Canine and Feline Transfusion Medicine

Gretchen Lee Schoeffler, DVM, DACVECC
Chief, Section of Emergency and Critical Care / Cornell University Hospital for Animals
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. equi)
  - Neorickettsia risticii (previously E. risticii)
  - Leishmania donvani
  - 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
   ✧ Rtype 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