

Getting Your Fill on Fluids

Amber Hart, RVT, VTS (ECC)



Fluid Therapy Compartments

Total Body Water: 50-70%		
Intracellular Water (30-40%)	Extracellular Water (16-20%)	
	Interstitial (16%)	Plasma (4%)

*Not drawn to scale



Types of Fluids

Crystalloids

Lipids

Colloids

Blood
Products



Routes of Administration

Multiple routes available; need to factor in multiple patient considerations (i.e. patient status [lab work, previous/current/continued losses, etc.], percent dehydration, osmolality of fluid, etc.)

- Intravenous (IV)
- Intraosseous (IO)
- Subcutaneous (SC)



Dehydration/Hypovolemia/Hypotension

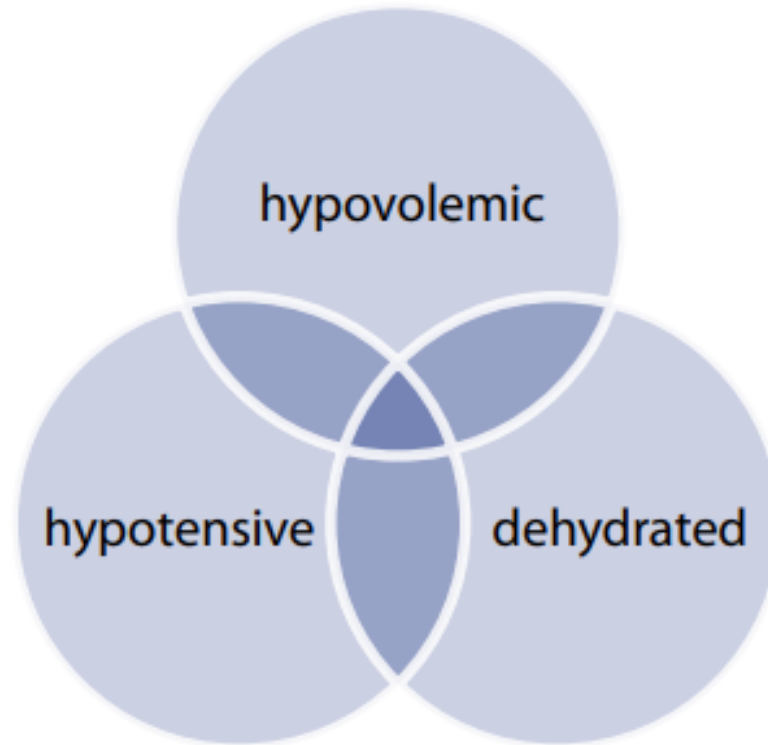
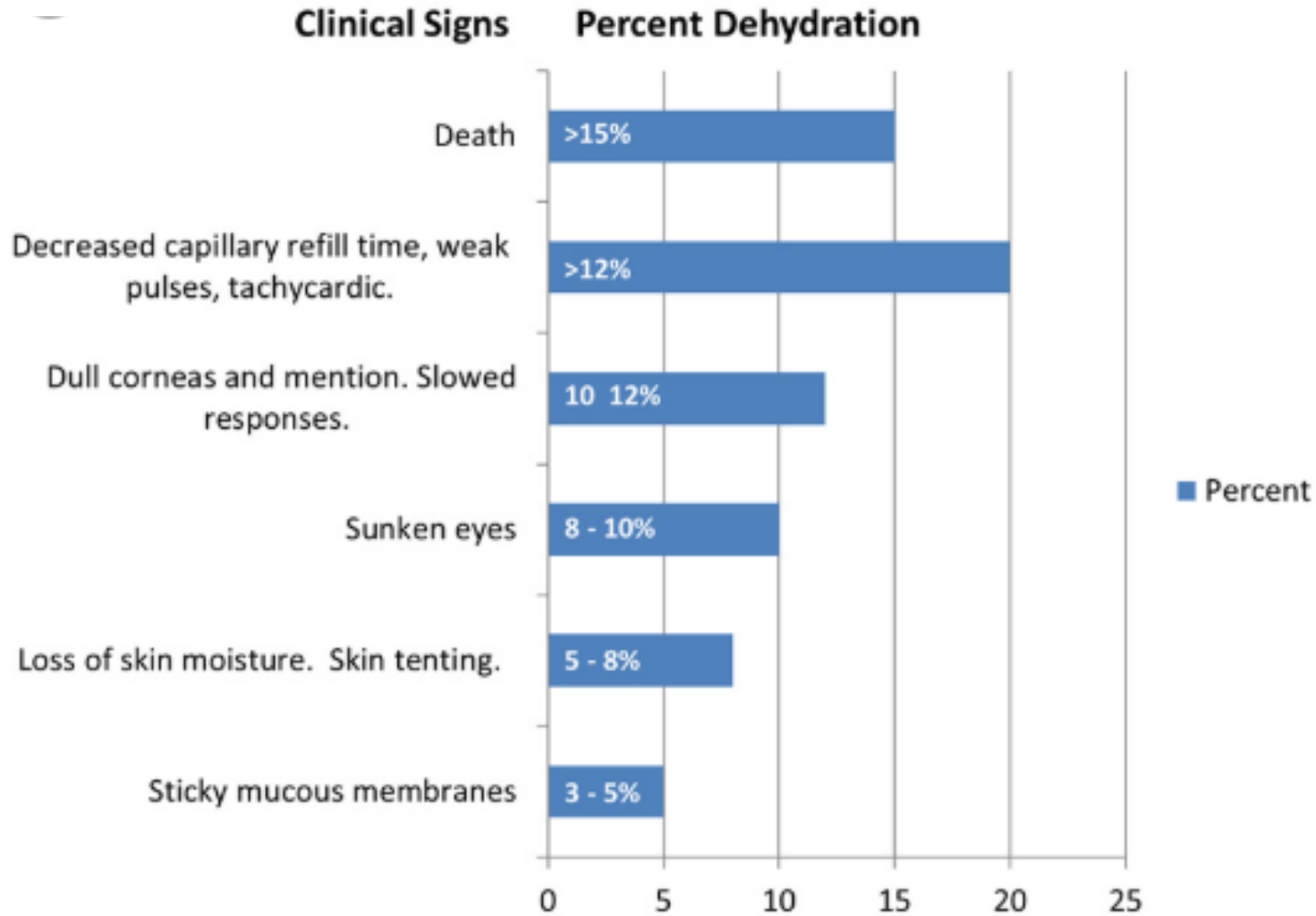


FIGURE 1

Patients may be hypovolemic, dehydrated, hypotensive, or a combination of all three.

