Principles of Transfusion Medicine

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Introduction

- Blood group systems
  - Canine
  - Feline
- Blood typing
- Crossmatching
- Component therapy
- Transfusion administration
- Recognition and treatment of transfusion reactions
Canine Blood Group System

- No naturally occurring alloantibodies
- Dog Erythrocyte Antigen – 7 types
- DEA 1
  - Clinically most important
- DEA 1.1*
  - Most antigenic type
  - Used for typing purposes
  - Positive and negative
Canine Blood Group System

- DEA 1 negative
  - 55% of dogs
  - Often considered ‘universal’ donor in animals *that have never been transfused*
  - Least immunogenic/antigenic - more appropriate term

- DEA 1 positive
  - Can be given to a negative dog
  - May not see acute reaction
  - Will decrease RBC survival time
Canine Blood Group System

- DEA 4 positive
  - 99% of dogs are positive
  - ‘Universal’ if negative for all antigens except DEA 4
  - Only 15% of canine population would qualify

- DAL group
  - Can induce a reaction
Feline Blood Group System

- Naturally occurring alloantibodies
- AB blood group system
  - Type A (95%)—a/a, a/b, a/ab
    - Most common to DSH/DLH in USA
    - Dominant over types B and AB
  - Type B (5%)—b/b
    - Most common in exotic shorthair, Cornish and Devon rex
    - More common in Europe/Australia
  - Type AB (<1%)—ab/b
    - Rare - Ragdolls?
Feline Blood Group System

- Type A
  - 20% have weak anti-B antibodies
- Type B
  - 100% have strong anti-A antibodies
- Type AB – rare
  - No naturally occurring alloantibodies
  - IF AB blood is not available, use type A
- Mik group
  - positive vs negative or Mik vs non-Mik
Neonatal Isoerythrolysis (NI)

- Hemolytic Reaction
- Cats
  - Fading kitten syndrome
  - \((B)\) queen \(+\) \((A)\) tom \(=\) \((A)\) kittens
  - Anti-A transferred to kittens via colostrum
- Dogs
  - Results from incompatible transfusions
  - Sensitized \((-)\) female \(+\) \((+)\) male \(=\) \((+)\) puppies
  - Anti-(+) transferred to puppies via colostrum
Blood type determination
Blood type determination
Crossmatching

- Compatibility of donor and recipient
- Incompatibility results in autoagglutination and hemolysis
  - Do not transfuse
  - Find an appropriate donor

http://www.cdha.nshealth.ca/pathology-laboratory-medicine/clinical-chemistry/hemolysis
Crossmatching

- **Major Crossmatch**
  - Donor RBC’s with recipient plasma
  - Most important

- **Minor Crossmatch**
  - Donor plasma with recipient RBC’s
Crossmatching

- Cats
  - Ideally should be recommended in all transfusions
- Dogs
  - ≥ 4 days since initial transfusion
  - History of transfusion reaction
  - Breeding animal
  - Transfusion history unknown
Crossmatch - gel kit

![Images showing positive and negative results for agglutination]

Positive for agglutination

Negative for agglutination
Crossmatch - manual

- EDTA tube from recipient and possible donor(s)
- Centrifuge at 1000 x 9 for 5 minutes
- Remove plasma from each sample with clean pipette
  - Transfer to no-additive RTT and label – put aside
- Wash RBCs 3 times with saline solution
- Re-suspend to make 3 – 5% RBC solution
  - 1 drop RBC: 20 drops saline = 5%
Crossmatch - manual

- Prepare for each donor 3 tubes labeled with Major, Minor, and Recipient control.
- Add to each tube 2 parts of plasma and 1 part of RBC suspension
  - Major BCM: recipient plasma + donor cells
  - Minor BCM: donor plasma + recipient cells
- Recipient control: recipient plasma + recipient cells
- Gently mix and incubate for 15 minutes
Crossmatch - manual

