

Transfusion Medicine in Dogs and Cats
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Transfusion medicine is an important and life-saving treatment for dogs and cats in veterinary medicine. However, like anything else, it does not come without its own risks and considerations. In this talk, we will review the types of blood transfusions, proper administration of them, monitoring, and most common complications/reactions seen in dogs and cats.

1) Types of Transfusions

- a) Whole Blood (WB)
 - (1) Has all components of blood (RBC, WBC, PLT, Proteins) + anti-coagulant
- b) packed red blood cells (pRBC)
 - (1) Contains only RBC and some WBC unless leukoreduced
- c) Fresh Frozen Plasma (FFP)
 - (1) plasma that is separated from whole blood and frozen within 6 hours of collection
 - (2) Theoretically FFP contains all coagulation factors (including labile factors V and VIII), as well as von Willebrand Factor (vWF), fibrinogen, albumin, antithrombin, and macroglobulins
 - (3) Must be administered within 1 year of collection to maintain “Fresh” status
 - (4) product is still viable for transfusion after 1 year but is then called “Frozen Plasma”
- d) Frozen Plasma (FP)
 - (1) plasma that is separated from whole blood and frozen after 6 hours of collection; also any unit of FFP that remains frozen for > 1 year is considered FP
 - (2) Contains Vitamin K-dependent factors (II, VII, IX, X), albumin, globulin, macroglobulin, fibrinogen, von Willebrand Factor
 - (3) Does not contain labile Factors V and VIII
 - (4) Must be administered within 5 years of collection
- e) Platelet rich Plasma (PrP)
- f) Cryoprecipitate (CP)

2) Selection of replacement product

- a) What are you trying to replace/treat with patient
- b) What’s available/accessible
 - i) Commercial blood bank product
 - ii) In house donor program

3) Pre-Transfusion Compatibility Testing

- a) **Blood typing**
 - (1) ***DOGS: many different types***
 - (a) 13 different blood types
 - 1. DEA 1.1 +

2. DEA 1.1 negative: Can be given to Neg or Positive recipient (Universal donor)
 3. DEA 1.2 +
 4. DEA 1.1 Negative
 5. DEA 3B
 6. DEA 4C
 7. DEA 5D
 8. DEA 7Tr
- (b) Blood typing is ideal BUT not required for dogs **UNLESS** a practice carries both DEA 1.1+ and DEA 1.1- blood.
- (c) Commercially acquired DEA 1.1- blood can be transfused to any dog. **(Universal donor)**
- (2) **CATS**
- (a) **Blood types**
1. Type A (most common): receive blood product from Type A donor
 2. Type B: receive blood product from Type B donor
 3. Type AB (rare): Type A products are utilized because the anti-B antibodies present in the plasma are weaker compared to the anti-A antibodies originating from a type B donor.
 4. MIK cat (rare) and no test to screen for it, therefore crossmatch always need prior to transfusing
- (b) **Blood typing is required for all cats.**
- (c) **Transfusion of type A blood to a type B cat can be fatal.**
- (3) **Blood typing techniques**
- (a) **Blood type card:**
- (i) Canine blood typing cards contain three wells. ***The well that agglutinates tells you what type the dog is.***
 - (ii) Feline blood typing cards contain three wells (Control, A, B). ***The well that agglutinates tells you what type the cat is.***
- (b) **Lab gel test:** The immunochromatographic cartridge contains three areas linearly impregnated with anti-A antibodies, anti-B antibodies, and a control band. As singular red cells wick up the membrane, red cells agglutinate at the forming a visible line on the respective membrane. Type AB cats will have visible lines at both the A and B sites.



Example: Top line is Type A cat, middle cat is AB cat and bottom test is Type B cat

b) Crossmatching

i) Types of Crossmatch testing

- (a) Tube method (RapidVet crossmatch) – do first if test kit in stock
- (b) Rapid slide method: - do when no crossmatch kits in stock

ii) *DOGS*

- (a) If never had a transfusion of any kind before (RBC or plasma) then crossmatch ideal but NOT required in dog.
- (b) A dog MUST have a cross-match performed if he/she has had ANY type transfusion prior in their life or recently before the last 3-5 days.
- (c) Cross-matching is recommended for any dog that has a history of transfusion reaction or noted hemolysis after transfusion (within any time frame).

iii) *CATS*

- (a) A cat **SHOULD** have a cross-match performed for **any transfusion at any time.**
- (b) Cross-matching is **REQUIRED** for any cat that has received a transfusion in the past (within any time frame).

