

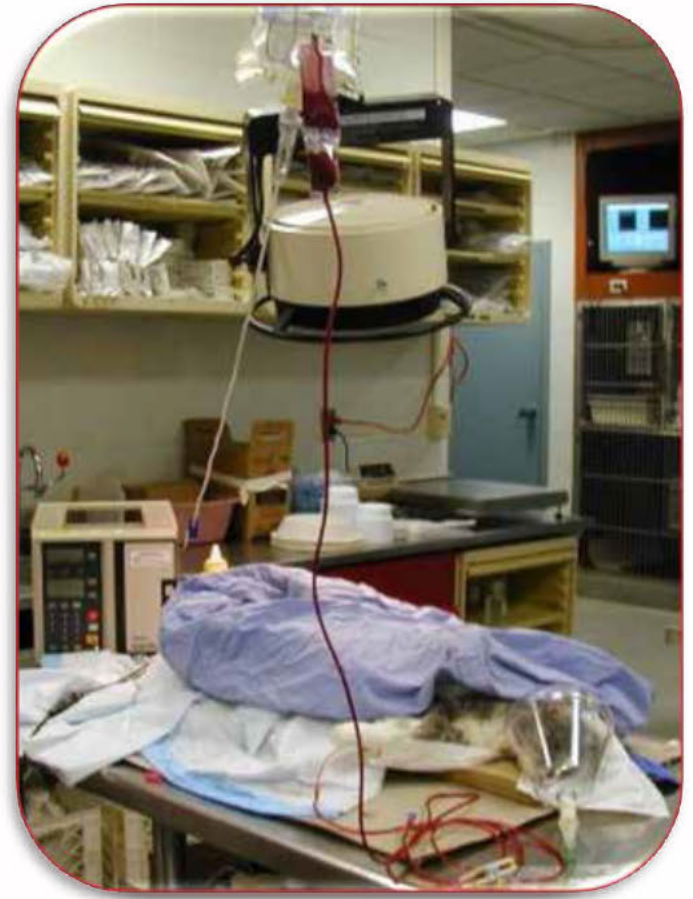
Canine and Feline Transfusion Medicine

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Overview

- ✧ Blood components
- ✧ Blood banking
- ✧ Selection of donors
- ✧ Blood types
- ✧ Cross-matching
- ✧ Transfusion reactions
- ✧ Clinical use of blood components
- ✧ Autotransfusion



Whole Blood

- ✧ Units
 - ✧ K-9 (450 ml/unit)
 - ✧ Feline (50-60 ml/unit)
- ✧ Store at 1-6° C
- ✧ Cellular components
 - ✧ RBCs viable for ~21-28 days
 - ✧ All coagulation factors
 - ✧ Most factors stable for up to 24 hours
 - ✧ Labile factors (V and VIII) stable for ~4 hours
 - ✧ Platelets
 - ✧ Viable for up to 8 hrs at room temperature
 - ✧ Specific additives and protocols must be followed to allow for cold platelet storage
- ✧ Plasma proteins are present through entire shelf-life
- ✧ 2 mL/kg will raise PCV by ~1%

Packed Red Blood Cells

- ✧ Stored at 1-6°C
- ✧ RBCs should be gently mixed daily
- ✧ Shelf-life of 28-35 days (75% viability)
- ✧ Add 0.9% saline if no nutrient solution
- ✧ 1 mL/kg will raise PCV by ~1%



Fresh Frozen Plasma

- ✧ Separated and frozen w/i 6 hours of collection
- ✧ Store at -20° C
- ✧ Shelf-life of one year
- ✧ Contains all coagulation factors
 - ✧ Labile factors (V and VIII) stable if used within 4 hours of thaw
- ✧ Albumin and immunoglobulin remain stable for entire shelf-life
- ✧ Dose (to effect)
 - ✧ 10-20 mL/kg for most coagulopathy
 - ✧ 45 mL/kg should increase serum albumin by ~1 g/dL*

*Should not be used as 1st line treatment for hypoalbuminemia

Frozen Plasma

- ✧ Separated and frozen more than 6-8 hours post-collection
 - ✧ Store at -20° C
 - ✧ Shelf-life of 5 years
 - ✧ Contains all factors except V and VIII
 - ✧ Albumin and immunoglobulin remain stable for entire shelf-life
 - ✧ Dose (to effect)
 - ✧ 10-20 mL/kg for most coagulopathy
 - ✧ 45 mL/kg should increase serum albumin by ~1 g/dL*
- *Should not be used as 1st line treatment for hypoalbuminemia

Cryoprecipitate

- ✧ Prepared from fresh frozen plasma
- ✧ Store at -20°C
- ✧ Shelf-life of 1 year from processing date of FFP
- ✧ Coagulation factors stable if used w/i 8 hours of thaw
- ✧ Contains concentrated amounts of factors
 - ✧ VIII
 - ✧ vWF
 - ✧ Fibrinogen
- ✧ Advantage in that the patient can receive large amounts of specific factors without receiving excessive volumes
- ✧ Dose of 12-20 mL/kg q 10-12 hours or 1 unit per 10 kg of body weight until active bleeding stops