Hydration Assessment



Fluid Overload

- Can be caused by the disease affecting the patient or iatrogenic causes
- Patient monitoring should include observing for symptoms
 - Peripheral edema
 - Coughing
 - Increased respiratory rate and/or effort
 - Serous nasal discharge
 - Vomiting or diarrhea
 - Pulmonary edema or pleural effusion

*Treatment focuses on discontinuing fluid therapy and managing symptoms



Patient Monitoring

Fluids are a drug
Don't set it and forget it!

- Consider use volumetric pumps +/- burettes



Patient Monitoring

- Vital parameter monitoring
 - Skin tent/Skin Turgor
 - Moisture of Mucous Membrane
 - Pulse Rate and Quality
 - Mucous Membrane Color and Refill Time
 - Body temperature
 - Blood pressure
 - Body weight
- Serial electrolyte and lab work monitoring
- Urine output (UOP): 1-2 mL/kg/hr

**Frequent
Re-assessments!**

Crystalloids



Crystalloids

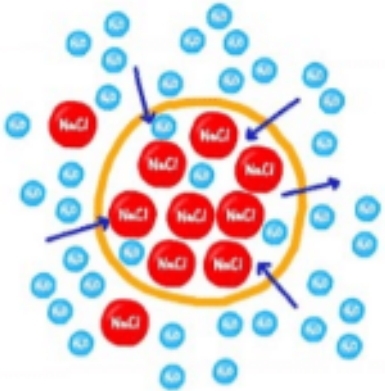
- Contains small solutes
- The effect and shifting of the fluids is driven by the tonicity
- The various crystalloids are categorized by their tonicity

Hypotonic
Hypertonic
Isotonic



Hypotonic Crystalloids

- Have a lower concentration of dissolved solutes than blood
 - This causes rapid shifts to the intracellular space
- Good for treating intracellular dehydration or hypernatremia
- Continued use will cause cerebral edema or worsening hypovolemia/hypotension

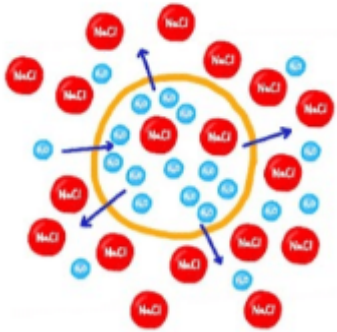


0.45% Sodium Chloride
2.5% Dextrose in Water



Hypertonic Crystalloids

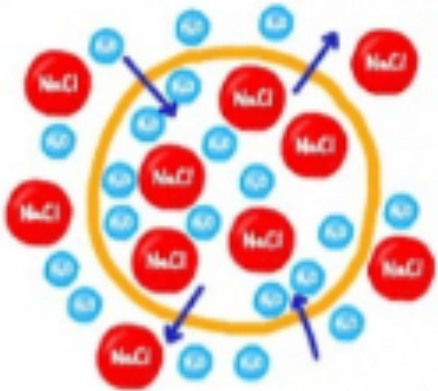
- Have a higher concentration of dissolved solutes than blood
 - Causes shift from interstitial to intravascular space
- Good for treating head trauma and intracranial pressure; improves cardiac function (decreasing afterload and increasing pre-load)
- Dosing should be slow to prevent hypernatremia and hypotension from acute hyperosmolarity
- Can cause phlebitis particularly to peripheral veins



3 to 7.5% Sodium Chloride

Isotonic Crystalloids

- The same concentration of solutes to blood
- This is most commonly used due to rapid redistribution
 - only 25-35% remains in vascular space in 20 min



Plasma-lyte
Normosol-R
Lactated Ringer's Solution
0.9% Sodium Chloride
5% Dextrose in Water



Isotonic Fluid Types and Components

FLUID TYPE	COMPONENT (unit)							BUFFER(S)
	pH	Sodium (mEq/L)	Chloride (mEq/L)	Potassium (mEq/L)	Magnesium (mEq/L)	Calcium (mEq/L)	Osmolarity (mOsm/L)	
0.9% Saline	5.5	154	154	0	0	0	308	None
0.45% Saline	5.6	77	77	0	0	0	154	None
Plasmalyte A	7.4	140	98	5	3	0	294	Acetate (27 mEq/L) Gluconate (23 mEq/L)
Plasmalyte 56	5.0	40	40	13	3	0	363	None
Normosol-R	7.4	140	98	5	3	0	294	Acetate (27 mEq/L) Gluconate (23 mEq/L)
Normosol-M	5.0	40	40	13	3	363	363	Acetate (16 mEq/L)
Lactated Ringer's solution (LRS)	6.5	130	109	4	0	2.7	273	Lactate (28 mEq/L)



Dosing of Crystalloids

Isotonic

- Maintenance dose is 60ml/kg/day
- Shock dose is 90ml/kg/day dogs; 40ml/kg/day cats
 - Given in $\frac{1}{4}$ dose aliquots

Hypertonic

- 4ml/kg slow bolus

Hypotonic

- dose is relative to sodium levels



Colloids



What is a Colloid?

