Zuku Review FlashNotes

What Fluids to Give

FLUID THERAPY, (part 2)

Two questions you always ask: Is there a fluid deficit? What fluids do I use to replace?

1. Is there a fluid deficit? Identify hydration deficit, estimate volume lost

- Physical exam should always include an estimate of hydration
- Estimate VOLUME of fluid deficit present with clinical signs (C/S) and laboratory data

  - Clinical signs (C/S) correlate with amount of fluid lost;
  - Hypotension w/severe hypovolemia
  - PCV, total solids, total protein, urine specific gravity, albumin increase with fluid loss;
  - Lactate increases with hypovolemia
  - Hemorrhage or protein loss may obscure lab picture

Clinical signs	Skin Elasticity (tenting)**	Mucous membranes	Capillary refill time (CRT)	Signs of Shock: ↑↑HR, weak pulses cool extremities
<5%	-	-	-	-
5-6%	+/-	Probably ok	+/-↑	Not likely
6-8%	Slow return	+/- Dry	Mild ↑	Less likely
10-12%	Very slow	Dry	↑↑	May be present
12-15%	May not retract	Very dry	↑↑↑↑	Severe
** Body condition may obscure elasticity testing: ↑tenting if thin, ↓ if fat				

Assessing hydration by physical exam

SLOW CRT (pale crescent where clinician's thumb was pressed) and hyperemic mucous membranes in a sick horse;

Image courtesy Dr. Erwin Pearson

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- In young calves with diarrhea, C/S correlate with **dehydration *AND* metabolic acidosis**
- Calves have **loss of fluid** and **loss of HCO^{3-}**, that may be severe

Calves with diarrhea	*Base deficit mEq/L	
Clinical signs	≤ 8 days old	> 8 days old
Alert, good suckle, standing	0	-5
Still standing but depressed Weak suckle, slight dehydration	-5	-10
Sternal, more depressed No suckle, moderate dehydration	-10	-15
Lateral, extreme depression No suckle, severe dehydration	-15	-20

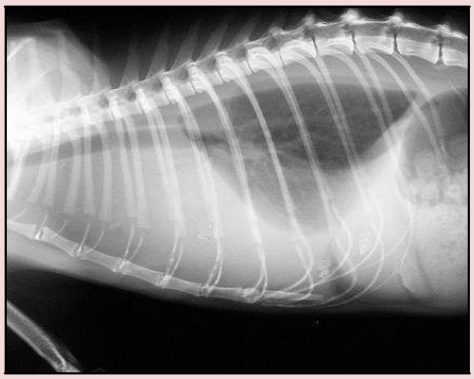
Naylor, J.M. 1989. Can Vet J. 30:577–580.

Hypovolemia results in a switch to anaerobic metabolism: see increased lactate and lactic acidosis

- Add maintenance requirements to fluid therapy plan – increase for lactation, etc.
  - Small animals – recommendations vary
    - 40 - 60 ml/kg/day; [(BW(kg) X 30) + 70];
    - if < 2 kg or > 50 kg, use ($BW^{0.75}$) X 70
  - Large animals
    - Horses/Cows 50 ml/kg/day;
    - 100 ml/kg/day neonates
- Add volume for ongoing losses
- Estimate via observation of losses, collection of urine/feces in some cases

Many pathways for deficits to occur

Gastric reflux



Effusion - feline infectious peritonitis

Cow with choke-salivation

Images courtesy Dr. J Adams (horse), Uwe Gille (cat), Dr. L George (cow)

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FLUID THERAPY, (part 2)

2. What fluids do I use for replacement? What type of deficit is present? How was fluid lost?

Many pathways for deficits to occur (part 2) – often more than one present ie:

- Lack of intake
- Hemorrhage
- Urine loss with polyuria
- Respiratory – excessive panting, esp dogs, sometimes horses
- Salivation, eg, esophageal obstruction, ptyalism
- Skin – burns, severe wounds; sweating in horses
- Inflammation – fluid shifts, vasodilation
- Intestine - lack of absorption, diarrhea, increased secretion, vomiting, reflux

Hemorrhagic colitis

Ethmoid hematoma removal

Calf diarrhea

- Type of deficit determines which replacement fluid to use
- Isotonic is best, no more than 600 mOsmoles/L
- Measure PCV or Hct, electrolytes and protein to determine severity & supplements needed

Supplements to intravenous fluids:

Potassium	Calcium	Dextrose	Bicarbonate
KCl - 20 - 40 mEq/liter added to fluids ≤ 0.5 mEq/kg/hr cardiac effects (↓ HR) Enteral intake best to correct K^+ deficits	Cannot mix with HCO_3^-, LRS Excessive sweating (EQ) Tx for hyperkalemia	Hypoglycemia Neonatal foals Toy dog breeds Liver disease	Calf diarrhea Not for lactic acidosis

Examples of replacement fluid choices: (See also-Fluids Chart on last page)