Cryopoor Plasma

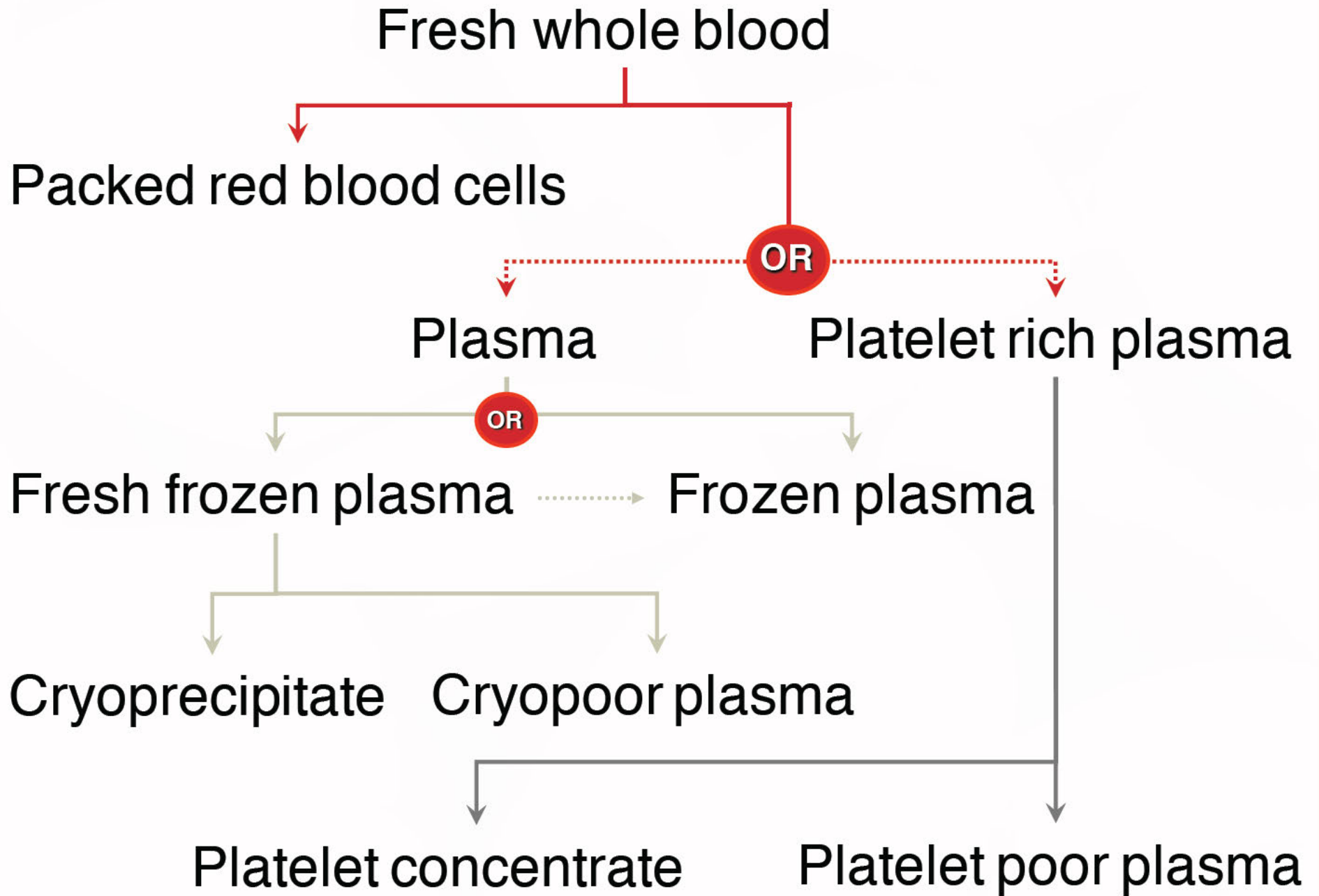
- ✧ Prepared from fresh frozen plasma
- ✧ Store at -20°C
- ✧ Shelf-life of 1 year from processing date of FFP
- ✧ Contains the remainder of the other factors, albumin, and IgG
- ✧ Coagulation factors stable if used within 8 hours of thaw
- ✧ Advantage
 - ✧ Patient can receive large amounts of these factors without receiving excessive volumes

Platelet Rich Plasma

- ✧ Prepared by differential centrifugation of fresh whole blood within 2 hours of collection
 - ✧ Special blood collection bags
 - ✧ Special centrifugation requirements
- ✧ Shelf-life of ~24 hours
- ✧ Storage
 - ✧ 20-24° C
 - ✧ Constant gentle agitation
 - ✧ Storage in certain types of plastic bags
- ✧ Dose administered is dependent upon the individual patients needs, but generally doesn't exceed 6 mL/kg/day

