Fresh whole blood = stored at room temperature for <8hrs

- 10mL/kg can give 10000 plts

Indications:

- Ideal PCV >30%, but if normovolemic oxygen delivery in resting animal can be maintained down to 10%

Component therapy can be considered because

- Avoids exposure of patient to unnecessary components
- Increases storage time
- One donation may then benefit more than one patient

Table 61-1 **Blood Products, Storage Guidelines, and Indications**

Blood Product	Storage	Temperature in Celsius	Indications
Fresh whole blood (FWB)	<8 hours	2 to 24	Combined red blood cell and plasma deficiency with need for platelets
FWB	<24 hours	4	Combined red blood cell and plasma deficiency without need for platelets
Stored whole blood (SWB)	28 days	4	Anemia Hypoproteinemia
pRBC	28 days	4	Anemia
Platelet rich plasma (PRP) or platelet concentrates	24 hours*	20-24	Thrombocytopenia with life-threatening bleeding
Fresh frozen plasma (FFP)	1 year	<–20 to –40	Any coagulation factor deficiencies; hypoproteinemia
Stored plasma	1 to 2 years	<–20 to –40	Hypoproteinemia
Cryoprecipitate (cryo)	1 year	<–20 to –40	von Willebrand's disease Hemophilia A (but not B) Hypofibrinogenemia
Cryoprecipitate-poor plasma (cryo-poor)	1 year	<–20 to –40	Hypoproteinemia Some coagulopathies (factors II, VII, IX, XI)

*If constantly mixed gently.

Red blood cell transfusions:

- Given for anemia related tissue hypoxia
- Healthy animals can tolerate up to 20% loss of blood volume
- Per-acute blood loss PCV may not drop for several hours until fluid shift/fluid therapy occurs
- Older pRBCS may be less safe and beneficial than fresher (<7 days) in IMHA

Fresh frozen plasma:

- Spun and frozen within 8hrs of collection
- Contains all coag factors, so used to treat hemorrhage secondary to coagulopathies
- Can be used to treat heparin and warfarin induced bleeding but so can protamine and vit K (respectively)
- Previous thought that FFP useful for
    - Pancreatitis - replace alpha macroglobulins and antiproteases
    - Parvoviruses - for antiparvo antibodies
- No evidence for these
- Effect on COP is minimal at clinically used doses
- Slightly higher doses are needed for vWD and hemophiliacs than rodenticides (15-30mL/kg)
- Frozen (not fresh) only has II, VII, IX, X (the non-labile factors) and albumin, not the anticoagulants or labile coag factors
    - V and VIII are the labile

Other blood products

- Cryoprecipitate
    - Made by freezing FFP then slow thaw
    - Fibrinogen, fibronectin, factor VIII, vWf
    - Preferred for hemophelia A or vWD

Original Study

Journal of Veterinary Emergency and Critical Care **27**(6) 2017, pp 638–644
doi: 10.1111/vec.12671

Comparison of albumin, colloid osmotic pressure, von Willebrand factor, and coagulation factors in canine cryopoor plasma, cryoprecipitate, and fresh frozen plasma

Table 1: Mean levels and standard error or median and 95% confidence interval *median and 95% confidence interval* for each plasma product

	FFP	CPP	CRYO	Reference range
Fibrinogen (g/L)	*1.19* (*0.98–1.40*)*,†	0.53 (0.05)‡	*3.46* (*2.65–4.27*)	1.00–3.84
Factor II (%)	*120.33* (*109.1–131.6*)	123.22 (8.29)	110.56 (8.38)	50–150%
Factor V (%)	113.63 (3.83)	118.00 (5.08)	88.3 (4.57)†,‡	50–150%
Factor VII (%)	118.8 (6.51)	101.75 (11.57)	116.2 (8.29)	50–150%
Factor VIII (%)	86 (7.98)*,†	22.2 (2.37)‡	427 (95.4)	50–150%
Factor IX (%)	84.7 (5.92)	67.9 (2.96)*,‡	131.9 (21.87)	50–150%
Factor X (%)	145 (13.4)	121.8 (10.9)	125 (11.5)	80–175%
vWf (%)	130.7 (6.12)*,†	22.5 (1.88)‡	504.7 (41.39)	70–180%
COP (mm Hg)	12.73 (0.31)*,†	14.5 (0.65)‡	9.8 (0.74)	20–25
Albumin (g/L)	28.9 (0.5)*,†	31.7 (0.6)‡	23.1 (1.3)	31–43