Colloids are a large molecules substance suspended in a second substance that do not separate out over time

- Aerosols (liquid particles in a gas medium)



- Foams (gas particles in a liquid medium)



- Solid Foams (gas particles in a solid medium)



Colloids in Veterinary Medicine

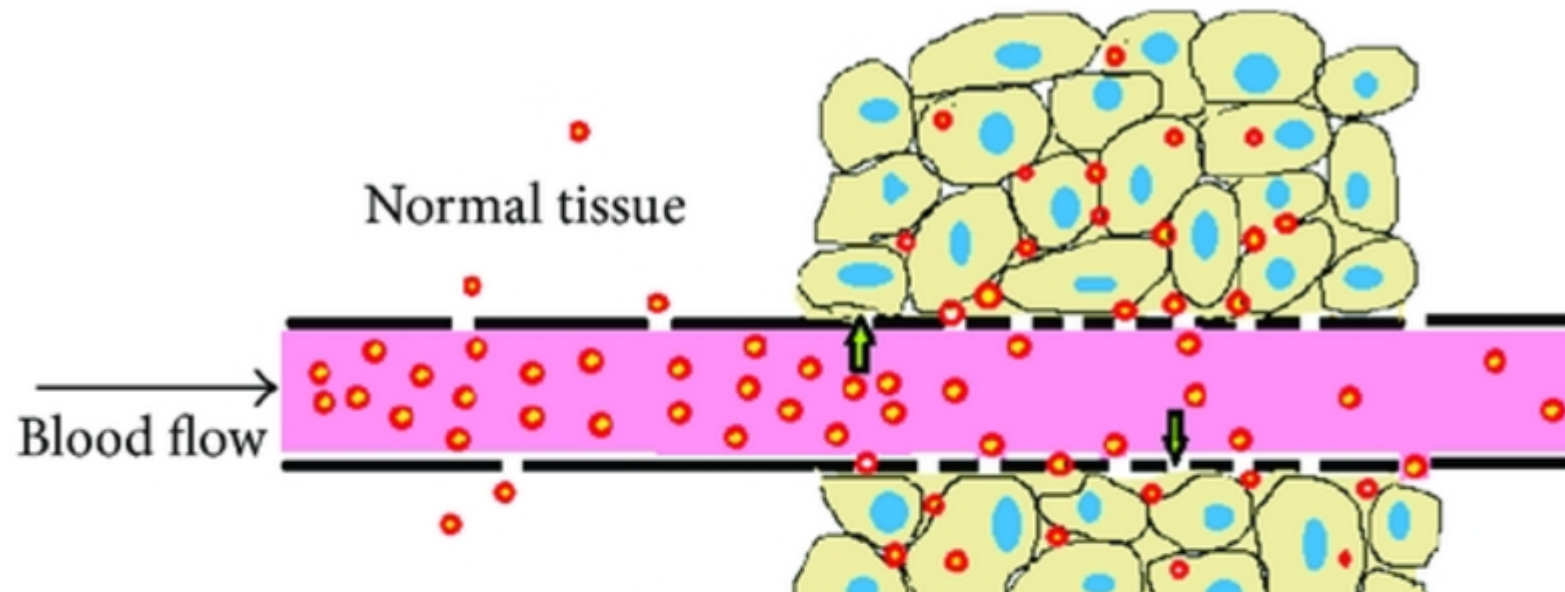
- Found naturally in the body as plasma proteins
 - Albumin
 - Globulin
 - Fibrinogen
- Blood products (that's next)
- Also can be manufactured (synthetic)
 - Dextran
 - Hydroxyethyl starch solutions (HES)
 - Hetastarch, Vetstarch