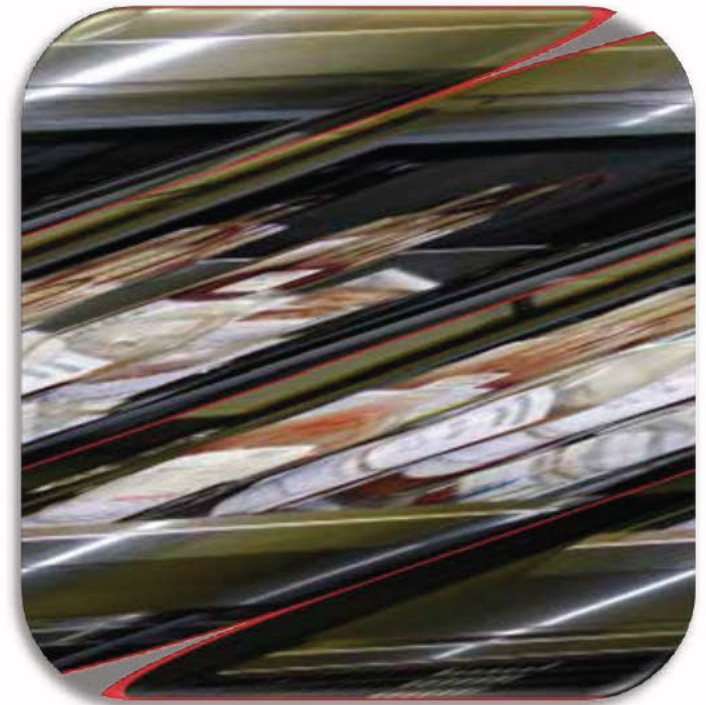
Platelet Concentrate

- ✧ Platelets are separated from plasma and RBCs
- ✧ Store at -20°C or below
- ✧ Shelf-life of 6 months (dependent on product)
- ✧ Thaw at room temperature with gentle agitation for 1 hour prior to use (no water bath)
- ✧ Use within 4-6 hours of thaw
- ✧ Efficacy
 - ✧ Acquire a variety of functional defects
 - ✧ Defects are not fatal as frozen platelets retain hemostatic function in vivo (human)
 - ✧ No in vivo veterinary studies to date demonstrating efficacy or lack thereof
- ✧ Dose is 1 unit / 10 kg of body weight
- ✧ Not for routine prophylaxis



Blood Banking

- ✧ Collection containers
- ✧ Anticoagulants and preservatives
- ✧ Donor selection



Blood Collection Containers

- ✧ Glass inactivates platelets, factors VIII and XII
- ✧ Plastic bags
 - ✧ Do not readily break
 - ✧ Facilitate separation of components
 - ✧ Avoid mechanical trauma to RBCs
 - ✧ Less likely to activate platelets and factors
 - ✧ Allow for gas exchange

Anticoagulants

- ✧ Heparin
 - ✧ Combines with and potentiates antithrombin
 - ✧ Inhibits serine proteases
 - ✧ No preservative properties
 - ✧ 5-10 units per ml of blood
- ✧ 3.8% sodium citrate
 - ✧ Chelates calcium
 - ✧ No preservative properties
 - ✧ 1 ml per 9 ml of blood
- ✧ Acid-Citrate-Dextrose
 - ✧ Citrate chelates calcium
 - ✧ Preserves cells for 21-28 days
 - ✧ 1 ml per 7-9 ml of blood



Anticoagulants & Preservatives

✧ Citrate-Phosphate-Dextrose-Adenine

- ✧ Commercially available

- ✧ 1 ml per 7 ml of blood

- ✧ Viability

- ✧ K-9 pRBCs = 20 days

- ✧ K-9 whole blood = 82% at 35 days

- ✧ Feline whole blood = 85% at 35 days

✧ Additive Solutions

- ✧ Protein free solutions added to pRBCs

- ✧ Adsol increases pRBCs shelf-life to 38 days

- ✧ Nutricel increases pRBCs shelf-life to 38 days



Selection of Canine Donors

- ✧ Weigh at least 25 kg, be 1-7 yrs of age and have a good personality
- ✧ Exclude previously transfused dogs
- ✧ Normal physical exam and health screen
 - ✧ Complete blood count
 - ✧ Manual platelet count
 - ✧ von Willebrand factor assay
 - ✧ Biochemical profile
 - ✧ Urinalysis



Selection of Canine Donors

- ✧ Infectious disease profile
 - ✧ *Mycoplasma haemocanis*
 - ✧ *Babesia canis* and *gibsonii*
 - ✧ *Ehrlichia* spp
 - ✧ *Anaplasma phagocytophilum* (previously *E. equii*)
 - ✧ *Neorickettsia risticii* (previously *E. risticii*)
 - ✧ *Leishmania donovani*
 - ✧ *Bartonella vinsonii*
 - ✧ Heart worm antigen test
 - ✧ *Brucella canis*

