

A Bloody Good Time: Transfusions in the ER and ICU

NOËL VEZZI, DVM, DACVECC



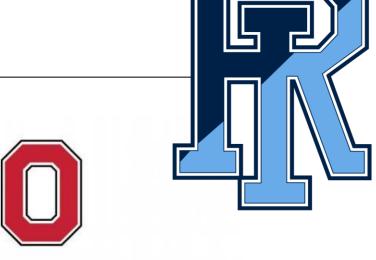
Who am I?

- Grew up in Adirondack region of upstate NY
- Currently living in Bourne with 3 corgis



Education

- University of Rhode Island
 - o Bachelors of Science 2014 Animal Science
 - Minors Biology, Business
- The Ohio State University College of Veterinary Medicine
 - Doctor of Veterinary Medicine 2018





COLLEGE OF VETERINARY MEDICINE

Specialty Training

- Veterinary Medical Center
- Veterinary Medical Center of Central New York
 - Rotating Internship 2018-2019
- University of Georgia College of Veterinary Medicine

College of

- o Emergency and Critical Care Residency 2019-2022
- o Board certification October 2022



Employment

- Cape Cod Veterinary Specialists
 - Criticalist October 2022 to present
 - o Blood Bank Director
 - Special interests transfusion medicine, sepsis, immune disease, fluid therapy, surgical emergencies





Tonight's Topics



PHYSIOLOGY REVIEW



INDICATIONS FOR TRANSFUSIONS



BLOOD PRODUCTS



TRANSFUSION ADMINISTRATION



CCVS BLOOD BANK



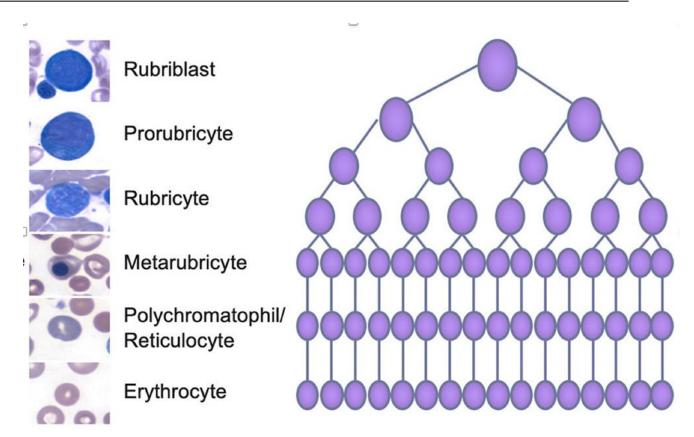
Physiology Review

BLOOD CELL BASICS; HEMOSTASIS



Blood Cell Basics

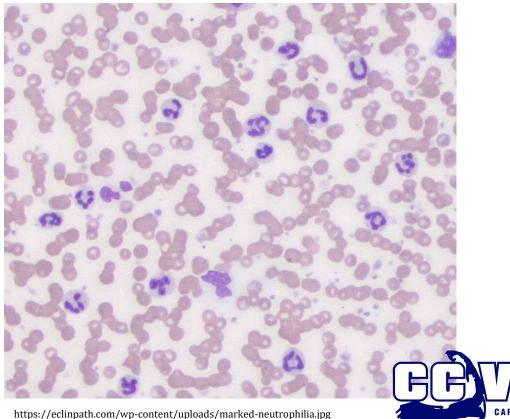
- Production
- Maturation
- Release into circulation



https://eclinpath.com/hematology/physiology/erythrocytes/erythropoiesis-pyramid/

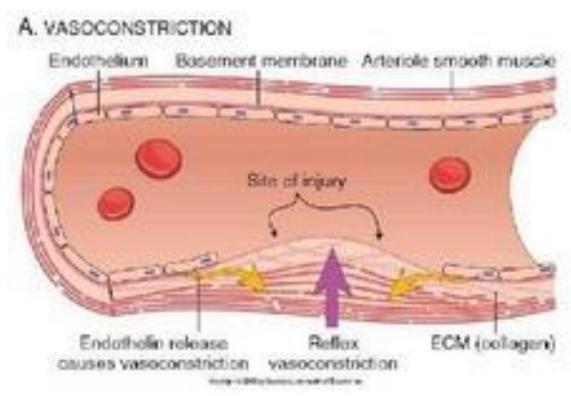
Lifespan of Circulating Cells

- Red blood cells
 - ○Dogs 4 months
 - OCats 2 months
- \circ Neutrophils \rightarrow 5-15 hours
- \circ Platelets \rightarrow 5-7 days