- Liophilized platelets/PRP/platelet concentrate
    - Used for life threatening hemorrhage in thrombocytopenia
    - Fresh PRP/concentrate is just from spinning
    - Frozen concdentrate generally collected by apheresis then stabilized with DMSO
        - Reduces half life and recovery of platelets compared to fresh
    - Lyophilized have mild aldehyde cross-linking
- Cryoprecipirate-poor plasma (cryosupernatant)
    - Hypoproteinmia
    - Coagulopathies (II, VII, IX, X)
- Leukocyte transfusions are not done as only have a half life of hours

Blood typing

- Blood type = genetic marker on erythrocyte surfaces
    - Species specific
    - Antigenic in individuals without the same markers, developing *alloantibodies*
- Even a small volume (1mL) of incompatible blood can cause life threatening immune reactions
- Recommend to type: all patients before receiving blood, all donors, all breeding queens (type B can get neonatal isoerythrolysis)

Dog blood types:

- More than a dozen DEAs exist
    - Independently inherited so can have multiple different antigens present on RBCs
    - DEA 1.1, 1.2 and 1.3 also exist

        - If dea 1.2 or 1.3 positive will develop antibodies if transfused with 1.1 pos, so should always get 1.1 neg
    - 2 can no longer be identified as no longer have commercially available antibody
    - 3 is rare, more seen in greyhounds, Japanese dogs
        - 20% 3 negative dogs can have natural anti 3 antibodies -> delayed reaction
    - 4 98% positive, no natural antibodies
    - 5 rare, natural antibodies in 10% -> delayed reaction
    - 7 is actually a circulating antigen that attached to RBCs in passing
        - Approx. 50% of dogs positive
        - 20-40% of neg have natural anti 7 -> delayed reaction

Antigen	Frequency	Natural antibodies?	Reaction if Abs
DEA 1.1	45%	<2%	Acute severe
DEA 2	Can no longer be identified		
DEA 3	6% (greyhounds, Japanese)	15-20%	delayed
DEA 4	98%	rare	
DEA 5	10-15%	8-12%	delayed
DEA 6	100%		
DEA 7	40-55%	10-40%	delayed

- DEA 1.1 most important as can cause severe reaction after sensitization
    - Other transfusion reactions are rarely described
    - DEA 4, Dal (in Dalmatians) have been reported
- Dogs are either DEA 1.1 negative, or to varying degrees 1.1 positive
- No important alloantibody sources prior to transfusion in dogs (pregnancy nto shown to be important)
- Different methods
    - Simple cards with monoclonal antibody may have false positives if autoagglut, or false negatives if only mild agglut
    - Alvedia immnochromatographic strip
        - Only reliable method for persistent agglutination
    - Abaxis has cartridge with automatic reader but seems less accurate
- Typing sera also exist for DEA 3, 4 and 7, others will need crossmatch
- In bitches neonatal isoerythrolysis does not occur unless previous transfusion with missmatched blood
- Dal has high frequency, except in Dalmatians
    - If alloantibodies are present then can have severe reactions
    - Dal- dogs were identified mostly in Dalmatians (15/128; 11.7%), Doberman Pinschers (183/432; 42.4%), and Shih Tzus (12/21; 57.1%)

- Some discrepancies between blood type cards vs strips vs lab
    - For donors always send to lab
    - For recipients if you have to choose between high false negative and high false positive choose false negative (that way positive dogs may get negative blood but negative dogs wont get positive blood)

Feline blood types:

- Main blood group system is AB, consists of A, B and AB
  - A is dominant over B; only homozygous B will express B antigens
  - Only AB if there is a rare 3rd allele
  - Ragdolls more commonly have AB than other breed
  - Cats with a genotype A/A, A/ab, or A/b are type A, whereas only cats with b/b are type B. Rare AB cats are genotypically ab/ab or ab/b
- Frequency of A and B depends on breed and geographics
  - All Siamese type A
  - US 97% A, but an AMC study showed 6% B
- Cats have naturally occurring alloantibodies
  - Type B kittens get anti A alloantibodies through colostrum of queen
  - Can get neonatal isoerythrolysis when A or AB cats born to B queens
  - Type A cats have weak anti B alloantibodies (low titre) if present
    - Transfusion reactions when A get B blood are partially due to the A alloantibody in B blood
    - Do not have NI
  - Type AB cats don't have alloantibodies
    - Recommended that they get type A blood if cant get AB as will have less alloantibodies
    - Washed/pRBCs better
- Additional blood groups have been identified
  - Some DSHs have Mik antigen
    - Mik negative cats may have naturally acquired alloantibodies
- Immunochromatographic strips (Alvedia) are the only reliable in house test
  - All B and AB cats should be confirmed at lab

Crossmatching:

- Recommended in dogs when:
  - Unknown transfusion history
  - Reaction to first transfusion
  - >7d post first transfusion (this is longer than I thought…)
  - Donor DEA 7 status unknown
  - Not needed for previously pregnant
- Recommended in all cats where possible because
  - miK reactions can be fatal
  - typing is not 100% accurate
- Looks for presence or absence of alloantibodies without determining blood type
- Major = patient plasma against donor cells
- Minor = donor plasma against patient cells
  - Less important as minimal plasma in pRBCs
  - Still do for B donors because of how many A antibodies they have
- Autoagglutination or hemoglobinemia may preclude some methods of testing
  - Washing RBCs 3 times with saline may help
  - Gel methods fine
- Can mix drop of donor blood to drop of recipient plasma to rule out strong incompatibilities
- Manual technique remains gold standard but is time consuming

Retrospective Study

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Influence of cross-match on posttransfusion packed cell volume in feline packed red blood cell transfusion

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Abstract

Objective – To evaluate the influence of major cross-match on transfusion efficacy based on the change in PCV following packed red blood cell (pRBC) administration in cats.
Design – Retrospective study from January 2000 to December 2010.
Setting – University Teaching Hospital.
Animals – Two hundred nine cats received 233 type-specific pRBC transfusions as treatment for anemia. Forty-three transfusions were cross-match compatible and 190 were not screened with cross-match.
Interventions – Pretransfusion major cross-match.
Measurements and Main Results – Signalment, body weight, dosage of pRBC transfusion, pretransfusion PCV, posttransfusion PCV, IV fluid volumes administered between the measurement of the pretransfusion PCV and posttransfusion PCV, time delay between pretransfusion PCV measurement and transfusion administration, time between administration of transfusion and posttransfusion PCV measurement, and major cross-match testing data were extracted from the medical records of cats receiving pRBC transfusions and were evaluated for their influence on posttransfusion PCV scaled to dose of pRBC administered. The mean pretransfusion PCV was significantly lower for cross-match compatible transfusions (13.7 ± 4.2%) compared to noncross-matched transfusions (16.1 ± 4.5%; independent samples *t*-test, $P < 0.0001$). The PCV increase posttransfusion scaled by dose was significantly greater for cross-match compatible transfusions (1.02 ± 0.51%/mL/kg) than for noncross-matched transfusions (0.74 ± 0.65%/mL/kg; independent samples *t*-test, $P = 0.0093$). Of age, dose of pRBCs, cross-match status, reason for transfusion, pretransfusion PCV, and dose of IV fluids administered between the pretransfusion and posttransfusion PCV, only pRBC dose, cross-match status, and pretransfusion PCV were independent predictors of change in PCV with transfusion on multiple regression analysis (coefficient = 0.507, $P < 0.0001$; coefficient = 1.64, $P = 0.041$; coefficient = –0.235, $P = 0.0009$, respectively).
Conclusions – In this retrospective study, administration of type-specific, cross-match compatible pRBC transfusions resulted in significantly greater increases in the posttransfusion PCV when compared to administration of typed, noncross-matched pRBCs. Future prospective studies evaluating the effect of cross-match on transfusion efficacy in cats are warranted.

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STANDARD ARTICLE

Prevalence of naturally occurring non-AB blood type incompatibilities in cats and influence of crossmatch on transfusion outcomes

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Background: Recognition of the feline red blood cell (RBC) antigen *Mik* and the presence of naturally occurring anti-*Mik* antibodies resulting in acute hemolytic transfusion reactions prompted the recommendation to perform a crossmatch before a cat's first RBC transfusion, but this guideline has not yet become a standard practice.