- ✧ Currently vaccinated on HW preventative and ectoparasite control

- ✧ Full dog erythrocyte antigen assay



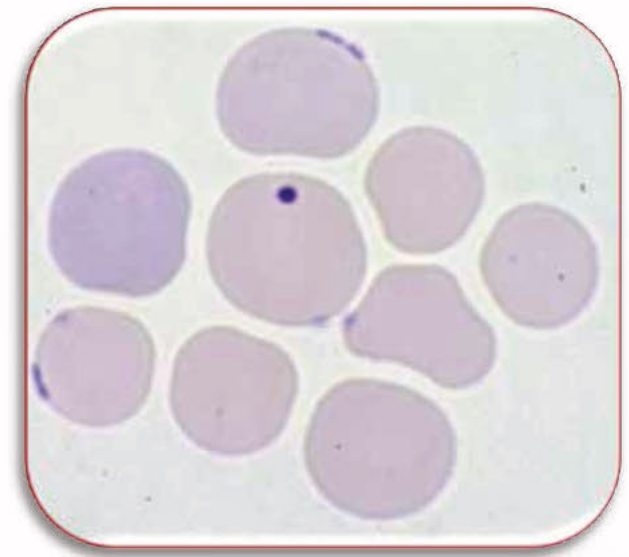
Selection of Feline Donors

- ✧ Weigh at least 5 kg, be 1-7 yrs of age and have a good personality
- ✧ Regardless most cats will need to be sedated
- ✧ Exclude previously transfused cats
- ✧ Normal physical exam and health screen
 - ✧ Complete blood count
 - ✧ Manual platelet count
 - ✧ Biochemical profile
 - ✧ Urinalysis
 - ✧ NTproBNP



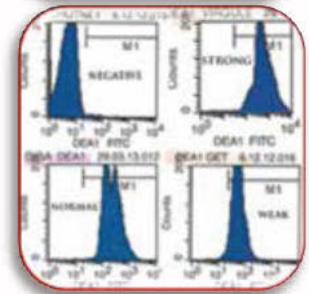
Selection of Feline Donors

- ✧ Infectious disease profile
 - ✧ Feline leukemia virus status
 - ✧ Feline immunodeficiency virus status
 - ✧ Heartworm antibody / antigen test
 - ✧ Bartonella spp
 - ✧ Mycoplasma hemofelis
 - ✧ Candidatus Mycoplasma hemominutum
- ✧ Current vaccination status
- ✧ Lives strictly indoors and is currently vaccinated
- ✧ Feline erythrocyte antigen assay



Canine Blood Types

- ✧ Dogs do not have preformed antibodies to other types and as a result are unlikely to react to a first transfusion
- ✧ The most important of at least 12 blood groups include
 - ✧ DEA 1.1- strong hemolysin produced post-exposure
 - ✧ DEA 1.2 – now known to be a weak expression of 1.1
 - ✧ DEA 7 - sensitized dogs exhibit delayed transfusion reactions
 - ✧ DEA 4 - >98% of dogs possess and sensitized dogs do not exhibit a reaction
- ✧ Dal
 - ✧ Present in 93% of US dogs
 - ✧ Less commonly present in Dalmatians
 - ✧ Sensitized Dal negative dogs could experience acute and delayed hemolytic reactions

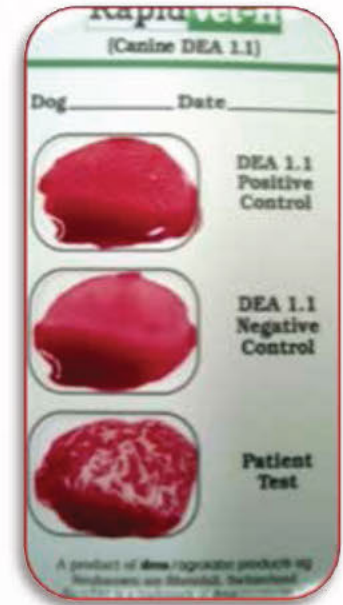


Canine Blood Typing

✧ Cards

✧ Alvedia Quick Test

- ✧ Monoclonal AB specific to DEA 1.1 impregnated onto membrane
- ✧ AB will retain DEA 1 positive cells, characterized by a red band on the mid-portion of the membrane