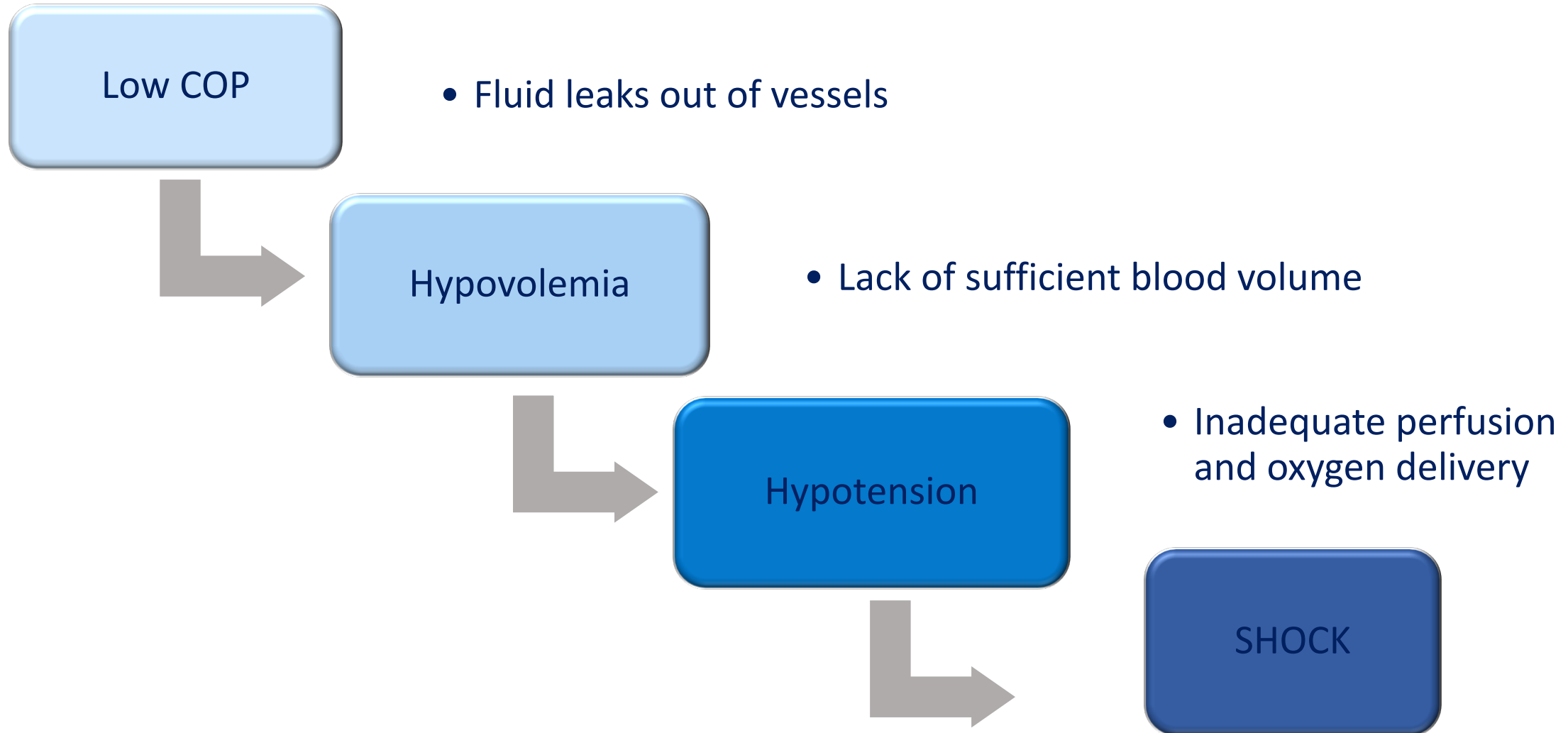
Colloid Osmotic Pressure

Due to the large molecule size in these fluids, they do not move through vascular membranes easily, but they pull water into the blood vessels; improving Colloid Osmotic Pressure (COP)

- COP is the intravascular pressure exerted by the plasma proteins



Why Colloids are Important



Indications for Colloid Therapy

- Can be used for rapid volume expansion in conjunction with crystalloid fluid therapy to treat hypotension and hypovolemia
- Can be used for volume expansion when large volume infusions are not appropriate to the patient (co-morbidities including cardiac disease)
- Can be used when there is increased intravascular permeability (from hypoalbuminemia) to reduce edema from third spacing of fluids



Administration of Colloids

- Always given IV
- Synthetic colloids are cheap and store well

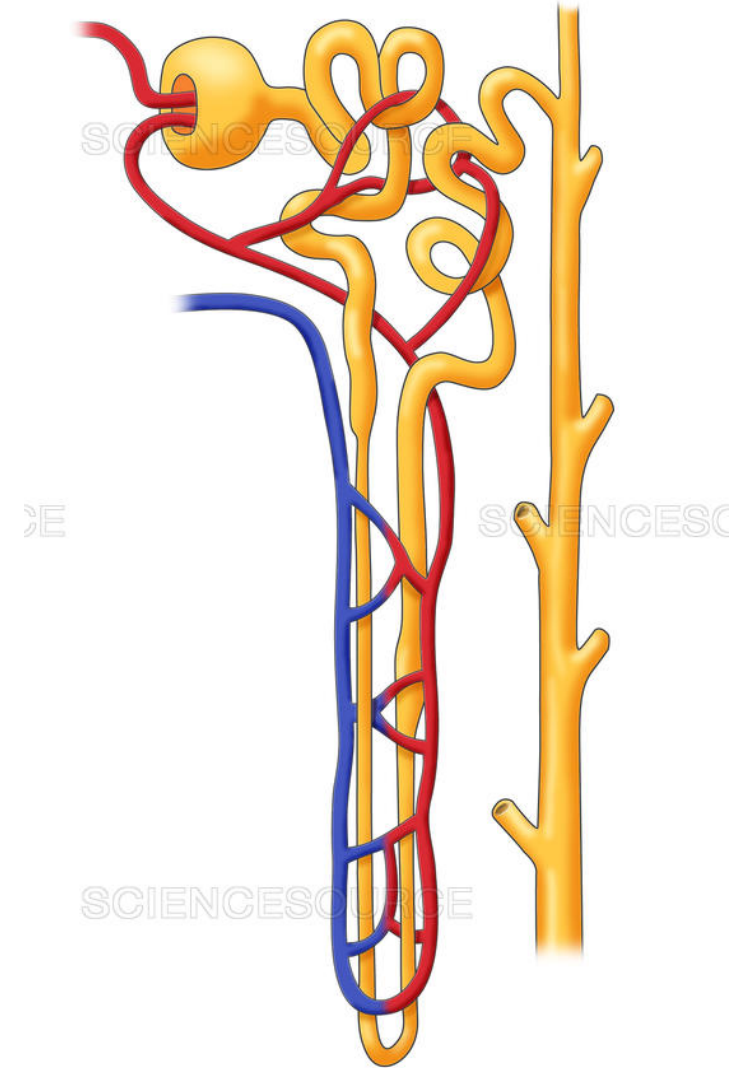
Dose dependent on product

- Bolus
 - Used to treat shock and emergency cases
- Constant Rate Infusion
 - Used in the hypoproteinemic patients (presumed low COP) in conjunction with crystalloids



Cons to Synthetic Colloids

- Potential for fluid overload
- Risk for anaphylaxis
 - Seen with dextran products
- Negative effects on coagulation
 - Affects platelet function
- Risk for acute kidney injury
 - Documented in humans



Blood Products



Fresh Whole Blood

Contains

- All components

Concerns

- Volume overload

Shelf Life

- Good for 8 hours at room temperature
- Refrigerate till used
- If stored whole blood – pulled and stored for 28 days



When to Use Whole Blood

- With the availability of other products, it has fallen out of favor
- Hemorrhage with coagulopathy is a consideration



Do NOT use in chronic anemia patients as they have compensated for vascular volume loss

Packed Red Blood Cells (pRBC)