4) Proper Transfusion administration

a) Packed RBC/Whole Blood Administration Protocol

i) Preparation of Blood product

- (1) Clean/sterile technique when handling blood products.
- (2) Any bag that is opened for a specific patient must be labeled with the date and time of opening and is only good for 24 hours as long as it remains in the refrigerator.
- (3) RBC units NOT warmed unless large volume given rapidly to small dog or cold patient
- (4) Inspect unit thoroughly before giving
 - (i) Check expiration date to make sure not expired
 - (ii) Check blood type of unit to patient for compatibility.
 - (iii) Check for leaks or evidence of contamination (brown coloration, yellow/white aggregates, air bubbles)

ii) Administration technique

- (1) **All blood products should be administered using a blood filter to prevent delivery of microscopic blood/fibrin clots to patient.**
- (2) The transfusion should be administered **ALONE** through the IV line.
 - (a) If fluids must be run with the blood product, ***0.9% NaCl (normal saline) is the ONLY fluid that is compatible with blood products.***
 - (b) Lactated ringer's solution should never be administered in the same IV line or IV catheter as pRBCs because the calcium in LRS will precipitate with the citrate in the transfusion.

- (c) Blood products should be administered through a dedicated IV catheter or lumen port. If that patient requires other fluids during the transfusion, place a second catheter if feasible.
- (3) Premedication is not required but can be considered:
 - (a) Benadryl
 - (b) Corticosteroids have not been shown to reduce the risk of any transfusion reaction and have been associated with increased risk of dyspnea after transfusion.
- (4) Administration of medications during a transfusion should be avoided, if possible.
- (5) Food and water should be withheld during the transfusion as well.

(6) Feline

- (a) Syringe pump method: pRBC unit, small transfusion filter spike set, three way stopcock, extension set and 35ml syringe, syringe pump
 - (i) ***For cats AND small dogs receiving only a portion of a unit of blood the syringe pump method is recommended.***
 1. To remove blood from a bag, spike the bag with a blood transfusion set with an in-line filter.
 2. Attach a 3-way stopcock to the end of the line.
 3. Using the appropriate sized syringe, slowly withdraw the desired amount from the line. Do not apply excessive pressure to the syringe.
 4. Cap the three-way stopcock and close off to the bag.
 5. Return the opened bag and line to the refrigerator. Label the bag with a patient sticker and the date and time the bag was opened. This bag is now okay for use for 24 hours only.
 6. Attach an extension set to the syringe used in step 1. Administer the blood transfusion to the patient using a syringe pump over the appropriate time frame.
 7. A filter should **not** be used in this step. Microlines should not be used to administer the transfusion.

(7) Canine

- (a) Syringe pump method: pRBC unit, transfusion filter spike set, three way stopcock, extension set and 35-60ml syringe, syringe pump
 - (i) ***For small dogs receiving only a portion of a unit of blood or cats, the syringe pump method is recommended.***
 8. To remove blood from a bag, spike the bag with a blood transfusion set with an in-line filter.
 9. Attach a 3-way stopcock to the end of the line.
 10. Using the appropriate sized syringe, slowly withdraw the desired amount from the line. Do not apply excessive pressure to the syringe.
 11. Cap the three-way stopcock and close off to the bag.
 12. Return the opened bag and line to the refrigerator. Label the bag with a patient sticker and the date and time the bag was opened. This bag is now okay for use for 24 hours only.
 13. Attach an extension set to the syringe used in step 1. Administer the blood transfusion to the patient using a syringe pump over the appropriate time frame.

14. A filter should **not** be used in this step. Microlines should not be used to administer the transfusion.

(b) Gravity drip method: pRBC unit, transfusion filter spike set, extension set

(i) ***For any dog receiving an entire bag of blood, gravity flow is the preferred method of administration.***

1. Most blood transfusions can be safely delivered over 2-4 hours.
2. Longer transfusion times should be avoided as they may increase the risk of infection due to prolonged time at room temperature.
3. A drip rate may need to be calculated to ensure that a transfusion is administered in fewer than 4 hours.
4. ***Only a blood filter set is appropriate*** – regular fluid lines and the pediatric or micro-drip lines **should not** be used for gravity transfusions.
5. Technicians should **monitor the drip rate** and bag to ensure that the transfusion is proceeding as it should.
6. Need to know the drops/ml drip rate of fluid set. (the drip factor) and if do, can calculate the time to give

$$\frac{\text{Total volume in mL}}{\text{Time to be delivered (minutes)}} \times \text{Drip factor (drops/mL)} = \text{Drops/min}$$