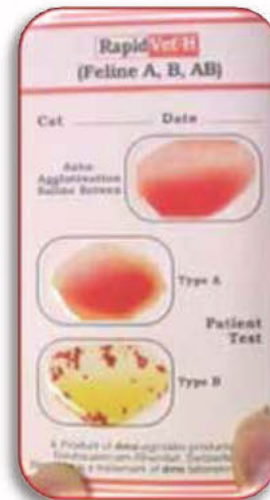
Feline Blood Types

- ✧ Cats have preformed circulating antibodies against the other distinct blood type
- ✧ Blood types
 - ✧ Type A (most common type)
 - ✧ 99% of cats in the United States
 - ✧ 100% of Siamese, Burmese, Tonkinese, Russian blue
 - ✧ Anti-B antibodies - weak (IgG and IgM)
 - ✧ Type B (uncommon)
 - ✧ 20-50% of exotic shorthair, British shorthair, and Rex
 - ✧ 11-20% of Abyssinian, Birman, Persian, Somali, sphinx, Scottish fold
 - ✧ Anti-A antibodies - strong hemagglutinins and hemolysins (IgM)
 - ✧ Type AB (rare) - no allo-antibodies present
 - ✧ Mik antigen
 - ✧ Present in 94% of cats tested
 - ✧ Mik negative cats could experience acute hemolytic reactions after transfusion of type matched blood
 - ✧ **Discovery of Mik antigen, provides rationale for cross-matching cats prior to any transfusion**
- ✧ **All donors and recipients MUST be typed and or cross-matched!**

Feline Blood Typing

✧ Cards

✧ Alvedia Quick Test



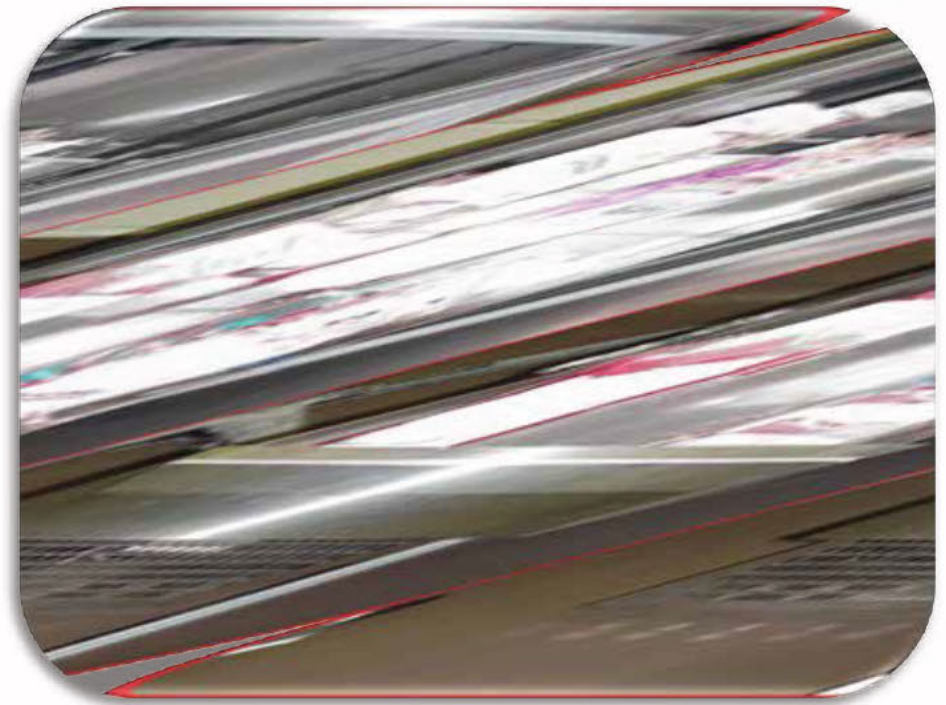
Universal Donors

✧ Dogs

- ✧ DEA 1.1 (weak or strong), and 7 negative
- ✧ DEA 4 positive

✧ Cats

- ✧ None!



Feline Blood Transfusions

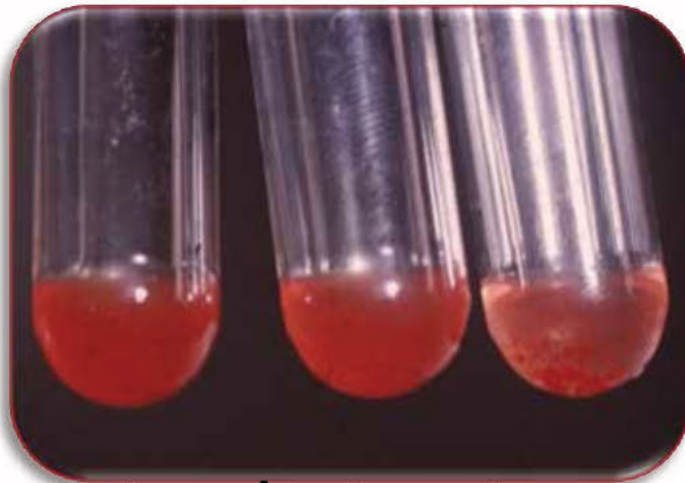
- ✧ 'A' blood given to 'A' cat
 - ✧ RBC lifespan of ~36.3 days
- ✧ 'B' blood given to 'A' cat
 - ✧ RBC lifespan of ~2.1 days
 - ✧ Can be a significant hemolytic reaction
- ✧ 'A' blood given to 'B' cat
 - ✧ RBC lifespan of ~1.3 hours
 - ✧ Fatal in many of these cats!
- ✧ 'AB' cat should be transfused with 'AB' blood but if unavailable should be transfused with 'A' type blood