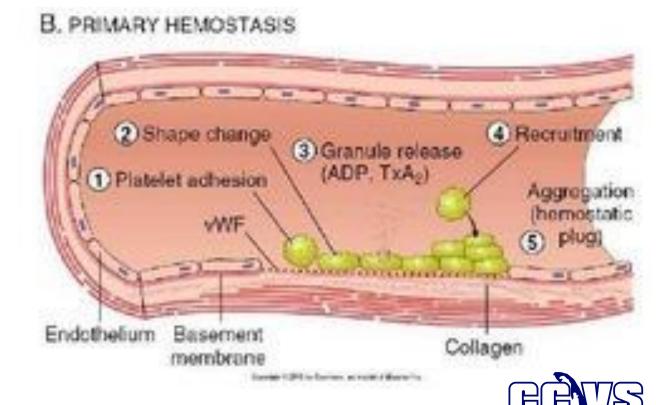


Primary Hemostasis

Endothelial injury Vasoconstriction Platelet adhesion, activation, aggregation

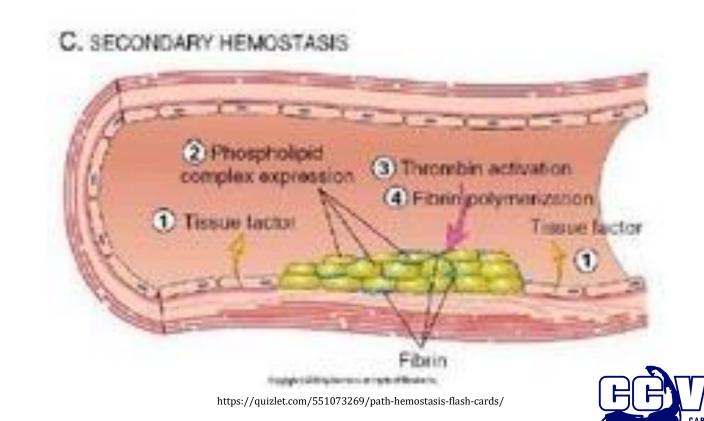


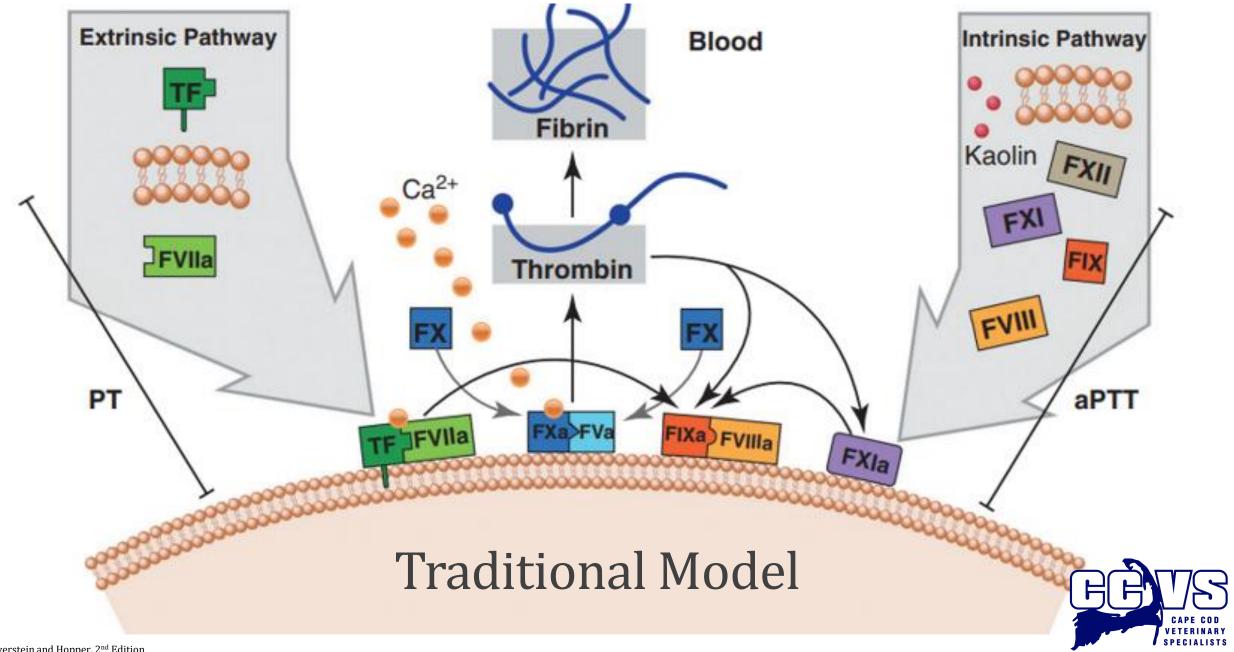
https://quizlet.com/551073269/path-hemostasis-flash-cards/

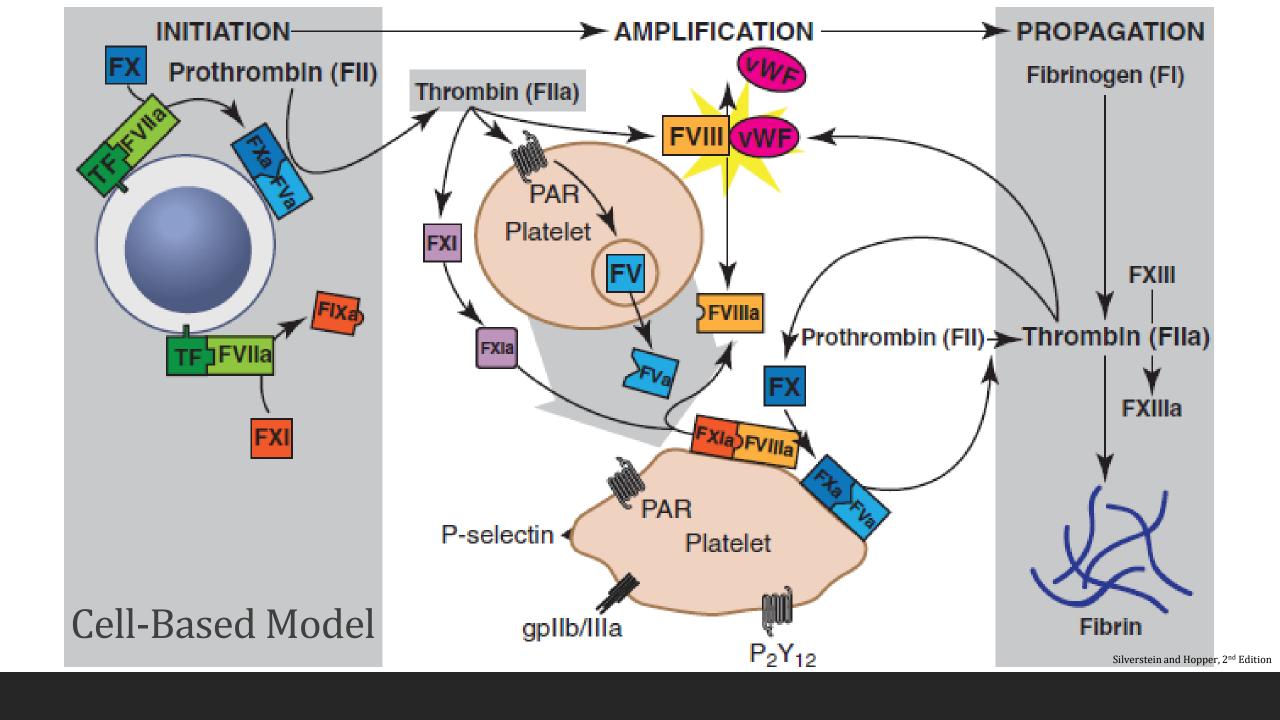


Secondary Hemostasis

- Initiated concurrently with primary hemostasis
 - o Tissue factor
 - Fibrin formation
- o Thrombin → fibrin
- Cell-based vs traditional model of coagulation

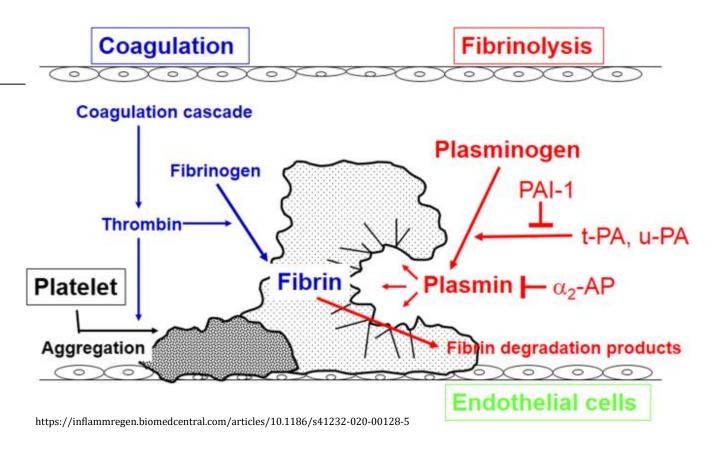






Anti-Coagulation

- Balance between coagulation and anti-coagulation very important
- Fibrinolysis
 - Dissolution of a stable fibrin clot for restoration of normal blood flow
 - Plasminogen
 - Tissue plasminogen activator (TPA)
 - o Plasmin
 - \circ Antiplasmin





Indications for Transfusions

ANEMIA; THROMBOCYTOPENIA; COAGULOPATHY



Anemia

- Differential diagnoses
 - \circ Hemorrhage
 - $\circ Hemolysis\\$
 - oDecreased/deficient production





Hemorrhage

- Hemoabdomen
- Hemothorax
- GI bleeding
- Fractures/wounds/recent surgery
- Urinary bleeding
- Flea infestation
- *Secondary to coagulopathy



Hemolysis

- O IMHA
- Toxins
- Hereditary
- Heat stroke
- Severe hypophosphatemia
- Heartworm, erythrocyte parasites
- Mechanical damage



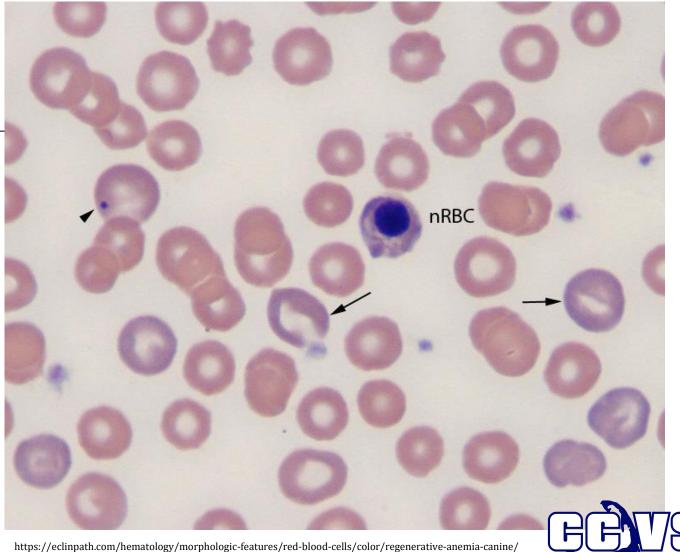
Decreased/deficient production

- Bone marrow disease
- Decreased EPO
- Anemia of chronic disease
- Anemia of inflammatory disease
- Iron deficiency anemia
- Toxins