Contains

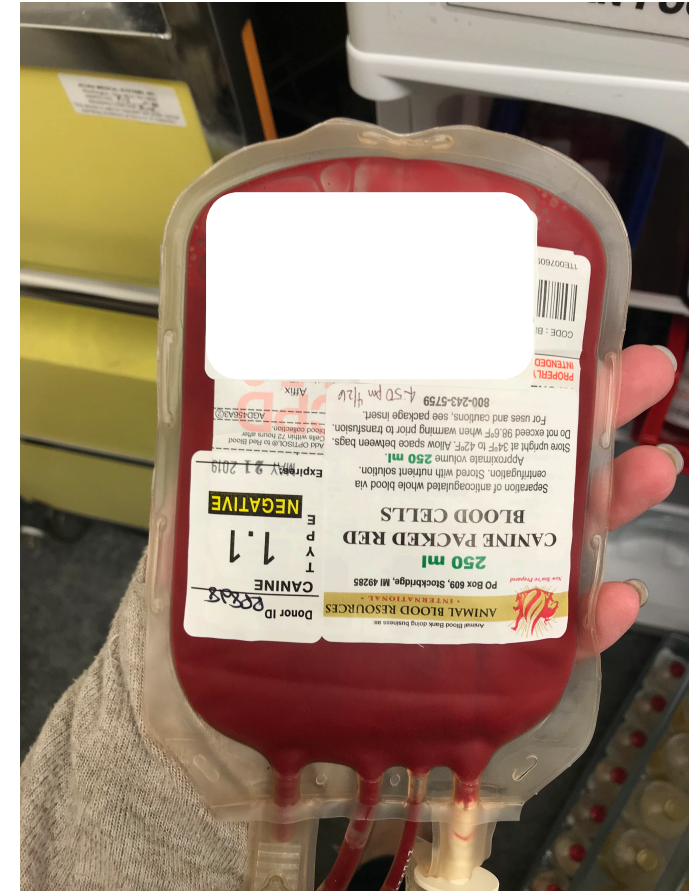
- Red blood cells

Concerns

- Only has one component, so therapy can be limited

Shelf Life

- Good for 28 days refrigerated



When to Use pRBC

Used with a decreased circulatory mass (lack of RBC)



Blood loss

- Surgical
- Traumatic hemorrhage

Increased RBC destruction

- Immune mediated diseases
- Toxicities

Decreased RBC production

- Nutritional deficiencies
- Bone marrow suppression

Fresh Frozen Plasma & Frozen Plasma

Contains

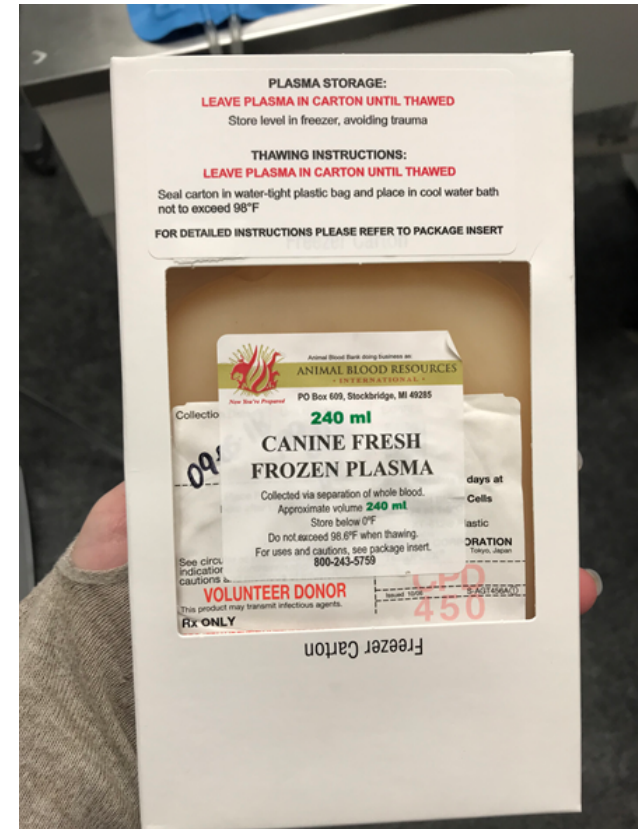
- All coagulation factors (only in FFP)
 - FP only contains Vitamin K Factors
- Albumin (small volume)

Concerns

- Volume overload
- Expensive source of albumin
- Expensive for volume needed

Shelf life

- 1 year fresh frozen
- Then becomes frozen plasma for 2 years



When to Use Plasma



Fresh frozen plasma

- Coagulopathies involving any factors
- Hypoproteinemia
- Parvovirus
- PLE
- Burns

Frozen plasma

- Coagulopathies (Vitamin K dependent)
- All the above listed problems

*Contains very little albumin, and should not be used for supplementing that value



Cyroprecipitate

Contains

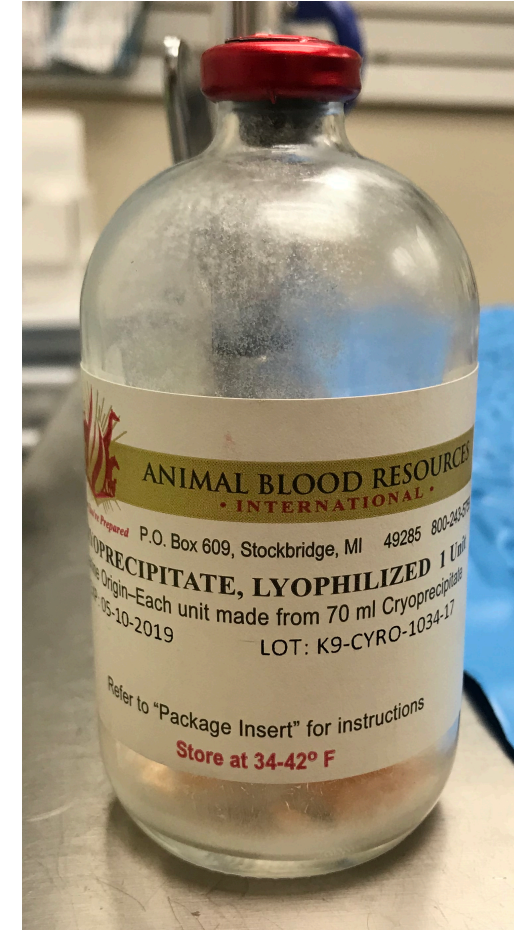
- Von Willebrand factor
- factor VIII (hemophilia A) and V
- fibrinogen