Cause	Type of loss	Electrolytes	Fluid choices	Additions/comments
Stress, exercise	Hypertonic	-	Normosol-R, LRS, Saline	KCl
Endurance exercise (EQ - sweating)	Hypertonic	↓↓ Cl^-, ↓Ca^{2+}	Ringers, Saline NOT LRS	Add Ca2+ +/- KCl
Heat stroke	Hypertonic	Na, K variable		
Vomiting	Iso or hypertonic	Na, K, Cl loss	0.9% NaCl + KCl	KCl
Diarrhea	Iso or hypertonic	Na, K, Cl loss; HCO^- loss, > in LA	Normosol-R or LRS	KCl Calves – need HCO^{3-}
Renal failure		↓ Na, Cl, HCO_3^-	Normosol-R, LRS, Saline	
Liver disease			0.45% NaCl/2.5% Dextrose	KCl; cannot handle lactate
Urethral obstruction	Iso or hypertonic	↑↑ K^+ Na, Cl variable	Ringers, Saline	Tx to ↓ K^+, Dextrose, insulin; Ca if dysrhythmia
Salivation/Choke			Normosol-R or LRS	
Hemorrhagic shock	Isotonic		Normosol-R or LRS	+/- Transfusion
Endotoxic shock	Isotonic		Normosol-R or LRS	Colloids, hypertonic saline

LRS = Lactated Ringers solution;

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Electrolytes – facts and function

Sodium Na^+	Potassium K^+	Calcium Ca^{2+}
Most important **extracellular** ion	Most important **intracellular** ion	Very important – muscle contraction
Cellular transport; membrane pumps	Cellular transport; membrane pumps	Cellular transport
Water follows sodium	Cardiac rhythm	Cardiac contractility/rhythm
Nerve conduction	Cardiac contractility	Ionized form is biologically active
Acid/base status; volume status	Affected by diet, anorexia, renal ds	Protein bound + ionized = total calcium
Plasma, tissue, cellular osmolality	Changes with acid/base status	Total affected by albumin, but not ionized
Regulated by kidney		Ionized level changes with pH
Fluid volume regulation		

Chloride Cl^-	Magnesium Mg^{2+}
Important **extracellular** ion	Greater **intracellular** concentration
Follows sodium	Most under-appreciated ion
Acid base status - ↑ Cl = acidosis	Levels vary with calcium status
Lost with vomiting	With Low K^+ or Ca^{2+} Must correct low Mg
Very low with abomasal obstruction	

Constituents of commonly used fluid products in veterinary medicine; comparison to plasma

	pH	Osmolarity mOsmo/L	Tonicity	Na^+ mEq/L	Cl^- mEq/L	K^+ mEq/L	Ca^{2+} mEq/L	Mg^{2+} mEq/L	HCO_3^-/ buffer mEq/L	Dextrose g/L	Use
Plasma	7.4	300	-	145	105	5	5	3	24	~1 (glucose)	
ECF	7.4			145	110	4	2.5	1	24	-	
ICF	7.4			12	4	140	4	34	12	-	
Crystalloids											
0.9% Saline	5.0	310	Iso	154	154	-	-	-	-	-	Rpl
Ringers	5.5	310	Iso	148	156	4	4.5	-	-	-	Rpl
Lactated Ringers	6.5	272	Iso	130	109	4	3	-	28(L)	-	Rpl
Normosol R	6.4	296	Iso	140	98	5	-	3	27(A) 23(G)	-	Rpl
Normosol M	5.5	364	Hyper	40	40	13	-	3	16 (A)	50	M
Plasmalyte A	7.4	294	Iso	140	98	5	-	3	27(A) 23(G)		Rpl
Plasmalyte 148	5.5	312	Iso	140	98	5	-	3	27(A) 23(G)	-	Rpl
Plasmalyte M	5.0	377	Hyper	40	40	16	5	3	12(A) 12(L)	50	M
5% Dextrose	4.0	252	Hypo	-	-	-	-	-	-	50	
2.5% Dex/0.45% NaCl	4.5	280	Iso	77	77	-	-		-	25	
2.5% Dex/½ str LRS	5.0	263	Hypo	65.5	55	4	3		28(L)	25	
7% NaCl	5.0	2567	Hyper	1283	1283	-	-	-	-	-	Rs
Colloids											
6%Hetastarch / NaCl	5.5	309	Iso	154	154	-	-	-	-	-	Rs
In Lactated Ringers	5.9	307	Iso	143	124	3	5	-	28(L)	-	Rs
6% Dextran 70 / NaCl				154	154					-	Rs
In 5% Dextrose				-	-					50	Rs

Buffers: A = Acetate, G = Gluconate = Lactate; Rpl = replacement, M = maintenance, Rs = resuscitation
Adapted from manufacturers' online sources and DiBartola's "Fluid Therapy in Small Animal Practice", 2nd ed.