Regeneration

- Regenerative
- Non-regenerative ovs. pre-regenerative



Work-Up of the Anemic Patient

- o CBC
 - o HCT/Hgb
 - o Reticulocytes
 - MCV (micro/normo/macrocytic)
 - MCHC (hypo/normo/hyperchromic)
 - o Platelet count, WBCs
- O PCV/TS
- Saline agglutination
- Peripheral smear
- Additional diagnostics chemistry, imaging, infectious disease testing, coagulation testing, etc.





Most Important...

- HISTORY AND PHYSICAL EXAM!
 - o Toxin exposure
 - Recent vaccinations/medications
 - o Travel history
 - o Potential trauma



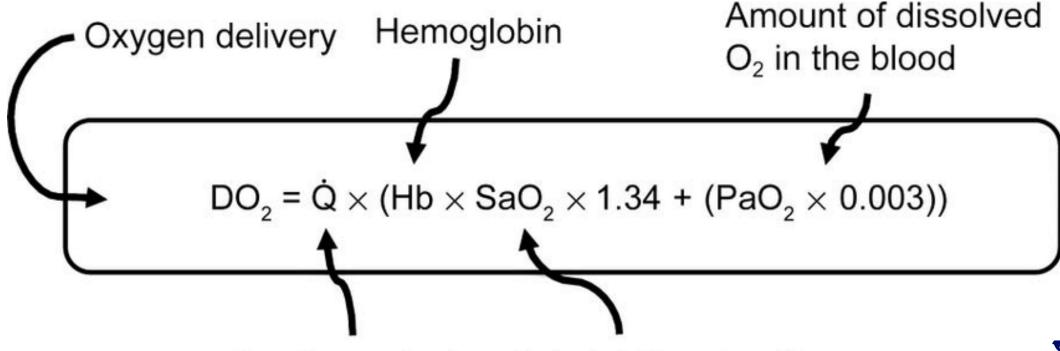
Transfusion Triggers

- Clinical REGARDLESS of PCV or HCT
 - \circ Tachycardia
 - o Tachypnea
 - o Pale mucous membranes
 - $\circ\,Prolonged\,CRT$
 - Hypotension or hypertension
 - o Dull mentation
 - o Bounding pulses



Oxygen Delivery Equation

Cardiac output





Arterial O₂ saturation

PCV Trigger Point

- Normovolemic resting animal can maintain O2 delivery to PCV of 10%
 - \circ Transfuse before they get to this point \rightarrow <15%
- Rapidly progressive anemia → 20-25%
 - Chronic process can likely tolerate much lower
- O Anesthesia or surgery → ideally >20%



Thrombocytopenia

- Differential diagnoses
 - Destruction
 - oLoss
 - \circ Consumption
 - \circ Sequestration
 - Decreased production



Destruction

- o ITP
 - $\circ Primary \\$
 - \circ Secondary
 - $\circ\, Neoplasia$
 - o Infectious disease
 - Inflammation
 - $\circ\, Drugs$



Loss

- Hemorrhage
 - ORanges from mild to severe





Consumption

- o DIC
- Thrombosis
- Vasculitis



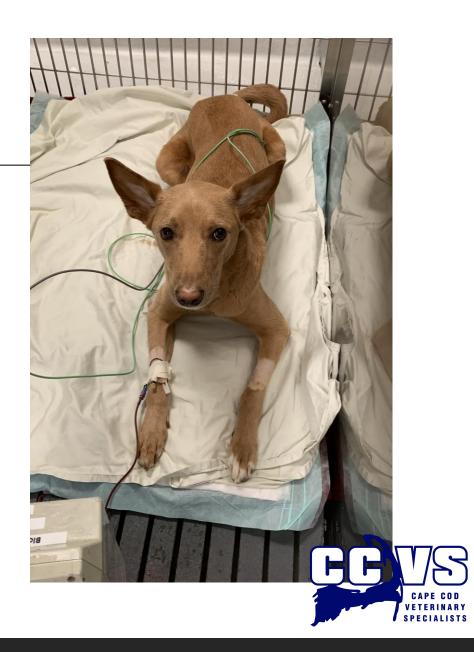
Sequestration

Splenomegaly



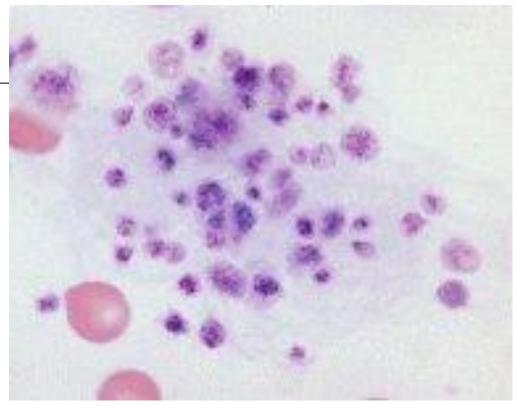
Decreased Production

- Bone marrow disease
 - ○Neoplasia
 - OInfectious or immune disease
 - oDrugs or toxins
 - Radiation



Artifact

- Clumping
- Cavalier macrothrombocytopenia

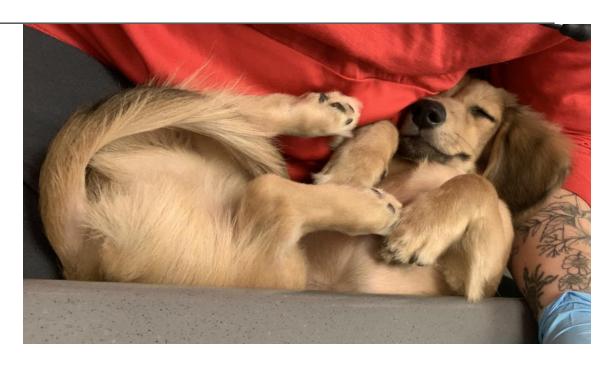


https://eclinpath.com/hematology/morphologic-features/platelets/platelet-changes/



Work-Up of the Thrombocytopenic Patient

- o CBC
- Peripheral smear1 PLT/hpf = 15,000 PLT
- Coagulation testing
 - \circ vWF
 - PT/aPTT
 - TEG/VCM
 - Platelet function assays
- Additional testing chemistry, infectious disease testing, imaging, etc.





Most Important...