Concern

- Cost
- Need large volume

Shelf Life

- 1 year frozen

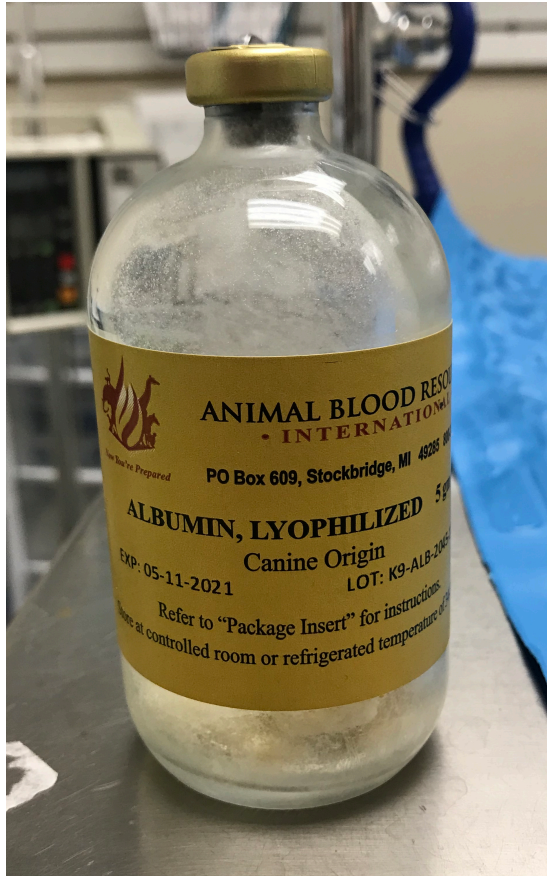


When to Use Cryoprecipitate



- Von Willebrand's Disease
- Hemophilia A
- Fibrinogen deficiency

Albumin



Contains

- Albumin (Human or Canine)

Concerns

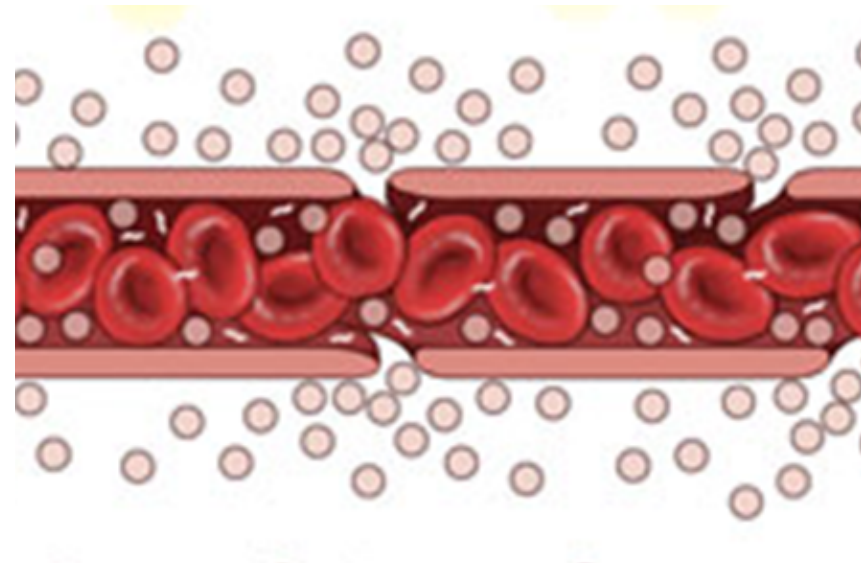
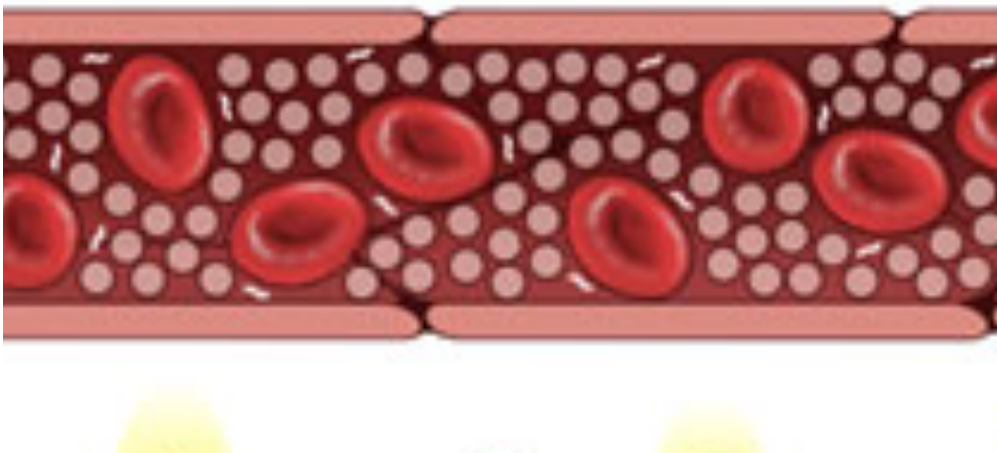
- Can only receive human infusion once
 - Develop antibodies after 5 days
- Intense immunologic reactions
- Expensive (human is less)

