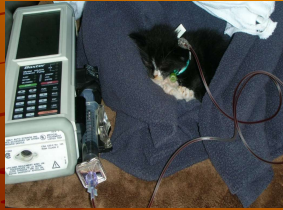
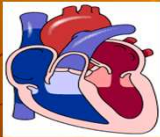


Transfusion Medicine... In the Veterinary World

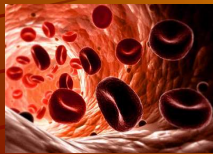


Heidi Houchen, DVM
VCA Northwest Veterinary Specialists
Critical Care Blood Bank

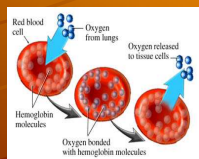
The basics of blood: what it does and where it goes...



- ✦ Pumped by the heart
- ✦ Travels throughout the body
- ✦ Delivers oxygen
- ✦ Carries away waste



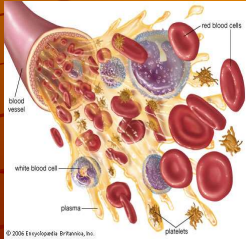
.....But there is more!



Before you hang that bag of blood or plasma...



...you need to know what is in that bag:

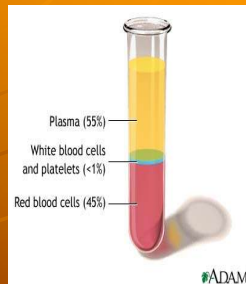
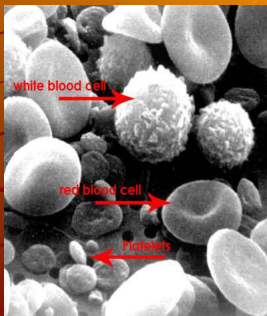


✦ What blood is:

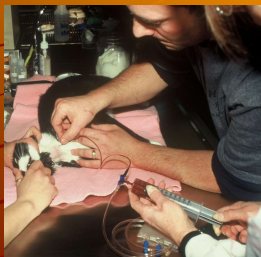
- ✦ Red blood cells
- ✦ White blood cells
- ✦ Proteins
- ✦ Platelets

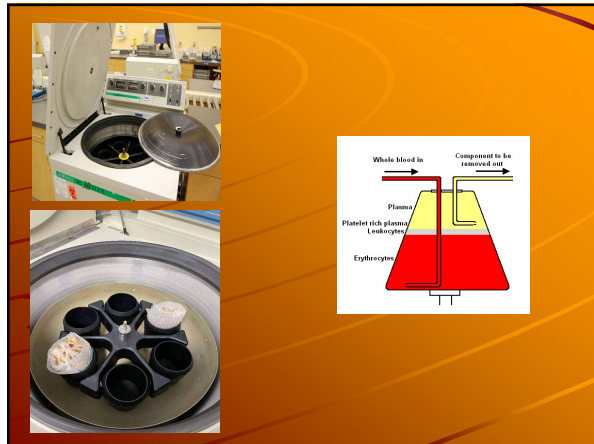
....all the good stuff

Components of **Blood**: How do you get them?



Find a pet (and an owner) with a
livesaving attitude...









Red blood cells and whole blood goes to the refrigerator..... and plasma goes to the freezer



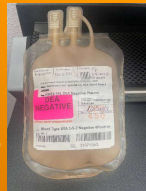
FRESH Whole Blood

- ✦ Contains:
 - ✦ RBC's
 - ✦ WBC's
 - ✦ Platelets
 - ✦ Plasma proteins
 - ✦ Some coagulation factors
- ✦ Good for:
 - ✦ Actively bleeding patients
 - ✦ Anemic patients with thrombocytopenia
- ✦ Not a long shelf life



Plasma

- ✦ Fresh Frozen Plasma:
- ✦ Lasts one year after collected.
- ✦ Contains: immunoglobulins, coagulation factors, and albumin.
- ✦ Does not contain functional platelets
- ✦ Many uses: DIC, rodenticide toxicity, hereditary coagulopathies
- ✦ Frozen Plasma:
- ✦ Contains Factors II, VII, IX, X, albumin, and immunoglobulins.
- ✦ Can be frozen and stored for 4 years.



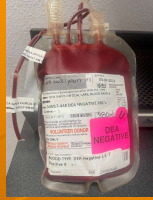
Packed Red Blood Cells: PRBC's

✦ pRBC's:

- ✦ Good for increasing RBC's in diseases of RBC destruction or lack of production.