- HISTORY AND PHYSICAL EXAM!
 - oToxin exposure
 - Recent vaccinations/medications
 - oTravel history
 - oPotential trauma



Transfusion Triggers

- Anemia (pRBC, whole blood)
 - Same as previously discussed (tachycardia, tachypnea, PCV <15%, etc.)
- Thrombocytopenia (platelet products) → bandaid
 - Pulmonary hemorrhage
 - Seizures/suspected intracranial bleeding
 - Refractory hemorrhage
 - Surgical procedures



Coagulopathies

- Hypocoagulability differentials
 - Toxins
 - Liver disease
 - Hereditary factor deficiencies
 - Factor consumption/depletion
 - Acute traumatic coagulopathy
 - Systemic illness
 - Hyperfibrinolysis



Anticoagulant Rodenticide

- Vitamin K antagonism
- Vitamin K dependent clotting factors
 II, VII, IX, X





Coagulopathy of Liver Disease

- Almost all coagulant, anticoagulant, and fibrinolytic proteins synthesized in the liver
 - Exceptions V, VIII, vWF, tPA
- Differentials → severe hepatic failure of any etiology
 - Acute infectious hepatopathy, chronic disease (cirrhosis), toxins (aflatoxin, blue green algae, sago palm, xylitol, etc.)
- Multifactorial causes of hemostatic imbalance



Hereditary Coagulopathies

- o vWD
- Hemophilia A (factor VIII)
- Hemophilia B (factor IX)
- Platelet disorders



Acute Traumatic Coagulopathy

- Coagulopathy that occurs in patients who experience trauma
 - ORange of coagulopathies normal, hypercoagulable, hypocoagulable
- Activation of coagulation system due to exposure of subendothelial tissue factor and cytokine release
- Occurs in the absence of clotting factor consumption
- Acidosis, hypothermia, and dilution from blood loss or IV fluid administration likely contribute



Systemic Disease

- Systemic inflammation (SIRS, sepsis)
- Consumption of clotting factors (DIC)
- Acute liver injury



Hyperfibrinolysis

- Differentials
 - oNeoplasia
 - Parasites
 - Cavitary bleeding
 - Liver disease
 - oTrauma €



Work-Up of the Coagulopathic Patient

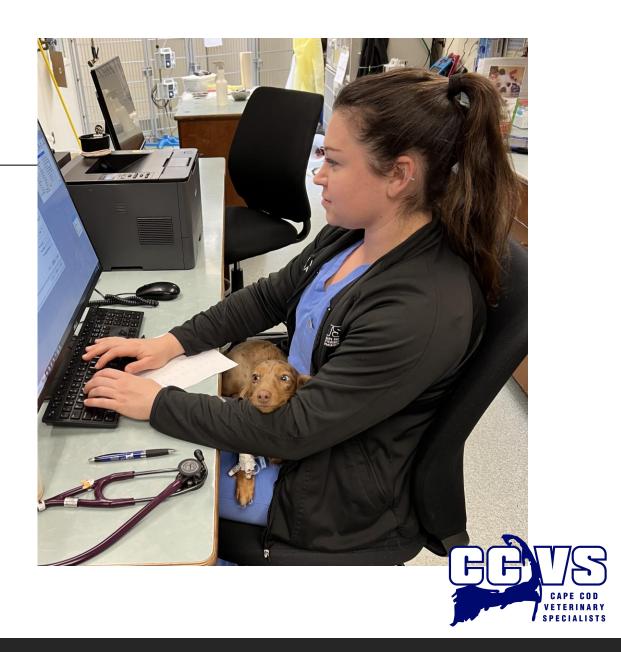
- Platelet count
- Factor assessment
 - PT/aPTT
 - \circ vWF/BMBT
 - o Hemophilia panel
- Platelet function assays
- Viscoelastic testing
 - Hypo/hypercoagulability
 - Hyperfibrinolysis



Most Important...

HISTORY AND PHYSICAL EXAM!

- ○Toxin exposure rodenticide!
- oPast surgeries
- ORecent trauma



Transfusion Triggers

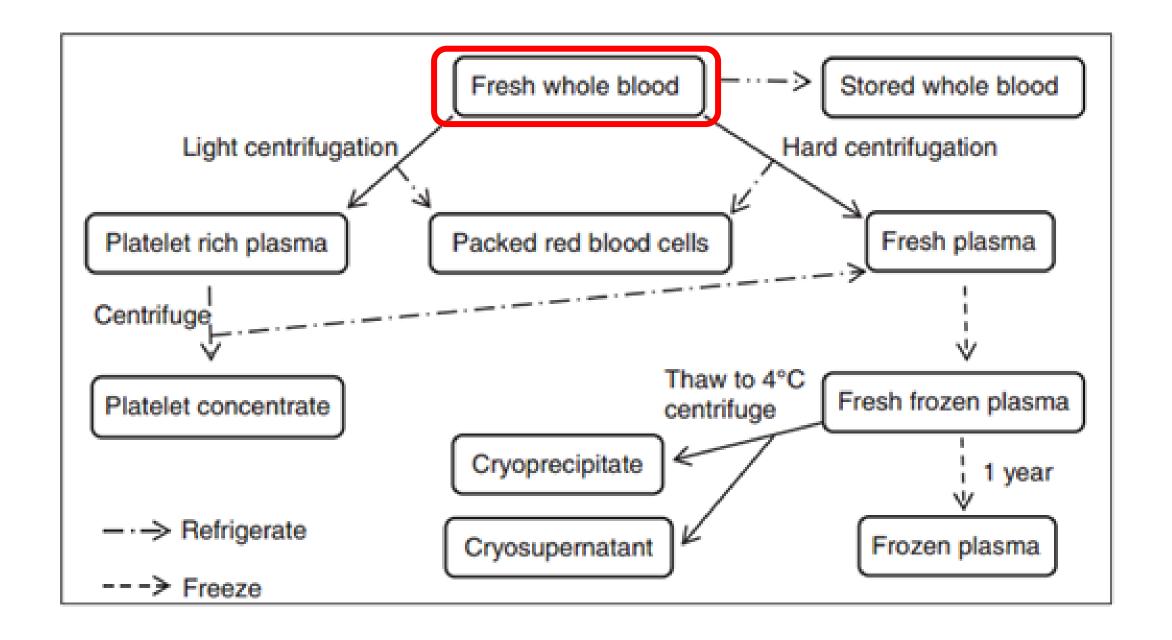
- Coagulopathy (FFP/FP/cryo)
 - Prolonged clotting times with or without evidence of clinical hemorrhage
 - >1.5x the high end of the reference range
- Anemia (pRBC, whole blood)
 - Same as previously discussed (tachycardia, tachypnea, PCV <15%, etc.)



