACKED RED BLOOD CELLS (PRBCs)

PLATELET **TRANSFUSIONS** FRESH FROZEN PLASMA













Platelets



cryoprecipitate

So Many Choices

- Contains all coagulation factors
- Usually 200-250ml
- Prepared from whole blood or apheresis
- Stored at -18 to -30 degrees Celsius
- Majority transfused for bleeding disorders
- If not given in 24hrs after thawing, Factors V & VII decline
- Reversal of warfarin therapy
- Factor deficiency require 10-20ml/kg

Fresh Frozen Plasma



BLOOD PRODUCTS



BLOOD PRODUCTS

WHOLE BLOOD

platelets

PACKED RED BLOOD CELLS (PRBCs)

PLATELET **TRANSFUSIONS** FRESH FROZEN PLASMA













Platelets



cryoprecipitate

So Many Choices

Cryoprecipitate

- Components
 - 100 units of factor VIII
 - 200mg of fibrinogen
- Used to correct inherited or acquired coagulopathies
- Used intraop for patients at risk of hemorrhage
- 1 unit/10kg can increase fibrinogen by 50 mg/dL

Primary use:

- Actively bleeding with vonWillebrand disease
- Massive transfusion with fibrinogen levels < 80-100mg/dL
- Prophylactic with congenital fibrinogen deficiencies or vonWillebrand disease unresponsive to DDAVP

BLOOD PRODUCTS



BLOOD PRODUCTS

WHOLE BLOOD

platelets

PACKED RED BLOOD CELLS (PRBCs)

PLATELET **TRANSFUSIONS** FRESH FROZEN PLASMA













Platelets



cryoprecipitate

So Many Choices

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Massive Transfusion Protocol

- >10 units in 24hrs or >5 units in 4hrs
- "*Ultramassive*" is >20 units in 48hrs
- Hemorrhaging patients develop refractory hemorrhage from:
 - dilution of clotting factors
 - hypothermia from cold products
 - hypocalcemia induced coagulopathy
 - acidosis

MTP Considerations

> PROPPR Study

MTP

Factors to Consider

How unstable is the patient?

How rapidly is the patient bleeding?

Is the bleeding continuing or stopping?

Is the patient in hemorrhagic shock?

Hgb level takes hours to fall after bleeding

HOTN is late manifestation

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MTP Considerations

> PROPPR Study

MTP

February 3, 2015

Transfusion of Plasma, Platelets, and Red Blood Cells in a 1:1:1 vs a 1:1:2 Ratio and Mortality in Patients With Severe Trauma The PROPPR Randomized Clinical Trial



Conclusions and Relevance Among patients with severe trauma and major bleeding, early administration of plasma, platelets, and red blood cells in a 1:1:1 ratio compared with a 1:1:2 ratio did not result in significant differences in mortality at 24 hours or at 30 days. However, more patients in the 1:1:1 group achieved hemostasis and fewer experienced death due to exsanguination by 24 hours. Even though there was an increased use of plasma and platelets transfused in the 1:1:1 group, no other safety differences were identified between the 2 groups.

Holcomb, J. B., Tilley, B. C., Baraniuk, S., Fox, E. E., Wade, C. E., Podbielski, J. M., del Junco, D. J., Brasel, K. J., Bulger, E. M., Callcut, R. A., Cohen, M. J., Cotton, B. A., Fabian, T. C., Inaba, K., Kerby, J. D., Muskat, P., O'Keeffe, T., Rizoli, S., Robinson, B. R., Scalea, T. M., ... PROPPR Study Group (2015). Transfusion of plasma, platelets, and red blood cells in a 1:1:1 vs a 1:1:2 ratio and mortality in patients with severe trauma: the PROPPR randomized clinical trial. JAMA, 313(5), 471–482. https://doi.org/10.1001/jama.2015.12

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MTP Considerations

> PROPPR Study

MTP

MTP



Adult Population (>50kg)

- 1:1:1 ratio (6 PRBC:6FFP:1Plt)
- Cryo considered with 2nd cooler or based on TEG
- Additional products can be considered as need
- TXA 2 grams IV
 - Back to back doses at beginning
 - 1 gram initially & second dose after 3rd cooler
 - 1 gram initially & second dose after 8hrs
- Consider calcium administration





Massive Transfusion Protocol

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MTP Considerations

> PROPPR Study

MTP

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