Objective: To determine the prevalence of naturally occurring non-AB alloantibodies detectable by tube crossmatch, and to compare transfusion outcomes in cats with and without a crossmatch performed.

Animals: Three hundred cats that received an RBC transfusion, with or without a major crossmatch performed.

Methods: Retrospective study.

Results: Major crossmatch incompatibilities were documented in 23 of 154 transfusion-naive cats (14.9%) and in 15 of 55 previously transfused cats (27%; $P = 0.042$). Type-specific packed RBCs (pRBCs) were administered to 167 and 82 cats with and without a crossmatch, respectively. Median volume of pRBCs administered during the first transfusion was 5.3 mL/kg (range, 2.4-18 mL/kg). Median change in PCV scaled to dose of pRBCs was +0.8%/mL/kg; administration of crossmatch-compatible pRBCs was not associated with a greater increase in PCV. Febrile transfusion reactions occurred more often in cats that received non-crossmatched (10.1%) compared to crossmatched (2.5%) pRBCs ($P = 0.022$). Seventy-six percent of cats that received pRBC transfusions survived to hospital discharge. A crossmatch was not associated with improved survival to discharge or at 30 or 60 days posttransfusion.

Conclusions and Clinical Importance: The prevalence of naturally occurring non-AB incompatibilities is sufficiently high to justify the recommendation to perform a crossmatch before all (including the first) RBC transfusions in cats.

Box 1
Crossmatching technique

1. Obtain blood in both ethylenediamine tetraacetic acid (EDTA) tube (purple top) and in a nonadditive tube (red top) from both donor and recipient. If using a stored RBC unit, use one of the provided tags and empty the sample into a red-top tube to spin.
2. Centrifuge and separate plasma and serum from the RBCs. Save the removed serum in a separate tube. Discard the plasma from the EDTA tube.
3. Wash the RBCs from the EDTA tube (purple top).
   a. Place the RBC in a second tube 12 × 75 mm and fill three-quarters full with saline.
   b. Centrifuge for 1 minute, decant the saline, and repeat 3 times, removing the supernatant the last time.
4. Resuspend the cells to make a 2% to 4% solution (0.2 mL of blood in 4.8 mL of saline gives a 4% solution).
5. Label tubes to make the following mixtures:
   a. Major crossmatch: 2 drops patient serum with 1 drop donor RBC suspension
   b. Minor crossmatch: 1 drop patient RBC suspension with 2 drops donor serum
   c. Control: 1 drop patient RBC suspension with 1 drop patient serum
6. Incubate for 15 to 30 minutes at 37°C.
7. Centrifuge for 15 seconds.
8. Interpretation of results:
   a. If either hemolysis or hemagglutination is seen macroscopically, or if agglutination is seen microscopically, the donor is not a good match

Modified from Lanevschi A, Wardrop KJ. Principles of transfusion medicine in small animals. Can Vet J 2001;42:447–54.

Blood donors and sources:

- *Autologous transfusion*
  - donation of blood by patient from 4wks to a few days before surgery if expecting significant blood loss
  - Can also collect immediately before, and dilute blood with crystalloid
- *Autotransfusion* - another form of autologous
  - Not to be done if effusion is >1hr old, contaminated, or malignant
- Dogs should weigh 23kg to donate 450mL
  - 15-22mL/kg whole blood per kg every 4-6wks
- cats 4kg to donate 40mL
  - 10-12mL/kg
  - Previous pregnancy ok
  - Strictly indoor
- should be:
  - calm in nature (aim to have donation done in 10mins with minimal restraint)
    - avoid donors that need sedation

- No prior transfusions
- Healthy, UTD
- Not on meds apart from preventatives
- labs and fecal every 6-12months
    - Additional tests depends on location etc but may include:
        - Dogs: microfilaria, Brucella, Babesia, Ehrlichia, Anaplasma, Bartonella, Mycolasma, Leishamania
            - Lyme and RMSF testing not recommended, positive for borellia does not mean needs to be excluded from donor pool as risk of transmission very low
        - Cats: FeLV, FIV, bartonella, mycoplasma
            - Not toxo, coronavirus
        - ACVIM consensus guidelines 2016
        - HW cannot be transmitted by microfiaria in blood, but can interfere with testing and cause spread to further vectors
        - When assessing which screening tests to perform, it is important to evaluate whether the diseases included are transmitted in blood, are present in asymptomatic donors, are geographically appropriate, and whether the test specificity and sensitivity for pertinent infectious diseases is acceptable
- Good diet +/- oral iron supplements
- PCV should be >40 in dogs, 30% in cats