Blood Products

WHOLE BLOOD; PRBC; PLASMA; PLATELETS

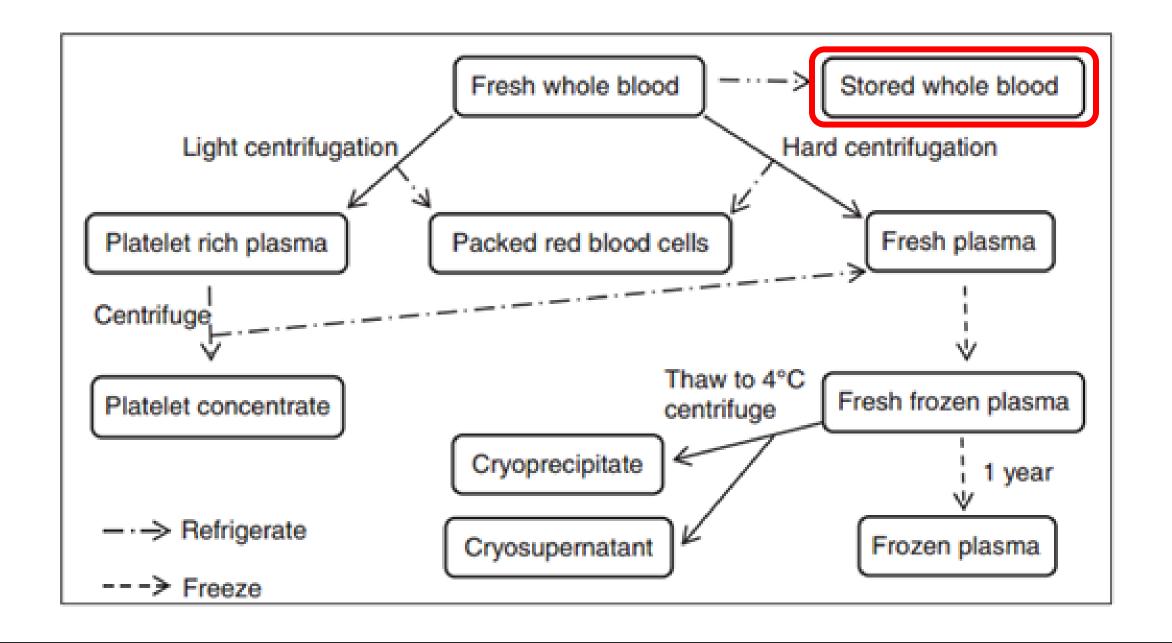




Fresh Whole Blood

- Stored <8 hours before administration
- Contains all components of blood
 - o RBCs, WBCs, platelets, plasma, all coagulation factors, albumin, globulin
- Main indications
 - Severe hemorrhage
 - Anemia with coagulopathy/platelet disorder

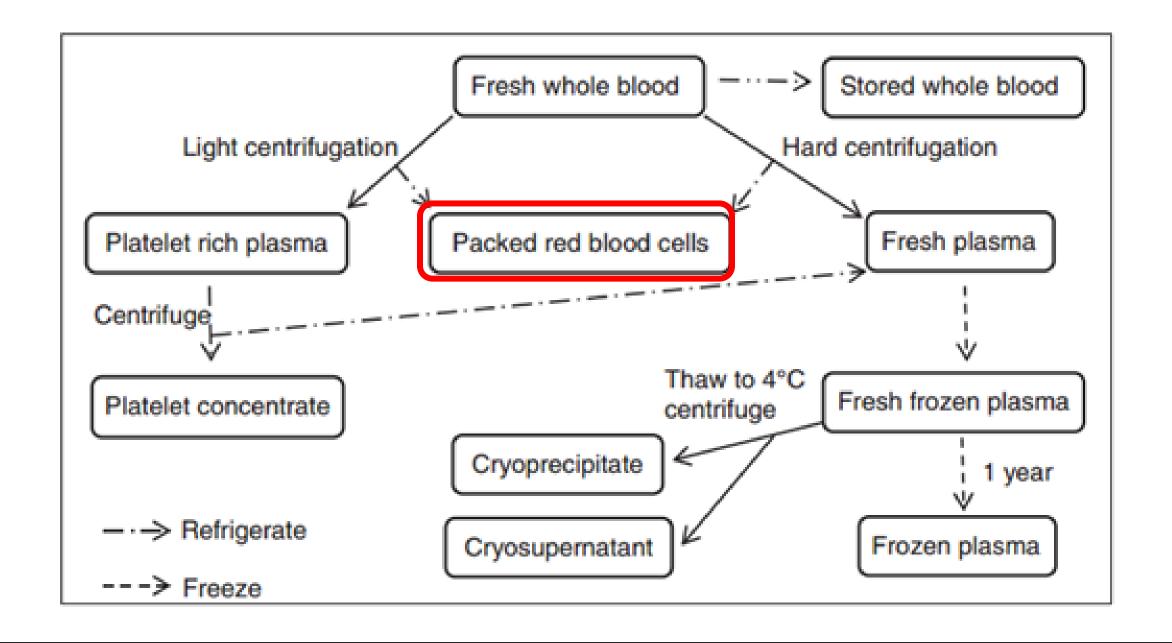




Stored Whole Blood

- Stored between 8 hours and 28-35 days
- RBC, WBC, platelets*, coagulation factors (except labile factors), albumin, globulin
- Cold stored whole blood retains ability to form a firm clot up to 21 days
- IndicationsBlood loss anemia

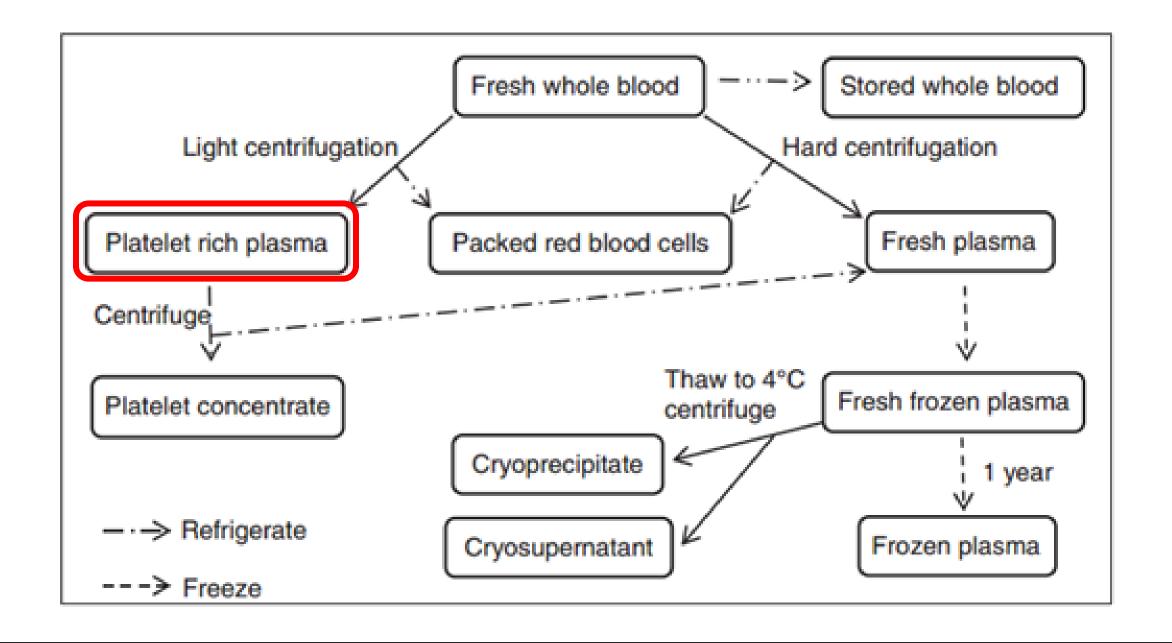




Packed Red Blood Cells

- Fresh whole blood centrifuged,
 plasma supernatant removed
- RBCs, WBCs, non-viable platelets, remnant plasma
- o Indications:
 - oAnemia (of any etiology)