Shelf Life

- 2 years for canine in refrigerator
- 2 years for human shelf stable

When to Use Albumin

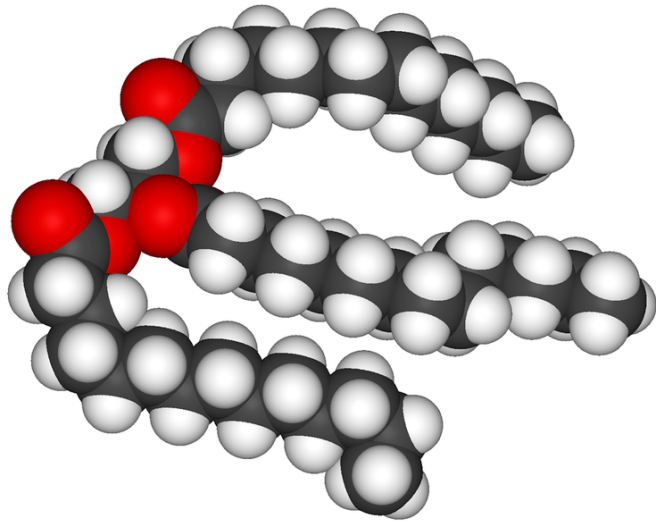
- Use when patient is hypoproteinemic



Lipids



Fats in the body

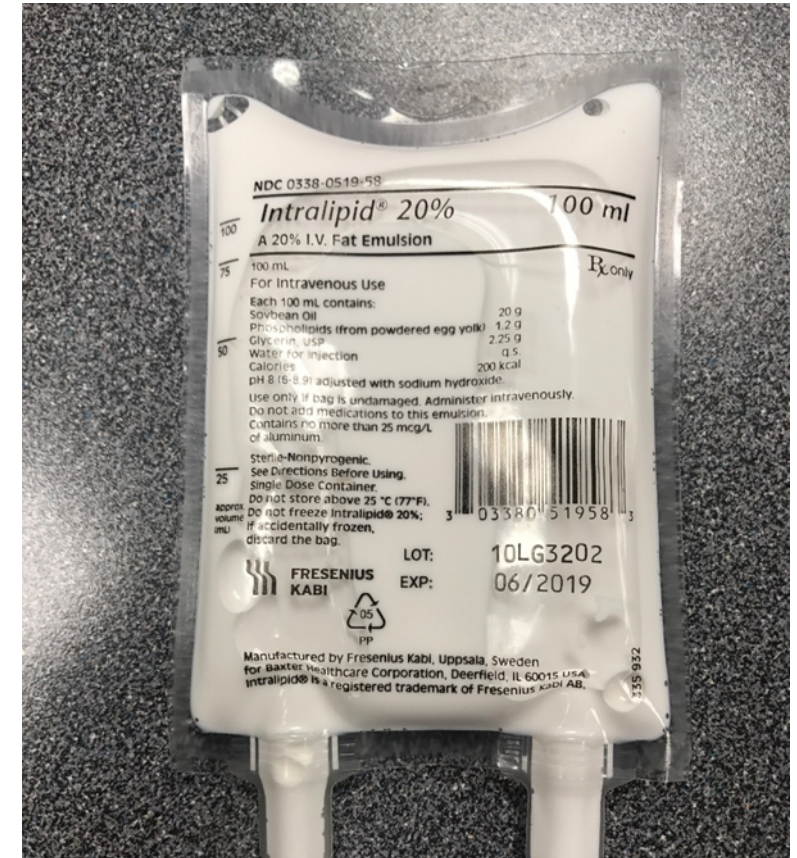


- Compose the phospholipid bilayer of cell membrane
- Base components of steroids, vitamins (A, D, K, E), hormones, cholesterol
- Source of stored energy
- Aid in thermoregulation as a protective layer
- Acts as a chemical messenger at receptors and as transport molecules

Lipid emulsions

- Solutions of lipids (long chain triglycerides)
- Typically made of soybean or safflower oils
- Made into a 10-20% solution

- Component of parenteral nutrition
- Component in toxicology therapy



Parenteral Nutrition

- Intravenous nutrition support
- Referenced as either total or partial depending on the formulation
 - Concentration/presence of dextrose
- Can be made 'in-house' by components or bought in an all-in-one administration system
- Used in critically ill patients

- Proteins in the form of Amino acids 3-15% solutions
- Carbohydrates in the form of dextrose 24-50% solutions
- Fat emulsion 10-20% solutions
- Electrolyte solutions (Sodium, Potassium, Magnesium)



Toxicology Therapy

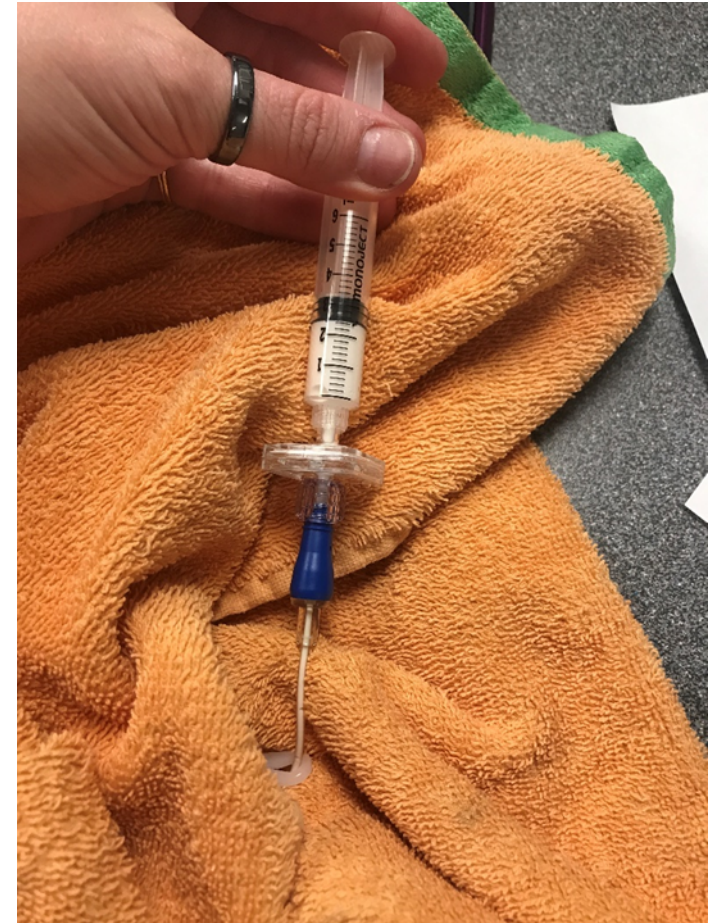


Lipid Sink Theory

- The toxic compound is sequestered into the lipid solution while in the blood stream
- Once bound the lipids are metabolized within the body and cleared
 - Metabolized in striated muscle, viscera, myocardium, subcutaneous tissue
 - Metabolized into free fatty acids and glycerols