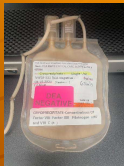
- ✦ Harvested from whole blood

- ✦ Longer shelf life



Cryoprecipitate

- ✦ Contains concentrated amounts of vWF, Factor VIII:C, Factor XIII (Fibrin stabilizing factor) and fibrinogen (Factor 1).



- ✦ Good for: vWD, hemophilia A, fibrinogen deficiency. (* Also sometimes used in the production of surgical "tissue glue").

When to Transfuse Red Blood Cell Products?

✦ Acute Hemorrhage

- Fluid resuscitate with crystalloids +/- colloids and transfuse with a red blood cell product when the PCV reaches 25-30%

✦ Chronic Anemia

- If not clinically affected, animals with chronic anemia may not require a PRBC transfusion until the PCV reaches 12-18%

✦ General Recommendation

- Transfusions are recommended if an anemic animal is showing early clinical signs and the PCV has fallen rapidly to below 20% in dogs and 15% in cats.

When to transfuse with plasma?

- ✦ The administration of plasma replenishes clotting factors and contributes to albumin levels.
- ✦ Very large amounts of plasma are required to increase serum albumin a small amount
- ✦ Plasma is most helpful in replacing clotting factors lost as a result of bleeding disorders related to genetics, toxicities, infections, trauma, or tumors.
- ✦ **Tip:** Correction of coagulopathies is the predominant indication for the usage of plasma

When to transfuse with a platelet-containing product?



- ✦ Platelets are extremely fragile, highly reactive and sensitive to temperature changes.
- ✦ It is difficult to acquire an adequate volume of platelets that will improve a patient's bleeding status; platelet transfusions are rarely given in veterinary medicine.
- ✦ Platelet transfusions are more useful in smaller animals.
- ✦ **TIP:** Platelet transfusions are for life-threatening hemorrhage in patients with thrombocytopenia or platelet dysfunction.

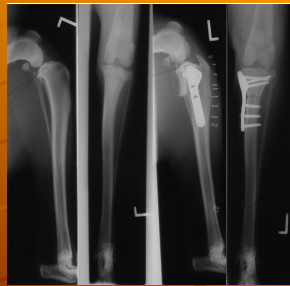
Cocker Spaniel with IMHA



Puppy with Parvovirus



vWD Doberman and Elective Surgery



Anticoagulant Rodenticide Toxicity ...



Golden Retriever and Heat Stroke/DIC

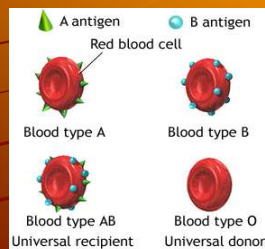


Before deciding which blood product to give...

- ✦ Fresh Whole Blood (FWB)
- ✦ Stored Whole Blood (WB)
- ✦ Packed Red Blood Cells (PRBC)
- ✦ Fresh Frozen Plasma (FFP)
- ✦ Frozen Plasma (FP)
- ✦ Cryoprecipitate (Cryo)
- ✦ Cryoprecipitate-poor Plasma (Cryo-poor)
- ✦ Platelet Concentrate or Platelet Rich Plasma (PRP)

...it is important *FIRST* to choose the right blood type...

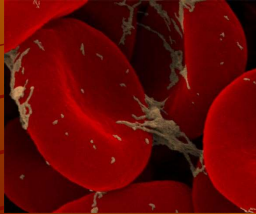
What is a "blood type" ?



✦ **DEA:** Dog erythrocyte antigens are proteins and lipids on the surface of the canine red blood cell.

✦ The presence or absence of these antigens determines a dog's blood type: at least 13 blood types are known.

How important is it that dogs get their own blood type?



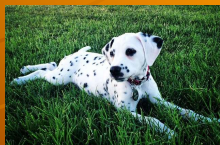
- ✦ In the past, we didn't think it was a problem. BUT...
- ✦ Dogs DO have naturally occurring antibody against DEA 3,5,7 ... AND

In the DEA 1 system...

- ✦ DEA 1 antigen-antibody interactions result in acute hemolytic transfusion reactions.
- ✦ A dog that is negative for antigens of the A system that is transfused with blood from a dog that is positive will have antibody induced.
- ✦ ALL transfusions afterwards carry the potential for being EXTREMELY DANGEROUS.