For example: To deliver a single unit (120ml) over 4 hours (240 minutes)

$$\frac{120 \text{ ml}}{240 \text{ min.}} \times 10 \text{ drops/mL} = 5 \text{ drops per minute OR 1 drop every 12 seconds}$$

ii) **Monitoring blood transfusions**

- (a) TPR immediately before administration.
- (b) Then q5 minutes for first 10 minutes, then q10min for 30 minutes thereafter, then q30min until done.
- (c) Record vitals on document (anesthesia sheet or transfusion sheet template for record)
- (d) The patient should also be monitored closely for vomiting, hyperthermia, increased respiratory effort, or the development of facial edema or urticaria.

iii) **Transfusion Duration:**

- (a) Typically 3-4 hours.
 - (i) NOT longer than 4hrs to avoid bacterial growth
- (b) A faster administration rate is selected when patients are unstable and are showing immediately life-threatening signs of anemia or coagulopathy/hemorrhage.
- (c) If concerned about the risk of volume overload, the total transfusion can be split into smaller portions with each portion of the transfusion administered over < 4 hrs and the remaining/left over product stored in the refrigerator until ready for use within a 24 hr period.

iv) **Transfusion Rate**

- (a) No single guideline exists for rate

- (b) Starting infusion at a slow rate for first 15-30 min, then increase to more rapid rate
- (c) Start at 0.25-0.5ml/kg/hr for 15-30 minutes, then 2-10ml/kg/hr until completion within 4 hours

b) Plasma products

i) Preparation of product

- (1) Clean technique should be employed and ***examination gloves worn when handling ALL blood*** products
- (2) Any bag that is opened for a specific patient must be labeled with the date and time of opening. Place a patient label directly on the bag. *Once a bag is punctured, it is good for 24 hours as long as it remains in the refrigerator*
- (3) Plasma products must be completely thawed prior to administration
- (4) Thawing procedure for FP and FFP. Plasma is warmed by thawing at room temperature OR in warm environment ***no warmer than 37celcius (98.6F)*** to accelerate the thawing process.
 - (a) Remove plasma from freezer.
 - (b) Sign-out to the patient according to hospital protocol
 - (c) Place entire plasma unit (bag and box) into a sealable plastic bag
 - (d) Place the sealed plastic bag into a 2nd plastic bag and submerge in a container of room temperature water.
 - (e) ***Do NOT use hot water*** – excessive heat will denature the proteins and reduce the efficacy of the transfusion
 - (f) If your facility has a dedicated plasma warming bath, please use the warming bath to thaw all plasma products. The plasma warmer should be filled with distilled water and the temperature is set at 37 Celsius.
 - (g) ***Weighting the bag down in the water bath should not be done***, as this can lead to breakage of the plasma bag and loss of product.
 - (h) Gently agitate and massage during thawing process, which can take 30-45 minutes.
 - (i) **Do not** forcefully break up frozen pieces
 - (j) Thawed plasma (FP or FFP) can be stored for up to 96 hours in the refrigerator prior to administration. Levels of II, VII, IV, X, and fibrinogen are maintained.
 - (k) If the bag remains unopened, it can be refrozen as Frozen Plasma (even if it was FFP to start – be sure to label the product appropriately.)
 - (l) Once the bag has been penetrated by a bag spike or fluid administration set, the plasma may only be stored for 24 hours in the fridge prior to administration.
 - (m) Do not refreeze unused portions once the bag has been opened!
 - (n) Inspect unit thoroughly before giving
 - (i) Check expiration date to make sure not expired
 - (ii) Check blood type of unit to patient for compatibility.
 - (iii) Check for leaks or evidence of contamination (brown coloration, yellow/white aggregates, air bubbles)