Cross Matching

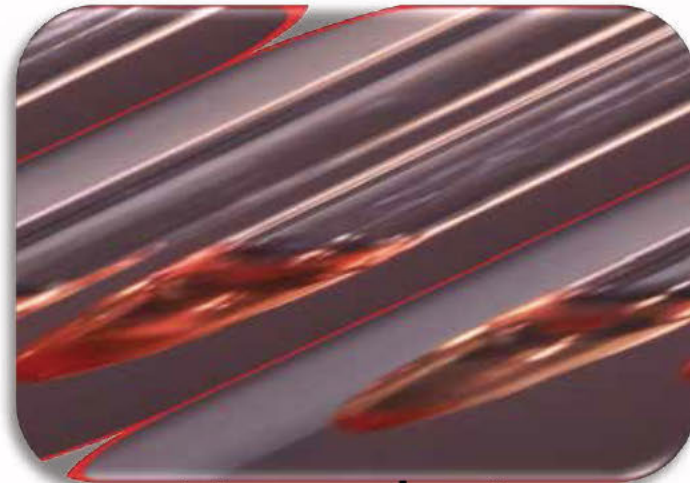
- ✧ Recommended before any RBC transfusion in any species as not all RBC antigen groups have been fully characterized
- ✧ Imperative if there is a history of exposure to RBC products
- ✧ Reasons to perform a cross match
 - ✧ Decrease the risk of transfusion reactions
 - ✧ Decrease the risk of sensitization

Cross Matching

- ✧ Major mixes donor RBCs with recipient serum
- ✧ Minor mixes recipient RBCs with donor serum
- ✧ Incompatibility is demonstrated by agglutination and or hemolysis



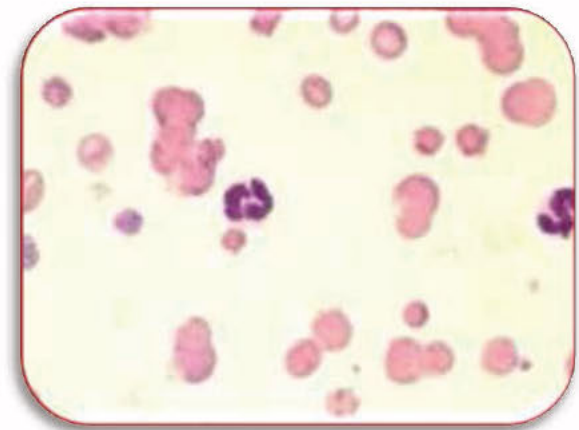
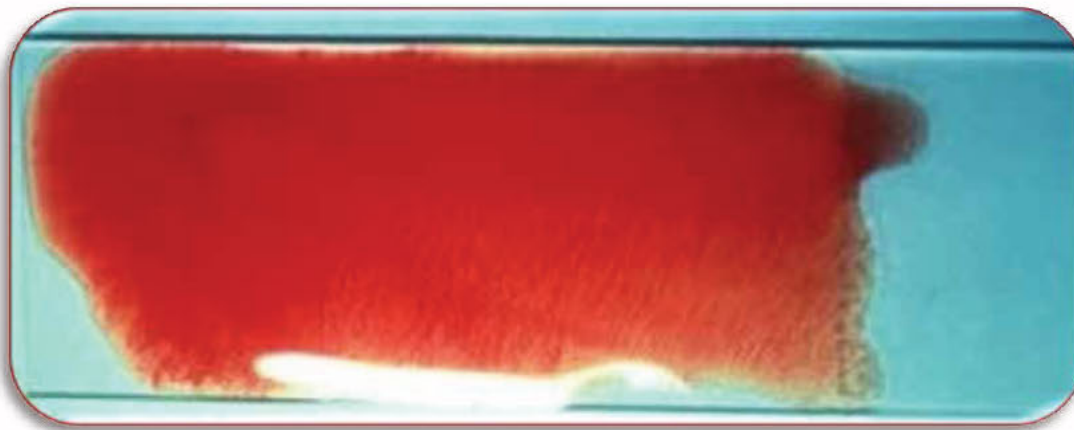
Agglutination