- Centrifuge for 15 sec. at 1000 x 9
- Examine supernatant for hemolysis
- Gently resuspend button of cells by tapping tube with a finger and examine for macroscopic agglutination
- Transfer a small amount onto a glass slide and examine for microscopic agglutination
Crossmatch - slide

- Major BCM
  - 2 drops recipient plasma + 1 drop donor EDTA blood
- Minor BCM
  - 2 drops donor plasma + 1 drop recipient EDTA blood
- Emergency
  - 1 drop donor + 1 drop recipient
Product Storage

- Blood
  - 1 to 6°C/34 to 43°F
  - Hung with space in-between units - diffusion
- Frozen Plasma
  - Below -18°C/0°F
  - Stored as far away from the door as possible
  - No automatic defrost cycle
- Blood bank/blood product refrigerator/freezer, or a designated area in a quality unit
- Away from medications/chemicals
- No not store blood in refrigerator drawers
# Blood Products

<table>
<thead>
<tr>
<th>Blood Product</th>
<th>Storage</th>
<th>Clotting Factors</th>
<th>Functional Platelets</th>
<th>Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh Whole Blood</td>
<td>&lt; 8 hours</td>
<td>Yes</td>
<td>Yes</td>
<td>Acute hemorrhage, DIC</td>
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<tr>
<td>Stored Whole Blood</td>
<td>28-35 days</td>
<td>No</td>
<td>No</td>
<td>Anemia, hypoproteinemia</td>
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<tr>
<td>pRBC</td>
<td>28-35 days</td>
<td>No</td>
<td>No</td>
<td>Anemia</td>
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<tr>
<td>Fresh Frozen Plasma (FFP)</td>
<td>1 year</td>
<td>Yes</td>
<td>No</td>
<td>Coag factor deficiencies, hypoproteinemia</td>
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<tr>
<td>Frozen Plasma</td>
<td>4-5 years</td>
<td>II, VII, X</td>
<td>No</td>
<td>Many coagulopathies/hemostatic disorders, hypoproteinemia</td>
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<tr>
<td>Cryoprecipitate (CRYO)</td>
<td>1 year</td>
<td>VIII, vWf, fibrinogen</td>
<td>No</td>
<td>vonWillebrand, Hemophilia A, hyposfibrinogenemia</td>
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<tr>
<td>Cryoprecipitate-poor plasma (CRYO-poor)</td>
<td>1 year</td>
<td>Yes; except VIII, vWf, XIII, and fibrinogen</td>
<td>No</td>
<td>Hypoproteinemia, some coagulopathies</td>
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<tr>
<td>Platelet rich plasma</td>
<td>24 hours</td>
<td>Yes</td>
<td>Yes</td>
<td>Thrombocytopenia w/ hemorrhage</td>
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</table>
Blood product administration

- Aseptic technique imperative
- Warming blood prior to administration is unnecessary
- Avoid giving blood products through anything smaller than a 22 gauge IV catheter
- Avoid pressure bagging unless *absolutely* necessary
- All blood products should be administered via blood administration set/filter
Blood product administration

- Avoid using any supplies (line, filter) beyond 4 hours due to risk for contamination
- The filter chamber should be completely filled
- Only 0.9% NaCl should be administered in the same line with blood
- Only use a fluid pump specifically approved for blood transfusion by the manufacturer
- Hemonate filters – 50-60mL
Blood product administration

- It is unnecessary to dilute pRBC prior to administration
- Avoid feeding or administering any other medication at the same time
- Pre-treatment is not recommended
Blood product administration

- Are fluid pumps and syringe pumps reasonable in dogs?
- Autotransfusion returned via gravity, syringe pump + 18μm filter, or peristaltic fluid pump
- Circulating cells 24 hours after transfusion
  - Fluid pump 4/8 subjects
  - Syringe pump 1/7 subjects – completely gone at day 7
  - Gravity fed group 8/8
- Average half life was 43 days

