Transfusion medicine is a growing field within veterinary emergency and critical care medicine. Critically ill patients and those undergoing surgical procedures often require blood component therapy for stabilization.

Canine blood groups are based on the Dog Erythrocyte Antigen (DEA) system and their blood type is determined by the antigens inherited on the surface of the RBCs. There are at least 8 internationally recognized canine blood groups, with DEA 1.1 being the most antigenically active. Commercial blood typing kits are available for DEA 1.1 testing, but are not available for the other DEA groups. Blood typing for these antigens is available through reference laboratories.

Feline blood types are based on the AB systems with cats being type A, B or AB. Cats are born with naturally occurring alloantibodies which means that type A cats are born with strong anti-B antibodies and type B cats are born with strong anti-A antibodies. Most cats in the United States are type A and the highest frequency of type B cats is reported in exotics, Devon rex, British Shorthair, and Cornish Rex.

Blood donor selection

Blood products can be purchased through veterinary blood banks or they can be obtained from in-house blood donors. Some practices will have in-house blood donors that are bled as needed while larger hospitals will typically bank blood in hospital.

Blood donors should be healthy animals with good temperaments that are up to date on vaccines and preventative care. Dogs must be between 1 - 8 years of age, weigh more than 50 pounds. Cats should be between 1 - 8 years of age and weigh more than 10 pounds. All potential blood donors will need to undergo extensive blood testing to ensure they are healthy and free of infectious diseases. In 2016 ACVIM published a consensus statement on blood donor testing. Blood screening should include a complete blood count, serum chemistry panel, heartworm testing, urinalysis and thyroid testing. Canine donors should also be tested for infectious diseases including *Anaplasma* spp., *Babesia* spp., *Bartonella* spp, *Brucella* spp, *Ehrlichia* spp., and *Mycoplasma* spp. Feline donors should be tested for *Anaplasma* spp., *Bartonella* spp, *Cyttauxzoon* spp., *Mycoplasma* spp and FELV/FIV.

Blood donors can donate up to every 4 weeks, but ideally should donate no more than every 2 - 3 months. Prior to each donation the donor should undergo a thorough physical examination and a
complete history should be obtained including any travel history or recent infectious disease exposure. A packed cell volume (PCV) or hemoglobin must also be performed. Canine donors should have a minimum PCV of 45% or Hb or 13 mg/dL and feline donors should have a PCV of at least 35% or Hb of 10 mg/dL.

**Component Therapy**

Anticoagulated whole blood can be administered directly to patients or it can be separated into various components. Today we will discuss a number of blood components but it is important to note that blood products can be further separated into individual factors. The current recommendations are to perform component therapy whenever possible.

Whole blood administered within 6 hours after collection is known as fresh whole blood. This product contains red blood cells (RBC), white blood cells (WBC), stable and labile clotting factors, albumin, immunoglobulins and platelets. If this product is refrigerated or transfused more than 6 hours after collection it becomes stored whole blood. The major difference between fresh whole blood and stored whole blood is that stored whole blood contains no viable platelets. Whole blood transfusions are most commonly administered in patients with blood loss secondary to coagulopathy, DIC, hemophilia or trauma. Whole blood transfusion are not recommended for thrombocytopenia as these platelets have a very short lifespan and a whole blood transfusion will not cause any significant increase in platelet count.

Packed red blood cells (pRBCs) are created when whole blood is centrifuged and the plasma is removed. These units contain the same amount of RBCs as whole blood but in a smaller volume. The average PCV of a canine pRBC unit is 55 - 80% and 45 - 65% for feline units. Packed RBC transfusions are indicated in anemic patients secondary to blood loss, hemolysis or lack of production. These units can be stored in a refrigerator for 35 - 45 days post collection depending on the anticoagulant used.

Plasma is the supernatant created when whole blood is centrifuged. Plasma that is removed and frozen within 8 hours of collection is called fresh frozen plasma (FFP), while plasma frozen more than 8 hours after collection or fresh frozen plasma that is over 1 year of age is considered frozen plasma (FP). Fresh frozen plasma contains all clotting factors and plasma proteins including albumin, von Willebrand’s factor (vWF) and your labile clotting factors (Factor V and VIII). Fresh frozen plasma is indicated in patients with coagulation deficiencies, including hemophilia, von Willebrand’s disease, rodenticide ingestion, liver disease and hypoalbuminemia. Frozen plasma, however, lacks your labile clotting factors and vWF, but can be used in treatment of rodenticide toxicity, hemophilia B and hypoalbuminemia.

When FFP is thawed and centrifuged it produces cryoprecipitate which contains a concentrated amount of vWF, factors VIII and XIII and fibrinogen. Cryoprecipitate is indicated in the treatment of von Willebrand’s disease, hemophilia A and dysfibrinogenemia. Cryoprecipitate can be stored up to 1 year at -18 °C.

Canine serum albumin (CSA) is a concentrated preparation of canine albumin. This product is typically purchased lyophilized (freeze dried) from a veterinary blood bank. Canine albumin is
indicated in patients with severe hypoalbuminemia (ie. postoperative septic abdomen). This product can be stored at room temperature and reconstituted as needed.