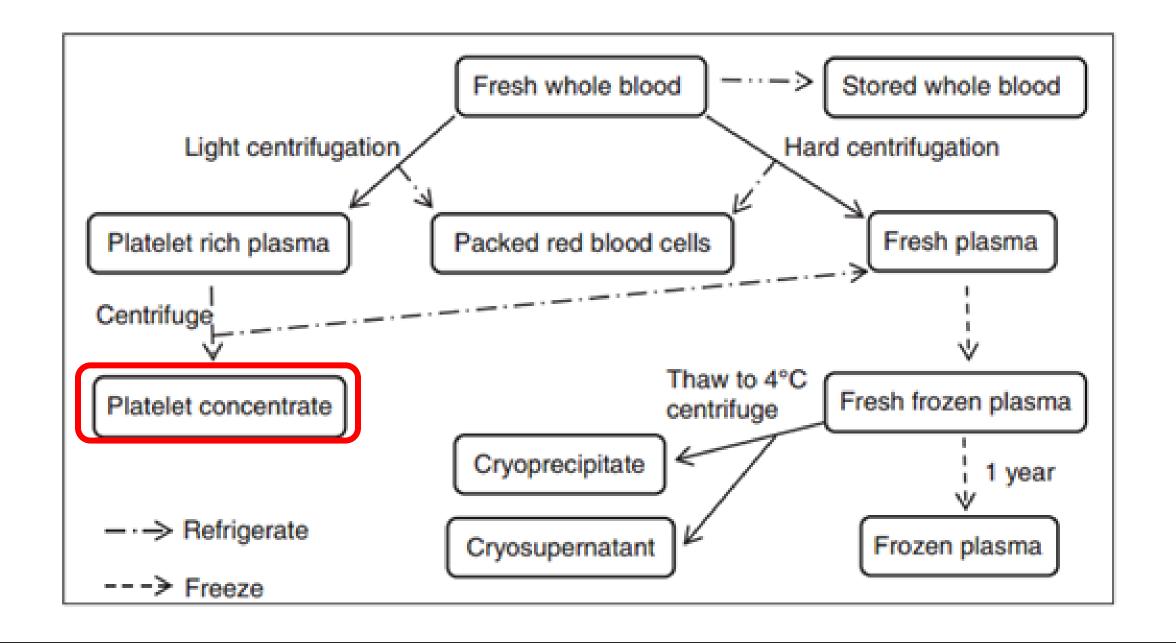




Platelet Rich Plasma

- Supernatant, plasma portion of fresh whole blood after light centrifugation
- Platelets, albumin, globulin, all coagulation factors
- o Indications:
 - Marked thrombocytopenia with critical hemorrhage
 - Surgical procedure





Platelet Concentrate

- Sediment after centrifuging platelet rich plasma
- Platelets, small volume fresh plasma
- o Indications:
 - Marked thrombocytopenia with critical hemorrhage
 - OSurgical procedure

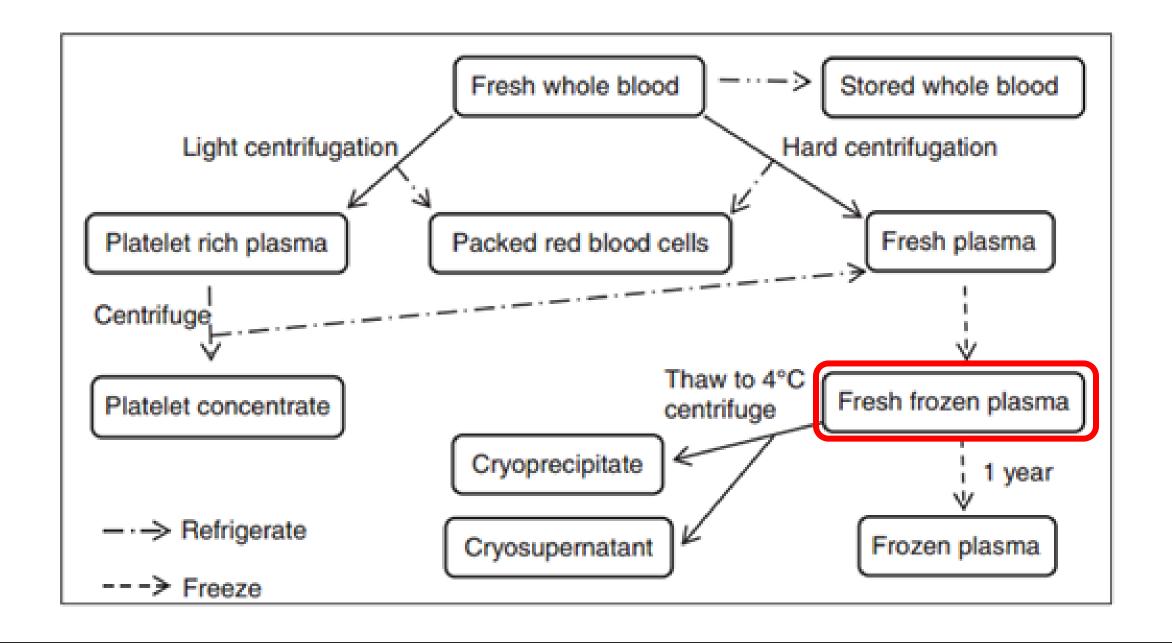


Frozen Platelet Concentrate

- DMSO-preserved frozen canine platelets
 - o Platelets, small volume plasma, 6% DMSO
- o Indications:
 - Marked thrombocytopenia with critical hemorrhage
 - Surgical procedure

*Lyophilized canine platelets no longer commercially available

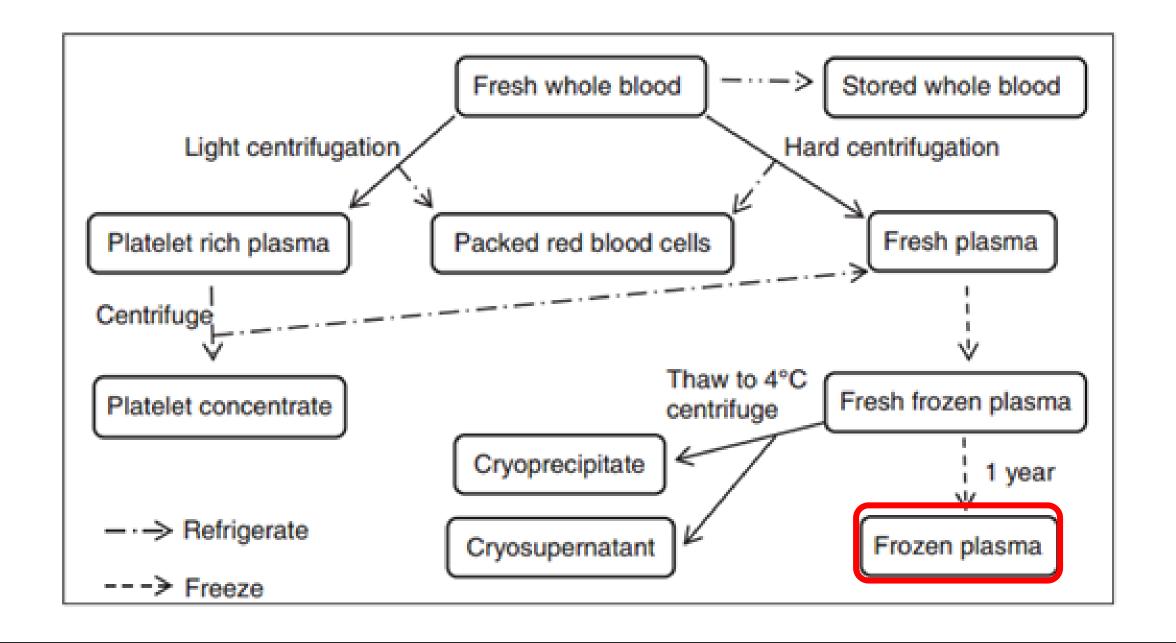




Fresh Frozen Plasma

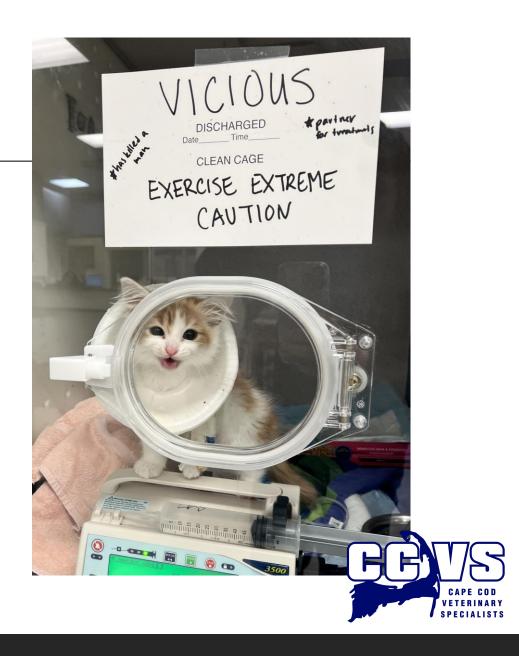
- Plasma portion of fresh whole blood after hard centrifugation
- All coagulation factors, albumin, globulins
- o Indications:
 - Coagulopathy with or without clinical evidence of hemorrhage
- Thawed plasma?
 - Factor stability and sterility maintained for up to 35 days in one study