Blood product administration

- Are syringe pumps reasonable in cats?
- Autotransfusion returned via gravity or syringe pump + 18μm filter
- Circulating cells 12 hours after transfusion
  - Syringe pump 6/6 subjects
  - Gravity fed group 5/5 subjects
- Average half life was 23 days

Calculating Drip Rates

- Divide unit volume by 4 to get ml/hr?
- Alternatively, can start slower and increase rate
- \# of mL/hr x 10 drops/ml = drops/hour
- Drops/hour 60 minute/hour = drops/minute
- Drops/min 60 second/min = drops/second
\[
\frac{\text{ml}}{\text{hr}} \times \frac{10 \text{ drops}}{\text{ml}} \times \frac{1 \text{ hour}}{60 \text{ min}} \times \frac{1 \text{ minute}}{60 \text{ sec}} = \frac{\# \times 10}{3600} \]

Drops per second
### Patient Monitoring

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<th>Parameter</th>
<th>0</th>
<th>15 min</th>
<th>30 min</th>
<th>45 min</th>
<th>1 hr</th>
<th>2 hr</th>
<th>3 hr</th>
<th>4 hr</th>
<th>5 hr</th>
<th>6 hr</th>
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<td>Rate (mL/hr or drop/sec)</td>
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Transfusion reactions may include vomiting, increase in heart rate or temperature, diarrhea, angioedema, hypotension, or collapse. Notify clinician immediately in the event of a possible transfusion reaction.
If a reaction is suspected

- Stop the transfusion – record volume and rate of transfusion
- Notify clinician
- Double check patient is getting correct blood type/product
- Examine patient and donor unit for hemolysis
- Crossmatch a pre- and post-transfusion sample
- Blood cultures
- Pigtail PCR or culture
## Transfusion Reactions

### Immunologic
- Immune mediated hemolysis
- Febrile nonhemolytic reactions
- Allergic reactions

### Non-immunologic
- Transfusion-associated sepsis
- Transfusion-associated circulatory overload
- Nonimmune-mediated hemolysis
Immune-Mediated Hemolysis

- An acute reaction
- Severity depends on number of RBC’s destroyed
- Clinical signs include:
  - Fever, restlessness, vomiting
- Will also lead to:
  - Hypotension
  - Hemoglobinemia/hemoglobinuria
  - Acute renal failure
- Stop the transfusion and resuscitate
Febrile non-hemolytic reactions

- Increase in body temperature greater than 1°C (1.8°F) that can’t be blamed on another reaction

- Treatment
  - Slow or stop the transfusion
  - NSAID? Steroids?
  - Diphenhydramine?
Allergic reactions

- Anywhere from hives, anaphylaxis, and death
- Usually afebrile reaction
- Stop transfusion and give diphenhydramine
- Restart if signs resolve
  - Respiratory signs
  - Hypotension
  - GI Signs

ABORT!
Non-immunologic Reactions

- Sepsis (or other disease)
  - Contamination
- TACO - Transfusion-associated circulatory overload
- TRALI – Transfusion related acute lung injury
- Hemolyzed samples
  - Improper storage
  - Warming blood
  - Mechanical damage
- Hypocalcemia
- Hypothermia
- Coagulopathy
Delayed transfusion reactions

- No clinical signs during the transfusion
- PCV markedly decreases
  - 3-5 days or 1-3 weeks post-transfusion
Delayed transfusion reactions

- Due to:
  - Low levels of recipient antibodies against donor antigen – may be caught with cross-match
    - After transfusion, these antibodies go into production and destroy transfused cells
  - The transfusion itself induces new antibody production
    - Won’t pick up on cross-match
    - Culprit antibodies not present pre-transfusion
Conclusion

• Highly skilled and knowledgeable veterinary technicians are indispensable to patient care!
• Monitor transfusion patients closely
• Know how to recognize a reaction, be able to tell the difference, and know what to do
• Transfusions are not straightforward. Risks and benefits must be weighed with every patient.
References

- Wells RJ. Transfusion Medicine. Western Veterinary Conference. 2012.