It is extremely important to ensure all blood products are properly stored. Whole blood and pRBC should be stored refrigerated, ideally in a dedicated blood banking refrigerator, between 1-6 °C. Whole blood and pRBC should be stored upright with space in between the units to allow for air circulation. The products should also be inverted every few days. Plasma and cryoprecipitate should be stored at temperatures below -18 °C. Improper storage can lead to contamination, loss of effectiveness, and transfusion reactions (see below).

Pre-transfusion Testing

Patients should be blood typed prior to receiving blood products. Commercial blood typing kits are available for the canine DEA 1.1 antigen and feline AB blood type. These tests work by detecting a visible agglutination reaction between the patient’s RBC surface antigens and known reagents in the cards/columns. Dogs that test DEA 1.1 negative should only receive DEA 1.1 negative blood. DEA 1.1 positive dogs however can receive DEA 1.1 negative or positive blood. Cats should ONLY receive type specific blood. The one exception is type AB cats who can receive type A or AB blood.

Crossmatch tests should also ideally be performed prior to any whole blood or pRBC transfusion to help prevent immune-mediated hemolytic transfusion reactions. Major crossmatches are performed with commercially available kits that utilize donor RBC and recipient serum, while minor crossmatches use donor plasma and recipient RBC. A major crossmatch should be performed in all cats and any dog that has undergone a previous blood transfusion more than 72 hours prior or those with an unknown transfusion history.

Administering a Transfusion

Prior to transfusion the units should be evaluated to ensure proper color and consistency. Whole blood and pRBC do not need to be warmed unless being given to a neonate, but plasma products will need to be thawed in a warm water bath at 37°C/98.6°F. The units should be placed in 2 sealed plastic bags to prevent water contamination when thawing.

Blood filters should be used in administration of all blood products to help prevent emboli formation. No medications should be mixed with blood products and the only fluid that should be given concurrently through the same peripheral intravenous catheter is 0.9% NaCl. Blood and blood components should be given over no more than 4 hours. If a longer transfusion is required the product should be separated and the unused portion aseptically stored in a refrigerator.

Patients need to be monitored very closely during transfusions. A baseline temperature, heart rate, pulse quality and respiratory rate should be performed prior to the transfusion. The transfusion should be stated at ¼ the initial rate and then doubled every 10-15 minutes until the final rate has been achieved. Vitals should then be checked every 5 minutes for the first 15 minutes, then every 15 minutes for the first hour and then every 30 minutes thereafter until the
transfusion is completed. Any vomiting, diarrhea, discolored urine, increase in temperature, difficulty breathing, facial swelling weakness or collapse should immediately be reported to the overseeing clinician as these can all be signs of a transfusion reaction.

Transfusion Reactions

There are a number of different transfusion reactions that can occur either immediately during or following a transfusion. The most common transfusion reaction is a febrile nonhemolytic transfusion reaction. This occurs when the temperature of a patient increases by 1 °C (1.8 °F) typically due to a leukocyte and platelet sensitivity reaction. To treat this the transfusion should be slowed or temporarily stopped and then restarted at a slower rate. Leukoreduction may help prevent these reactions. Leukoreduced blood products are available from some commercial blood banks. Other types of transfusion reactions include immune mediated hemolytic transfusion reactions, true allergic reactions (anaphylaxis), transfusion related acute lung injury (TRALI), transfusion associated sepsis, transfusion related circulatory overload (TACO) and non-immune mediated hemolysis.

Immune mediated hemolytic transfusion reactions may be the most life threatening type of transfusion reaction. This is a Type II hypersensitivity reaction (antigen/antibody mediated) where circulating recipient antibodies attack the transfused RBC. Clinically this can be seen as restlessness, gastrointestinal signs, tachycardia, hypotension, pale gums, collapse, fever, hemoglobinemia or hemoglobinuria (dark red urine). If left untreated this can lead to renal failure, disseminated intravascular coagulopathy and death. If an immune mediated transfusion reaction is suspected the transfusion should be immediately discontinued and supportive care including fluid therapy instituted. Antihistamines and steroids have not been shown to be beneficial in this type of reaction. Non-immune mediated hemolytic transfusion reactions can also occur. These reactions typically occur secondary to improper blood storage or administration leading to decreased red blood cell life span.

Transfusion related acute lung injury (TRALI) is one of the leading causes of transfusion related mortality in humans and is more commonly seen post plasma administration. Clinical signs of include an acute onset of tachypnea within 6 hours of transfusion with no signs of circulatory overload. Treatment is symptomatic (supplemental oxygen therapy with or without mechanical ventilation). This typically is a self-limiting complication that resolves within 96 hours if the patient survives.

Transfusion associated sepsis occurs when the blood products become contaminated with bacteria. Clinical signs are similar to other reactions and treatment is supportive. If this is suspected blood cultures of the transfused unit should be performed. Transfusion associated circulatory overload occurs when a patient becomes hypervolemic (fluid overloaded) following administration of blood products. Treatment is symptomatic including diuretic therapy and supplemental oxygen.

If any transfusion reaction is suspected the transfusion should be immediately stopped and the clinician informed.