ii) **Administration of product**

- (1) All blood products should be administered using a blood filter to prevent delivery of microscopic blood/fibrin clots to patient.
- (2) **Only a blood filter set is appropriate** – regular fluid lines and the pediatric or micro-drip lines **should not** be used for gravity transfusions
- (3) The transfusion should be administered ALONE through the IV line. Blood products should be administered through a dedicated IV catheter or lumen port.
- (4) If that patient requires other fluids during the transfusion, place a second catheter.
- (5) If fluids must be run with the blood product, **0.9% NaCl (normal saline) is the ONLY fluid that is compatible with blood products.**
- (6) Premedication is **not required** but can be considered:
 - (a) Benadryl
 - (b) Corticosteroids have not been shown to reduce the risk of any transfusion reaction and have been associated with increased risk of dyspnea after transfusion.
- (7) Administration of medications during a transfusion should be avoided, if possible.
- (8) Food and water should be withheld during the transfusion as well
- (9) **Cats/small dogs**
 - (a) **Syringe pump method is recommended.**
 - (i) To remove blood from a bag, spike the bag with a **blood transfusion set with an in-line filter.**
 - (ii) Attach a 3-way stopcock to the end of the line.
 - (iii) Using the appropriate sized syringe, slowly withdraw the desired amount from the line. Do not apply excessive pressure to the syringe.
 - (iv) Cap the three-way stopcock and close off to the bag.
 - (v) Return the opened bag and line to the refrigerator. Label the bag with a patient sticker and the date and time the bag was opened. This bag is now okay for use for 24 hours only.
 - (vi) Attach an extension set to the syringe used in step one.
 - (vii) Administer the blood transfusion to the patient using a syringe pump over the appropriate time frame.
 - (viii) A filter should **not** be used in this step. Microlines should not be used to administer the transfusion.
- (10) **Dogs**
 - (a) **Gravity flow method**
 - (i) For any dog receiving an entire bag of blood, gravity flow is the preferred method of administration.
 - (ii) Most transfusions can be safely delivered over 2-4 hours.
 - (iii) Longer transfusion times should be avoided as they may increase the risk of infection due to prolonged time at room temperature.
 - (iv) A drip rate may need to be calculated to ensure that a transfusion is administered in fewer than 4 hours.
 - (v) Technicians should **monitor the drip rate** and bag to ensure that the transfusion is proceeding as it should.

(vi) The *canine blood filter lines at Ethos hospitals deliver 10 drops/mL* (the drip factor) and the *feline blood filter lines are 20drops/ml*. In order to calculate the drip rate, use the following equation:

$$\frac{\text{Total volume in mL}}{\text{Time to be delivered (minutes)}} \times \text{Drip factor (drops/mL)} = \text{Drops/min}$$

For example: To deliver a single unit (120ml) over 4 hours (240 minutes)

$$\frac{120 \text{ ml}}{240 \text{ min.}} \times 10 \text{ drops/mL} = 5 \text{ drops per minute OR 1 drop every 12 seconds}$$

iii) Monitoring of patient

- (a) TPR immediately before administration.
- (b) Then q5 minutes for first 10 minutes, then q10min for 30 minutes thereafter, then q30min until done.
- (c) Record vitals in smart flow Transfusion sheet template for record
- (d) The patient should also be monitored closely for vomiting, hyperthermia, increased respiratory effort, or the development of facial edema or urticaria

iv) Transfusion Duration:

- (a) Typically 3-4 hours.
- (b) NOT longer than 4hrs to avoid bacterial growth
- (c) A faster administration rate is selected when patients are unstable and are showing immediately life-threatening signs of anemia or coagulopathy/hemorrhage.

v) Transfusion Rate

- (a) No single guideline exists for rate
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5) Guidelines for blood storage

a) Whole blood/Packed red blood cells

- i) Should be stored in a dedicated refrigerator with a temperature monitor and alarm.
- ii) The recommended storage temperature is (1-6oC) 34-42°F.
- iii) There are two acceptable methods for physical orientation with the refrigerator:
 - (a) Hanging – the units are hung from a rack such that air can move freely between each unit.
 - (b) Standing upright (vertically) or on the side (horizontally) – the units are propped such that air can move freely between each unit.
 - (c) The units should not touch or rest on one another.
 - (d) The flat part of the bag should be in contact with the fridge shelf.
 - (e) Stored packed red blood cells units should be briefly mixed or ‘massaged’ no more than once weekly.

- (f) The mixing should occur rapidly to avoid exposing the units to room temperature for too long. More frequent mixing has not been shown to be necessary or more beneficial.

b) Plasma products

- i) (FP and FFP) Store at or below -18 degrees Celsius
- ii) Handle frozen bags carefully as the bags are prone to breakage.
- iii) A broken bag must be discarded, as sterility has not been maintained.