Hemolysis

Simple Major Crossmatch

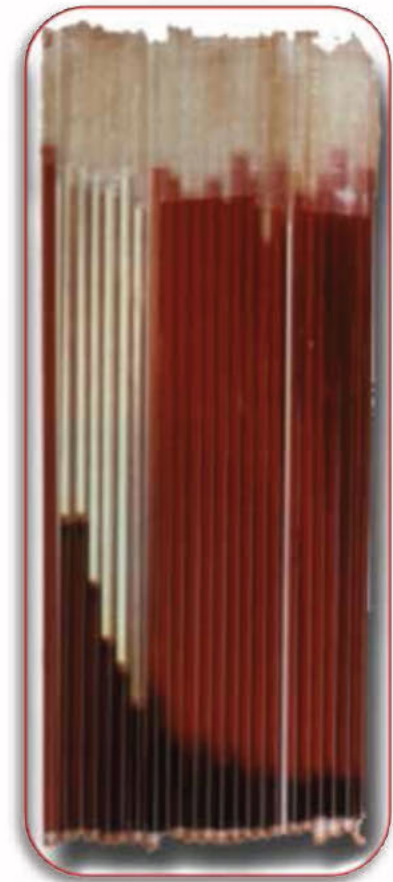
- ✧ Two drops recipient serum or plasma
- ✧ One drop donor cells – mix
- ✧ Check for agglutination and or hemolysis



Immunologic Transfusion Reactions

Acute Hemolytic Rxn

- ✧ Type II hypersensitivity – antibodies directed against RBC antigens
- ✧ Mediated by IgG, IgM, and complement
- ✧ Clinical signs
 - ✧ Agitation
 - ✧ Tachycardia
 - ✧ Tachypnea
 - ✧ Pyrexia
 - ✧ Vomiting
 - ✧ Hypotension or shock
 - ✧ Death
 - ✧ Hyperbilirubinemia, hemoglobinemia, bilirubinuria or hemoglobinuria
- ✧ Treatment
 - ✧ Stop transfusion immediately
 - ✧ IVF, supportive care, monitoring as dictated by clinical signs



Acute Febrile Non-Hemolytic Rxn

- ✧ Type II hypersensitivity – antibodies directed against donor leukocytes or platelets
- ✧ Clinical signs
 - ✧ Increase of at least 1° C body temperature with no other identifiable source of fever
 - ✧ Occurs within 30 minutes and lasts up to 20 hrs
 - ✧ Vomiting
 - ✧ Tachypnea
- ✧ Discontinue transfusion – if signs stabilize can consider restarting the transfusion at a slower rate

Acute Hypersensitivity Rxn

- ✧ Type I hypersensitivities – allergic (IgE)
- ✧ Most commonly associated with plasma transfusions
- ✧ Occur within 45 minutes of start of transfusion
- ✧ Stimulate mast cells to produce vasoactive substances
 - ✧ Urticaria
 - ✧ Pruritis
 - ✧ Facial edema
 - ✧ Rarely may result in death
- ✧ Treatment
 - ✧ Discontinue transfusion
 - ✧ Administer antihistamine (diphenhydramine 1-2 mg/kg IM)
 - ✧ Consider epinephrine if reaction is severe (0.01 mg/kg IM)



TRALI

- ✧ Transfusion related acute lung injury (TRALI)
- ✧ Rare, not documented in veterinary medicine
- ✧ Mechanisms of injury
 - ✧ Presence of antibodies in the donor plasma reactive to recipient WBC antigens
 - ✧ Production of inflammatory mediators during storage of cellular blood components
- ✧ Clinical signs
 - ✧ Acute onset of non-cardiogenic pulmonary edema
- ✧ Treatment
 - ✧ Stop transfusion
 - ✧ Supplement oxygen
 - ✧ Intermittent positive ventilation in severe cases

Delayed Rxn

- ✧ May occur in patients who develop antibodies as a result of previous transfusion
 - ✧ Delayed hemolysis
 - ✧ Thrombocytopenia (purpura)
- ✧ Neonatal isoerythrolysis
- ✧ Treatment
 - ✧ Supportive care as indicated by patient

Non-Immunologic Transfusion Reactions

Acute Non-Immunologic Rxn

- ✧ Clinical syndromes
 - ✧ Hypocalcemia
 - ✧ Embolism
 - ✧ Circulatory overload
 - ✧ Bacterial infection
 - ✧ Hyperammonemia
 - ✧ Hypothermia
 - ✧ Hemolysis secondary to physical or thermal damage to RBCs
- ✧ Treatment
 - ✧ Supportive care as indicated by patient



Delayed Non-Immunologic Rxn

- ✧ Disease transmission
- ✧ Immunosuppression

Prevention of Complications

- ✧ Blood typing and cross matching
- ✧ Use of components
- ✧ Screening of donors
- ✧ Appropriate storage and delivery of blood
- ✧ Prophylactic treatment?
 - ✧ Diphenhydramine may be indicated in patients with a previous history of type I transfusion reactions
 - ✧ Steroids – there is no scientific justification for their use
 - ✧ Do not suppress IgG or IgM
 - ✧ Do not prevent binding of IgE to mast cells

