VET 433A Electrolyte Disorders: Potassium, Calcium and Sodium

Electrolyte	Potassium	Calcium	Sodium
Location in the body	Intracellular	Extracellular	Extracellular
Major Role	Maintenance of resting membrane potential across excitable cells' membranes *Cardiac Myocytes *Neurons	Involved in coagulation, heart rhythm and muscle contraction	
Normal Reference Ranges	3-5 mEq/L in plasms *slightly higher in serum	Total: 9-11 mg/dL Ionized 1.1-1.45 mmol/L Ionized fraction is the active portion **Not a reliable relationship between total and ionized calcium*	140-160 mEq/L *Each individual varies only 1-2 mEq/L
Elimination Pathways	Kidneys	GIT (feces) Urine	Kidneys
Hyper-	Kidney failure (acute) Post-renal causes > inability to eliminate Urethral/ureteral obstruction Ruptured urinary tract with urine accumulation in a cavity Addisons Chronic body cavity effusions Excessive intake (iatrogenic) Shift from intracellular site > crushing or reperfusion injury	HARD IONS H: Hyperparathyroidism A: Addison's Disease R: Renal Failure D: Hypervitaminosis D I: Idiopathic (cats) O: Osteolytic diseases N: Neoplasia S: Spurious	Excessive water loss *most common Excess sodium intake -Play doughs, beef jerky, saltwater, sodium bicarbonate Excessive electrolyte-free water loss -Diabetes insipidus (central or nephrogenic) -Excessive panting (uncommon) -Rarely diarrhea since it is usually not electrolyte-free Inadequate water intake either as a sole problem or in combination with excess water loss (PU, GI loss)

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Clinical Signs	Cardiac arrhythmias *life threatening Can have neuromuscular signs such as weakness but the cardiac arrhythmias are more prevalent/important <u>ECG Changes</u> Tall/tented T waves Loss of P waves Slowing of Heart Rate Widening of QRS complex Asystole or ventricular fibrillation > noncirculatory rhythms and death	Pu/PD Poor Appetite, Lethargy Vomiting Causes acute kidney injury: azotemia is common	Animals with an intact hypothalamic thirst mechanism will seek water and drink Dysmetria signs are usually neurologic Obtundation Disorientation Head pressing Seizure Coma Death
Treatment	Cardioprotectant: Calcium Gluconate IV Elimination via IVF therapy Drugs to shift K+ into cells (dextrose +/- insulin) Sodium bicarbonate Terbutaline, albuterol, other sympathomimetics	Indicated with iCa^{2+} > 1.8 mmol/L or hypercalcemia with azotemia Fluid therapy 0.9% NaCl Furosemide > helps eliminate Ca^{2+} in urine Glucocorticoids *try not to use prior to definitive dx Treat underlying disease	When hypernatremia is an incidental finding and no neurological signs are present Administer electrolyte-free water source 3-7 mL/kg/hr with the goal of returning $[Na^+]$ to normal within 48 hours Monitor Na^+ on a single machine q 2-6 hours If neuro signs are present Administer electrolyte-free water source 7-10 mL/kg/hr 5% dextrose in water IV Treat until neurologic signs have resolved then treat for stable hypernatremia
Hypo-	Kidney Failure especially CKD Diuretics and other causes of PUPD Diabetes Mellitus Diarrhea, vomiting, decreased intake Toxin – beta agonist	Eclampsia (puerperal tetany) Chronic kidney disease > high phosphorous state Pancreatitis Critical illness Iatrogenic > blood transfusion, sodium bicarbonate therapy	Increased water retention -ADH action -Inadequate effective circulating volume -Diuretic therapy -Addison's disease Excess water intake

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			-Usually iatrogenic via feeding tube in animals with poor kidney function
Clinical Signs	Muscle weakness Cervical ventroflexion Hypoventilation requiring IPPV (rare) <u>ECG Changes</u> Diminished T waves, tall P waves	None if mild iCa^{2+} needs to be <0.8 mmol/L Moderate: moderate facial pruritic/rubbing, muscle tremors/tetany Severe: Seizures, obtundation, cardiac dysrhythmia/death	Dysmetria signs are usually neurologic Obtundation Disorientation Head pressing Seizure Coma Death
Treatment	Not *usually* an emergency Supplement with IV K^+ in fluids Treat underlying disease process Reduce diuresis if possible Mg^{2+} supplementation may be needed K_{max}=0.5 mEq/kg/hr	IV Calcium options: 10% Ca Gluconate 0.5-1.5 mL/kg over 10-20 min *23% solution also available 10% Ca Chloride 0.2-0.5 mL/kg over 10-20 min Monitor for bradyarrhythmia Slow or stop infusion if noted	If neuro signs are present, emergency Hypertonic saline 7.0-7.5% NaCl to increase plasma sodium concentration by 10-15% on the first day of treatment This is usually by 10-15 mEq/L in the first 24 hours Diuretic therapy with furosemide and/or mannitol may be needed
Additional Info	<u>Pseudohyperkalemia</u> Thrombocytosis >Platelet degranulation leads to K^+ release so there is a serum-to-plasma difference in $[K^+]$ Hemolysis in Japanese breeds (Akita, Shiba Inu) Na-K ATPase on RBCs leads to hemolysis during blood sampling or handling causes pseudohyperkalemia	<u>Eclampsia</u> Post-partum hypercalcemia Associated with greatest lactation demand just prior to weaning Smaller breeds and dogs with larger or a greater number of puppies are more likely to be impacted	<u>Pseudohyponatremia</u> Not clinically relevant and does not require treatment or concern Caused by hyperglycemia For every increase in BG by 100 mg/dL, plasma $[Na^+]$ drops by 1.6-2.4 mEq/L Caused by mannitol administration before mannitol has been eliminated by the kidneys

Water Distribution in the Body

Total Body Water

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Intracellular Fluid 2/3 of Total Body Water	Extracellular Fluid 1/3 TBW	Extracellular Fluid 1/3 TBW
Water can cross into cells but sodium cannot	¾ Interstitial *Equal sodium concentration	¼ IV *Equal sodium concentration