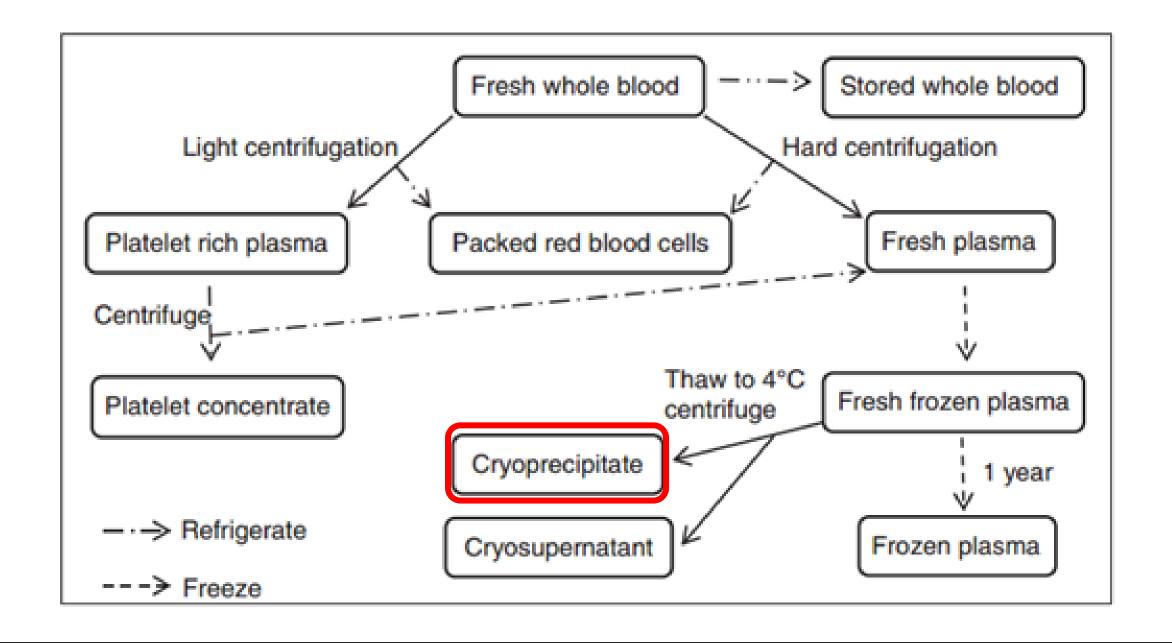




Frozen Plasma

- Fresh frozen plasma frozen 1-5 years
 - Thawed plasma that is re-frozen
- All coagulation factors, but lower concentrations of factor V, VIII, vWF
- Indications:
 - Anticoagulant rodenticide
 - Coagulopathy due to factors II, VII, IX, X, XI or fibrinogen deficiency

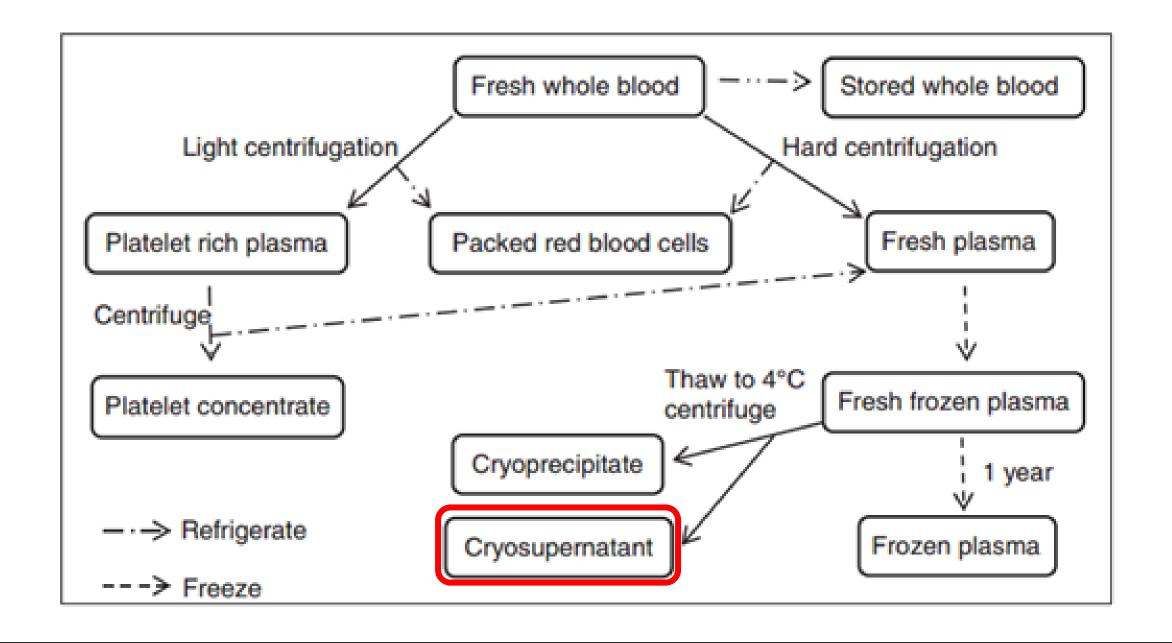




Cryoprecipitate

- Sediment of fresh frozen plasma
- Concentrated factors VIII, XIII, vWF, fibrinogen, fibronectin
- o Indications:
 - oHemophilia A
 - Von Willebrand disease
 - oFibrinogen deficiency





Cryosupernatant

- Supernatant of fresh frozen plasma
- Factors II, V, VII, IX, X, XI
- o Indications:
 - oDeficiency of factors II, V, VII, IX, X, or XI
 - o Includes anticoagulant rodenticide



Albumin

- Lyophilized canine albumin
- Human albumin
- o Indications:
 - Hypoalbuminemia, especially with thirdspacing or hypotension



Transfusion Administration

BLOOD TYPING; CROSSMATCH; ADMINISTRATION; MONITORING



Before You Transfuse

- Blood type
- Crossmatch



Canine Blood Types

- Most important blood type is DEA 1
 - \circ Elicits a strong alloantibody response after sensitization of a DEA 1-negative dog by a DEA-1 positive transfusion
- No clinically important alloantibodies present BEFORE sensitization of a dog with a transfusion
- DEA-1 negative dogs considered universal donors



Feline Blood Types

- Main blood group system in cats is AB
 - \circ Three main types \rightarrow type A, type B, type AB
- All cats have naturally occurring alloantibodies
 - Type B → very strong anti-A alloantibodies
 - DO NOT GIVE TYPE A BLOOD TO A TYPE B CAT! CAN HAVE FATAL TRANSFUSION REACTIONS!
 - Type A → weak anti-B alloantibodies
 - o Giving type B blood to a type A cat can still elicit a reaction
 - Type AB have no alloantibodies