6) Transfusion Reactions

a) Acute Hemolytic Reaction:

- i) Clinical findings (usually right away once starting transfusion)
 - (a) fever, vomiting, lethargy, shock (tachycardia, hypotension), tachypnea, hemolyzed serum, pigmenturia, and possibly death.
- ii) Treatment
 - (1) Stop transfusion.
 - (2) Check PCV/TS and evaluate serum or plasma for signs of hemolysis.
 - (3) Provide supportive care: IV, anti-emetics, +/- oxygen (as needed). Recheck if correct unit/type given or was crossmatched.
- iii) Prevention:
 - (1) ALL cats are blood typed AND crossmatched prior to transfusion.
 - (2) All dogs Blood typed. If dog, verify with owner no previous transfusions given. Perform crossmatch tests for ALL patients with history of transfusion more than 3 days prior.

b) Febrile Non-Hemolytic Reaction:

- i) Clinical findings
 - (a) Temp increased >1.8 degrees F above during or immediately following transfusion.
- ii) Treatment
 - (1) Slow transfusion rate. Monitor for progression of fever.
 - (2) Discontinue transfusion if dyspnea/tachypnea, hypotension or tachycardia occur
- iii) Prevention
 - (1) leukoreduction (removal of nearly all white blood cells) of blood products has reduced occurrence in human medicine.

c) Allergic Reaction:

- i) Clinical findings
 - (a) urticaria (hives), pruritus, angioedema, erythema, and/or Vomiting +/- Diarrhea. Anaphylactic shock (hypotension, tachycardia, +/- respiratory involvement) is uncommon but possible.
- ii) Treatment
 - (1) Slow or STOP the transfusion, depending on the severity of signs.
 - (2) Benadryl and/or steroid injection
 - (3) If anaphylactic shock, discontinue the transfusion immediately and give Epinephrine and aggressive supportive care.
- iii) Prevention
 - (1) Unpredictable reaction.

- (2) If patient had previous allergic reaction to plasma, then pre-medicate with an antihistamine prior to transfusion.
- d) **Transfusion-Related Acute Lung Injury (TRALI):**
- i) Clinical signs
 - (a) acute onset respiratory distress and hypoxemia within 6 hours of transfusion.
 - (b) Chest radiographs have bilateral pulmonary infiltrates without evidence of pulmonary venous distention
 - ii) Treatment
 - (1) Oxygen therapy +/- high flow or mechanical ventilation
 - iii) Prevention
 - (1) Unknown what causes in vet med
- e) **Transfusion Associated Circulatory Overload (Volume Overload):**
- i) Clinical signs:
 - (a) Similar to CHF patients (tachypnea, labored breathing, pulmonary crackles on auscultation).
 - (b) Chest radiographs: Confirm Volume overload
 - ii) Treatment
 - (1) Stop transfusion
 - (2) Oxygen therapy
 - (3) Consider diuretic (Lasix) administration
- f) **Electrolyte disturbances:**
- i) Clinical signs
 - (a) Tremors, shaking, hypotension, hypocalcemia
 - ii) Treatment
 - (1) Calcium supplementation via IV
 - iii) Prevention
 - (1) Avoid massive transfusion volumes w/ citrate based anti-coagulants
- g) **Hypothermia:**
- i) Small patients receiving large volumes of cold or room-temperature blood products at fast rates are at risk for developing hypothermia. Blood transfusions can be warmed in a warm water bath (up to ~100°F, avoiding higher temperatures to prevent protein denaturation) and the patient should be treated by providing an external heat source (Bair hugger, circulating warm water blanket).
- h) **Bacterial Contamination of Blood Products:**
- i) Prevention
 - (1) use aseptic technique
 - (2) check and strictly adhere to expiration dates,
 - (3) look for signs of contamination before starting transfusion, and administer transfusion aliquots over four hours or less.
- i) **Delayed Hemolytic Reaction:**
- i) Clinical signs
 - (a) transient fever, pigmentation of the serum or urine with bilirubin or hemoglobin.
 - ii) Treatment: no specific treatment.
 - iii) Prevention: performing crossmatch testing prior to giving the next transfusion.
- j) **Infectious Disease Transmission:**

- i) Rare if used commercial blood bank program
- ii) Infectious diseases transmitted by transfusion include (but are not limited to): FeLV, FIV, *Mycoplasma hemofelis*, Babesiosis, Bartonellosis, Ehrlichiosis, Leishmaniasis, and Brucellosis. Transmission of such diseases can be preven

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