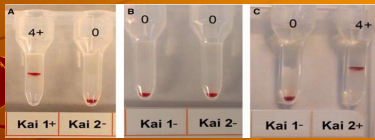
Canine *Dal* Blood Type: A Red Cell Antigen Lacking in Some Dalmatians

- ✦ Found in 2007: alloantibodies found in a Dalmation previously sensitized by a blood transfusion
- ✦ Since then: Dobermans, Beagles, Lhasas



Two NEW dog antigens found in South Korea: Named for the dog: "Kai 1" and "Kai 2"

Journal of Veterinary Internal Medicine
Open Access



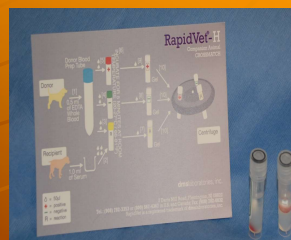
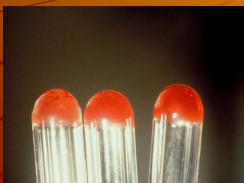
What is a Universal Donor?

- ✦ In the past, there was a more broad definition of a "universal donor"; this was any dog that was not positive for the antigens of the DEA 1 system.
- ✦ At present, "universal donor" is a dog that is negative for DEA 1, 3, 5, 7.



Beyond Typing: The Cross Match

- ✦ A cross match is a test performed to determine if there are antibodies in the patient's plasma against the red blood cells of the donor.



Cross-Matching is ESSENTIAL when:

- ✦ An animal will be receiving a transfusion 3-4 days after an initial transfusion
- ✦ An animal has been pregnant
- ✦ Unknown history



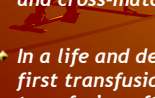
Tips on Dog Blood Types:

- ✦ The ideal transfusion is type-specific, cross-matched blood.



- ✦ Typed, unmatched first transfusions are USUALLY safe.

- ✦ If a patient requires a first blood transfusion and you are unable to type their blood, administer universal negative blood.
- ✦ If a patient requires a second (or subsequent) blood transfusion in more than 3 days from the first transfusion, a cross match **MUST** be performed -they have built up an antibody response.
- ✦ If a patient is autoagglutinating (i.e., IMHA), it is difficult and sometimes impossible to accurately interpret typing and cross-matching tests
- ✦ In a life and death emergency, an unmatched untyped first transfusion is usually safe. **HOWEVER**, every transfusion after this carries the potential risk of a hemolytic transfusion reaction



Cats: Truly a Breed Apart

- ✦ Three blood types: A, B, AB
- ✦ Type A have a low titer of anti-B antibodies
- ✦ TYPE B HAS A VERY HIGH TITER OF ANTI- A ANTIBODIES
- ✦ TYPE "A" BLOOD TO A TYPE "B" CAT:



DEATH !

What is the Most Common Cat Blood Type?

- ✦ Type A is the most common blood type for cats.
- ✦ The Northwest U.S. has a higher percentage of type B cats compared to rest of the United States --- some reports place it at 10% (or more.)

The Mik antigen

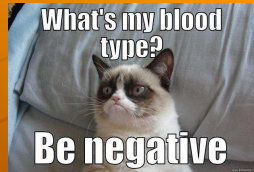
- ✦ 2007: New feline antigen reported
- ✦ Hemolytic transfusion reaction in a previously untransfused cat administered a matched AB unit of blood
- ✦ The Mik antigen (named after "Mike" the cat)
- ✦ Relevance is not entirely understood at this time
- ✦ The Mik antigen has been absent in about 6% of cats tested at this time



When it comes to Cats and Blood...

- ✦ Always blood type both the recipient and the donor - administer type-specific blood in cats. Cross-match whenever possible.
- ✦ If it is not possible to blood type the patient and the donor, then YOU MUST cross-match - even before the first donation.

Remember - THERE ARE NO UNIVERSAL DONOR CATS!



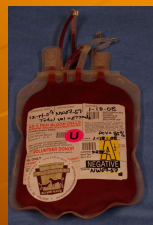
So what should we give all those patients who walk into the clinic?



Cocker Spaniel with IMHA:



**Packed Red blood Cells:
PRBC's**



Puppy with Hemophilia



Golden Retriever: Heat stroke



- ✦ Fresh Whole Blood (FWB)
- ✦ Fresh Frozen Plasma (FFP)
- ✦ LOTS!



Anticoagulant Rodenticide Toxicity



- ✦ Fresh Frozen (FFP)
- Or
- ✦ Frozen Plasma (FP)



Kitten with Flea Anemia



- ✦ Packed Red Blood Cells (PRBC)
- ✦ Whole Blood (WB)

vWF Doberman: Pre-TPLO Surgery

- ✦ Cryoprecipitate
- ✦ OR
- ✦ Fresh Frozen Plasma



✦ Whole Blood

Calculation #1

$$\text{Donor Blood (mL)} = \frac{80 \text{ (dog)}}{60 \text{ (cat)}} \times \text{BW (kg)} \times \frac{\text{Desired PCV} - \text{Recipient PCV}}{\text{PCV Transfused Blood}}$$

Calculation #2

Rules of Thumb:

2-3 mls/kg of whole blood will raise the PCV by 1%
20 mls/kg of whole blood will raise PCV 10%

Maximum recommended dose of whole blood has been published at 22ml/kg/day. However, this has been reported to be exceeded by twice without adverse effects.