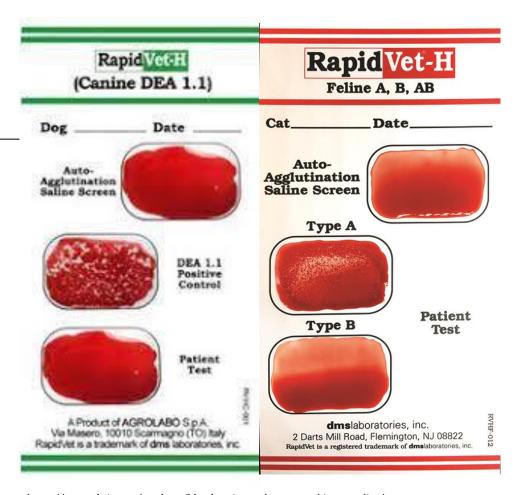


How to Blood Type

- Blood typing cards
- Immunochromatographic cartridges



https://www.qbiotech.gr/pet-rapid-test/eqt-bt-c.html?__store=en&__from_store=el



https://www.abrint.net/products/blood-typing-and-crossmatching-supplies/



Crossmatch

- Major
 - o Donor RBC and recipient plasma
- Minor
 - Donor plasma and recipient RBCs
- When to perform:
 - o All cats
 - Any patient who has received a prior blood transfusion
 - Not absolutely necessary if transfusion received within past 3 days





Transfusion Volume

- \circ Whole blood \rightarrow 12-20 ml/kg
- \circ pRBC \rightarrow 6-10 ml/kg
- \circ FFP \rightarrow 6-12 ml/kg
- Transfusion volume (mL) = BW (kg) × blood volume (90 mL) × [(desired PCV recipient PCV)/donor PCV]



Set-Up

- Aseptic technique
- Filters
 - OWhole blood/pRBCs vs plasma
- Drip set vs pumps



Administration & Monitoring

- Rates vary
 - OClassically 4 hours
 - Slower for patients who may not tolerate fluids
 - If giving over longer than 4 hours, should aliquot and keep in fridge
 - oFFP or FP as CRI for oncotic support
- Vital q5 minutes initially
 - oLess frequently as transfusion continues



Types of Transfusion Reactions

Immunologic

- ○Most common → febrile non-hemolytic, urticaria
- oLess common → hemolytic, immune suppression, decreased platelet counts

Non-immunologic

- Infectious disease transmission, sepsis
- ○Citrate toxicity → hypocalcemia
- oCirculatory overload (TACO)



Clinical Signs of Transfusion Reactions

- Mild → fever, urticaria, facial edema
- Moderate → fever, tachycardia, tachypnea, weakness, vomiting
 - Can be associated with hemolytic or non-hemolytic
- Severe → collapse, tachycardia, bradycardia, tachypnea, hypotension, fever, hypothermia, death



Treatment of Transfusion Reaction

- Mild → slow or stop the transfusion
 Diphenhydramine?
- Moderate → stop transfusion, shock
 fluid bolus if not volume overloaded
 Do not restart unless signs resolve quickly
- Severe → secure airway, ventilate as needed, epinephrine, shock fluid bolus
 - Evaluate for evidence of hemolysis
 - o Gram stain, culture, start antibiotics



TRALI

- Hypoxemia
- Bilateral lung infiltrates on radiographs
- No left atrial enlargement or left atrial hypertension
- Occurs during transfusion or within 6 hours of completion
 - Delayed TRALI → worse prognosis
 - \circ Treatment \rightarrow supportive



Massive Transfusion

Openition:

- Transfusion of a volume blood greater than the patient's blood volume within
 24 hours
 - o 90 ml/kg dog, 60 ml/kg cat
- Replacement of ½ blood volume in 3-4 hours
- OAdministration of 1.5 ml/kg/min of blood products over 20 minutes
- Predominantly used for massive trauma and subsequent hemorrhage



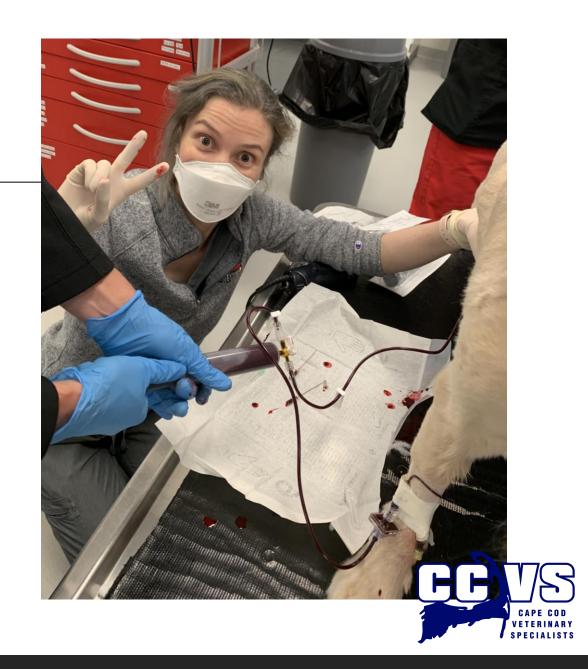
Massive Transfusion Concerns

- Electrolyte disturbances
 - o Hypocalcemia, hypomagnesemia, hyperkalemia
- Hemostatic defects
 - Thrombocytopenia/pathia, dilutional coagulopathy
- Hypothermia
 - Shock, refrigerated products
- Metabolic acidosis
 - Decreased pH in stored products
- Acute lung injury
 - Microaggregates of PLT, WBC, and fibrin → PTE



Autotransfusion

- May be a viable option for large volume cavitary bleeds
 - **OHemoabdomen**
 - OHemothorax



CCVS Blood Bank

DONOR REQUIREMENTS; SCREENING; DONATION



Basic Donor Requirements

- Lean body mass of 50lbs or greater (cats 10lbs)
- Between 1-8 years of age (cats 1-10 years)
- Spayed or neutered
- Current on vaccines, F/T/HW preventative
- No prior medical conditions or blood transfusions
- Comfortable with handling by the medical team



Donor Screening

- Minimum database
- Infectious disease testing



Blood Donation Process

- Physical exam
- IVC placement, PCV/TS
- Sedation +/-
- Blood draw
- Post-blood draw treatments
 - SQ vs IV fluid bolus
 - Maropitant +/-



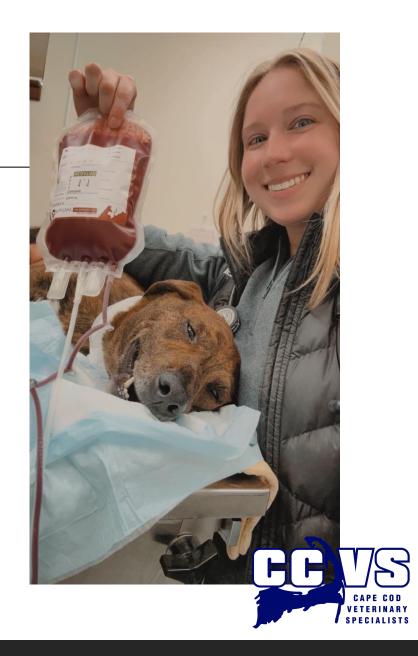
Current CCVS Donors

- 8 DEA 1.1 Negative dogs
- 27 DEA 1.1 Positive dogs
- o 6 Type A cats
- o 1 Type B cat



Know a Donor?

- Email <u>bloodbank@capecodvetspecialists.com</u>
- Donor perks
 - \$50 credit to account per donation
 - Free yearly screening bloodwork
 - Free physical exam before each donation
 - Free blood products equal to the number of donations given if they ever need a transfusion





Questions?

Feel free to email <u>noelvezzi@capecodveterinaryspecialists.com</u> or <u>bloodbank@capecodveterinaryspecialists.com</u>



Sources

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NOTICE

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