- Dog "universal" donor = negative for DEA 1.1, DEA 1.2, DEA 3, DEA 5, and DEA 7, and positive for DEA 4

Standard Article
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Factors Affecting Platelet Concentration in Platelet Concentrates from Canine Blood Donors

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Background: Physiologic factors in dogs that might contribute to enhanced platelet yield in platelet concentrates (PCs) are largely unknown.

Objective: To determine whether individual differences in weight, age, preprocessing blood chemistry, and CBC variables predict the final platelet concentrations in PCs. Our hypotheses were (1) increased lipemic indices would be positively associated with increased platelet concentrations in PCs and (2) increased preprocessing platelet concentrations would be associated with higher platelet concentrations in the PCs.

Animals: All blood donation records of dogs from February 2, 2009 through April 1, 2015 at the University of California—Davis Veterinary Blood Bank were examined with 104 cases included in this study.

Methods: In this retrospective study, data were collected from medical records of canine blood donors. Records were reviewed for internal consistency and accuracy and subjects were included in the study if donor screening and donation occurred on the same day and a viable PC was obtained. Univariate and multivariable regressions were used to test the impact that each variable had on the final platelet concentration in PCs.

Results: Final platelet concentration in PCs was positively associated with the predonation CBC platelet values ($P < .001$), lipemic index ($P = .01$), and phosphorous levels ($P = .001$). Collectively these 3 variables explained 29% of the variance in platelet concentrations in PCs.

Conclusions and clinical importance: Future prospective studies are required to determine if canine blood donations from dogs with lipemia yield PCs with higher platelet concentrations without negatively affecting other blood components.

Key words: Dog; Lipemic index; Thrombocyte; Transfusion.

Blood collection

- Some donors (AKA cats) need sedation
    - Avoid sedatives like ace that interfere with plt function or cause hypotension
- Collect from jugular via gravity or from vacuum pump
- Citrate-phosphate-dextrose-adenine (CPD-A1)
- In cats/tiny dogs can use 9mL blood, 1mL anticoag in syringe and use 3way stop cock into blood bag
    - This is open system though so risk of contamination
    - If collected this way do not store for more than 48hrs
- Max blood volume 20mL/kg dogs, 10mL/kg cats
- Fluid replacements not generally needed
- Can get blood components by centrifugation within 9hrsof collection
    - Best done when blood collection bag has satellite transfer containers for sterility
    - Keep cells/FWB at 4C, plasma products at -20C
        - Too hot -> bacterial growth
        - Too cold -> freezer induced hemolysis
- Storage of pRBCs results in
    - Reduction in 2,3-DPG
    - Accumulation of ammonia
- Partially used bags should be used within 24hrs
- Leukocyte reduction filters may be used at collection to reduce febrile reactions to white cell components

Retrospective Study

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Retrospective evaluation of unexpected events during collection of blood donations performed with and without sedation in cats (2010–2013)

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- More movement and anxiety in unsedated donors but considered minor

Xenotransfusion

- Consider in emergency when unable to get type-matched blood
- Clinical improvement was seen despite the very short life span of transfused cells
    - Cleared within 4 days
    - Hemolytic reactions
    - Suggestive that cats have naturally occurring anti-DEA antibodies
- Fatal reactions occur when a second transfusion is given after 7–8 days

Autologous transfusion

- Minimizes risk of reaction
- Minimizes risk of disease transmission
- Maximizes RBC lifespan
- Cell salvage
    - From surgical sites or drains

- Cell salvage machines pump the collected blood from a reservoir into a centrifugation bowl where dense RBCs are separated from plasma proteins and lighter cellular elements
- RBCs are then washed and suspended in 0.9% saline
- may then administered to the patient immediately or stored for administration within 6 h of collection
- better than standard auto transfusion as gets rid of contaminants