Response to Rxn

- ✧ If allergic reaction is mild and there is no evidence of hemolysis
 - ✧ Restart transfusion at slower rate and monitor closely
- ✧ If signs are severe or hemolysis is evident
 - ✧ Supportive care and treatment as indicated by clinical signs
 - ✧ Cross match recipient to a different donor
 - ✧ Save bag and administration set
 - ✧ Recheck labeling and orders to ensure appropriate specie, type, and administration protocol
 - ✧ Retype both recipient and unit
 - ✧ Consider culture of unit and re-cross matching of unit to recipient as clinical signs indicate

Administration of Blood Products

- ✧ Check that correct specie, type, and component is to be administered
- ✧ Warm gently in incubator or warm water bath at 37°C
 - ✧ Warmer temperatures
 - ✧ Destroy both stable and labile clotting factors
 - ✧ Cause fibrinogen and other proteins to precipitate
 - ✧ Destroys the ability of RBC to regain oxygen carrying capabilities
- ✧ Administer through standard blood filter (170-260µm)
- ✧ Use free gravity drip or approved peristaltic pumps
- ✧ Avoid same catheter administration of calcium containing or hypotonic fluids

Administration of Blood Products

- ✧ Stable patients
 - ✧ Initial transfusion rate of 0.25-5.0 ml/kg/hr for the first 15-30 minutes.
 - ✧ If no reaction, increase rate to deliver unit over no more than 4 hours
- ✧ Unstable or emergent patients
 - ✧ Bolus as necessary
- ✧ Monitor
 - ✧ Temperature
 - ✧ Heart rate
 - ✧ Respiratory rate and effort
 - ✧ Blood pressure
 - ✧ Vomiting
 - ✧ Urticaria, angioedema, and pruritus



Clinical Use of Blood Products

✧ Anemia

- ✧ Packed RBCs or whole blood
- ✧ Increase oxygen carrying capacity
- ✧ Transfusion trigger depends upon
 - ✧ Rapidity of onset of anemia
 - ✧ Clinical signs patient is displaying
 - ✧ Lethargy and weakness
 - ✧ Anorexia
 - ✧ Cold extremities
 - ✧ Hypothermia (cats)
 - ✧ Tachycardia
 - ✧ Pallor
 - ✧ Tachypnea
 - ✧ Strong pulse quality
 - ✧ Presence of continued RBC loss
- ✧ PCV < 15% is nearly always an indication for RBCs
- ✧ Critical illness raises the transfusion trigger (<25%)



Clinical Use of Blood Products

✧ Coagulopathy

- ✧ If concurrent anemia consider fresh whole blood
- ✧ Plasma products allow delivery of large amounts of clotting factors while minimizing risk of volume overload and sensitization to RBCs
- ✧ Congenital coagulopathy
 - ✧ von Willebrand disease – cryoprecipitate
 - ✧ Hemophilia A (factor VIII deficiency) – cryoprecipitate
 - ✧ Hemophilia B (factor IX deficiency) – cryopoor plasma
- ✧ Acquired coagulopathy
 - ✧ Vitamin K antagonism (II, VII, IX, X) – frozen plasma
 - ✧ Liver failure (all factors) – fresh frozen plasma
 - ✧ DIC (all factors) – fresh frozen plasma

Clinical Use of Blood Products

- ✧ Sepsis or SIRS – fresh frozen plasma

- ✧ All factors
- ✧ Antithrombotic proteins
- ✧ Antiproteases
- ✧ Albumin



- ✧ Hypoproteinemia (hypoalbuminemia)

- ✧ Plasma products are NOT a first-line choice in the treatment of hypoalbuminemia in a non-coagulopathic patient

Autotransfusion

- ✧ The process of collecting autologous blood after a bleeding episode
- ✧ Advantages
 - ✧ Ready source of compatible blood
 - ✧ Can be given quickly and inexpensively
 - ✧ No need to warm, type, cross match, or worry about infectious disease transmission
- ✧ Two methods
 - ✧ Simple
 - ✧ Cell saver technology

Autotransfusion

- ✧ Disadvantages to simple autotransfusion
 - ✧ Hemolysis secondary to physical damage to RBCs
 - ✧ Coagulopathy – remember clotting factors and platelets are not active
 - ✧ May contain large amounts of fibrin degradation products, RBC fragments, activated white blood cells, platelets, and inflammatory mediators
 - ✧ May initiate coagulation and exacerbate consumptive coagulopathy leading to DIC
 - ✧ Can disseminate neoplasia and bacteria

Autotransfusion

- ✧ Cell saver technology
 - ✧ Collects
 - ✧ Washes
 - ✧ Filters out free Hgb, plasma, platelets, WBCs and heparin
 - ✧ Results in autologous pRBC
- ✧ Simple autotransfusion is indicated when there is active bleeding into a major body cavity and no other sources of RBCs are available

Questions



Taughannock Falls

Michele Steffey Photography