◆ Packed Red Blood Cells:

Calculation #1

$$\text{Donor RBC (mL)} = 80 \text{ (dog)} \times \text{BW (kg)} \times \frac{\text{Desired PCV} - \text{Recipient PCV}}{\text{PCV Transfused Blood}}$$
 (in anticoagulant) (60 for cat)

Calculation #2
 Rules of Thumb: 1 mL/kg of PRBC's will raise the PCV 1%
 10-15 mls/kg of PRBC's will raise the PCV 10%

◆ While the target PCV for ongoing hypovolemic blood loss would be in the range of 25-30%, increasing the PCV to 20-25% in a stable anemic patient and to 20% in an immune-mediated hemolytic anemia patient would be adequate

◆ Plasma

For albumin replacement:
 ◆ Estimated Dosage: 45 mls/kg will raise the albumin 1 gm/dl.*

For clotting factor replacement:
 ◆ Estimated dosage: 10-30 mls/kg **

◆ Very large amounts of plasma are required to increase serum albumin a small amount; synthetic colloids such as hetastarch or dextran are often used in hypoalbuminemic animals for colloidal support.

◆ Clotting times should be rechecked at the end of a FFP transfusion to determine if more plasma is required.

◆ Cryoprecipitate

◆ One unit of cryoprecipitate is often derived from one unit of FFP. *Ask the blood bank where you purchase it.

◆ Estimated Dosage: One Unit of Cryoprecipitate/10 kg

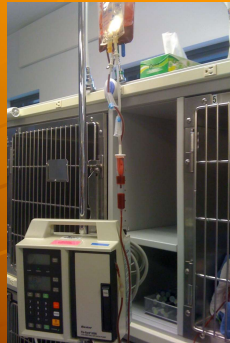
◆ *This dose is repeated Q 4-24 hours as needed until bleeding stops.

◆ If unavailable and the patient can handle a larger volume, FFP can be administered at 20 mL/kg as equivalent to one dose of cryoprecipitate.

How should a blood transfusion be set up?

- ✦ Blood should be filtered, warmed (if needed) and administered either by gravity flow or through a pump that will do no damage to the blood.
- ✦ Blood should NOT be given concurrently with LRS, hypotonic saline solutions, or dextrose-containing solutions.
- ✦ Use only 0.9% saline solution

Blood Filters and Transfusion Sets



Blood Administration Pumps



Syringe Pump Set-Up



To minimize the impact of a transfusion reaction, important to set up a transfusion properly and monitor the recipient closely while they are being given a blood product.



How fast should a blood transfusion be administered?

- ✦ Normovolemic patients:
 - 5-10 mls/kg/hour
- ✦ Severely hypovolemic patients:
 - 20mls/kg/hour
- ✦ Compromised patients:
 - 2 mls/kg/hour
- ✦ **For every transfusion, blood is administered slowly over the first 30 minute; the remainder of the transfusion is delivered over the following 1-4 hours.**

What is a transfusion reaction and what does it look like?

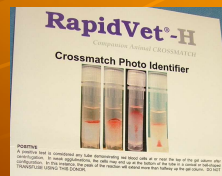
- ✦ Blood typing and cross-matching DO dramatically decrease the risk acute hemolytic transfusion reactions.
- ✦ These tests DO NOT eliminate the chance of an immediate or delayed reaction altogether.

Classification of Transfusion Reactions:

- ✦ Immediate
 - Immune versus Non-Immune
- ✦ Delayed
 - Immune versus Non-Immune


Immediate Immune-Mediated Transfusion Reaction

Hemolytic




Immune-mediated Immediate Transfusion Reactions...

- ✦ Febrile
- ✦ Urticaria
- ✦ TRALI




Immediate Non-Immune-Mediated Transfusion Reaction

- ✦ Sepsis
- ✦ Circulatory Overload
- ✦ Citrate Toxicity
- ✦ Hemolysis
- ✦ Hyperammonemia



Delayed Transfusion Reactions

- ✦ Delayed Immune Reactions
- ✦ Infectious Disease Transmission



How do I best monitor for a transfusion reaction?



Any questions before taking the transfusion "plunge"?

- ◆ Ready...
- ◆ ...set...
- ◆ ...transfuse!