Therapy for Lipophilic Drug Toxicity

- Bupivacaine
- Clomipramine
- Verapamil
- Mepivacaine
- Lidocaine
- Permethrin
- Haloperidol
- Doxepin
- Carvedilol
- Carbamazepine
- Amlodipine
- Propanolol
- Moxidectin
- Ivermectin



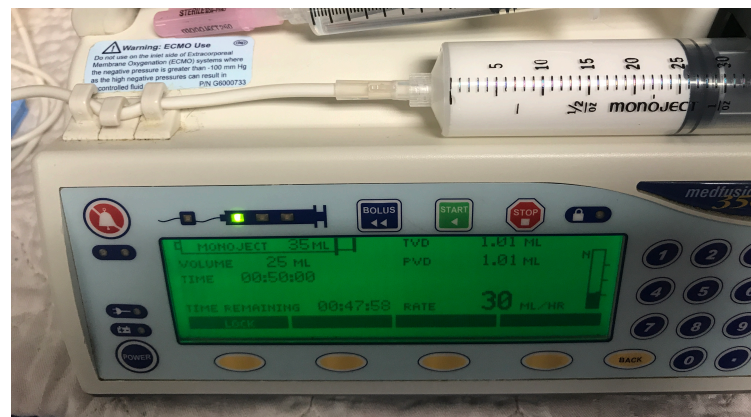
Dosing

- First give a bolus: 1.5 – 4 ml/kg given over 1 min
- Second give a slow bolus: 0.25 ml/kg/min over 1 hour
- Repeat doses can be given every 4-6 hours for 24 hours
 - Determination of repeat doses is done with lipemia checks
- Limit of 8ml/kg/day



Administration

- Can be administered through a peripheral intravenous catheter
 - Use of a micron filter is debated in regard to a lipid embolus
- Aseptic technique should be practiced to prevent contamination
 - Wear gloves with interactions
 - Line should be disconnected as little as possible
 - Open sources should be stored in the fridge for no more than 24 hours



Risks of Lipids

- Severe phlebitis, infection, and inflammation can occur
- Can progress to systemic sepsis



Fat overload syndrome

- Overwhelming of the clearing mechanism within the body
- Seen at rates over 0.11 g/kg/hr
- Displayed as fat embolism, hyperlipidemia, hepatomegaly, splenomegaly, thrombocytopenic, hypercoagulation, hemolysis, seizures
- Creates secondary conditions including cardiac disease and pancreatitis



Administration Consideration



- When giving lipids for one drug intoxication, if another drug is needed that is lipophilic, it won't work.
- Ex. If treating permethrin toxicity and the patient develops a ventricular tachyarrhythmia, if lidocaine is given, it won't work.....

Vascular Access



Not All Veins are Created Equally

- Cephalic
 - Most ideal due to ease of access and maintenance
 - Less likely to be contaminated
- Accessory
 - Very tempting neighbor to the cephalic
 - It is smaller and at a strange angle
 - Tape usually covers carpus, resulting in mega-paw
- Saphenous (medial in cat, lateral in dog)
 - Ensure taping follows the angle of the vein
 - More likely to get contaminated with urine/feces



Squeaky clean, but then....

- Wash your hands and wear gloves
- Disinfecting the site chosen is essential
 - This starts with gently clipping a wide path for access (avoiding clipper burn)
 - A disinfectant should be used (similar to incisional prep)
 - Bactericidal agents including Chlorhexidine, betadine, and/or alcohol



Watch for Re-contamination

- Feeling for the vein at the insertion site
- Dragging the catheter through hair
- Applying tape over blood
- Placing finger directly over insertion point

Taping

- Many methods of applying layers
- Consistency is helpful between team members

As a patient is rehydrated their tissues with expand, tightening the tape.

Personal Favorites

- Having tabs at the end of the tape
- Using cross over piece on t-port
 - Use of t-port (or y access port)
- Taping UP the leg (making contact with the leg)



Maintenance

Catheters should be inspected at least daily.

- They should be re-taped as needed
 - Blood, urine, fecal, vomitus, fluid contaminates should be removed
- They should be cleaned as needed
 - Catheters should be broken down and cleaned every 48 hours
- Catheters should be flushed several times a day to maintain patency and evaluate function



When do you replace catheters?

When it is needed.

- Average catheter lives 3 days.



2013 AAHA/AAFP Fluid Therapy Guidelines for Dogs and Cats*

Harold Davis, BA, RVT, VTS (ECC), Tracey Jensen, DVM, DABVP, Anthony Johnson, DVM, DACVECC, Pamela Knowles, CVT, VTS (ECC), Robert Meyer, DVM, DACVAA, Renee Rucinsky, DVM, DAVBP (Feline), Heidi Shafford, DVM, PhD, DACVAA



Picture Citations

1. Downs, D. *Hydration, Dehydration, and Rehydration in Animals*. Wilderness Medicine Magazine. 2020.
2. 2013 AAHA/AAFP *Fluid Therapy Guidelines for Dogs and Cats*. 2013.
3. Hughston, L. *The Basics of Fluid Therapy for Small Animal Veterinary Technicians*. Today's Veterinary Nurse. July/Aug 2016.
4. Admin. *What Is a Hypotonic Solution*. Get Education Skills. 2021.
5. Babu, A. et al. *Nanoparticle-Based Drug Delivery for Therapy of Lung Cancer: Progress and Challenges*. Journal of Nanomaterials. 2013.
6. Nephron of the Kidney. Science Photo Library. 2021.
7. Simmer, K. et al. *Standardized Parenteral Nutrition*. Nutrients. 2013.



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- Davis, H. 2013 AAHA/AAFP Fluid Therapy Guidelines for Dogs and Cats. 2013.
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Questions?

