Instructional Objectives / Learning Outcomes
DMP 775, Veterinary Clinical Pathology
Department of Diagnostic Medicine/Pathobiology
College of Veterinary Medicine, Kansas State University

Chapter 9: Monovalent electrolytes and osmolality

162. If given serum electrolyte concentrations, osmolality, and other relevant data (CBC, serum chemistry results, urinalysis results, and patient information),
    a. List or classify abnormalities using appropriate terms.
    b. Propose appropriate ideas or conclusions (i.e., diseases, syndromes, or pathologic states) that might cause the defined abnormalities.
    c. Based on your conclusions or ideas, explain the pathogenesis of each defined abnormality if the abnormality could be caused by the disorder.
163. State the specific analytes that are measured to determine serum concentrations of sodium, potassium, chloride, and total carbon dioxide content. Explain the relationship between serum bicarbonate concentration and total carbon dioxide content.
164. Using the ratio between total body Na^+ and total body H_2O ($tbNa^+$:tbH_2O ratio), explain the pathophysiologic events which cause hypernatremia, normonatremia, or hyponatremia in: a) a dehydrated animal; b) an animal with normal hydration; c) an edematous animal.
165. List the two basic processes that produce hypernatremia.
166. Explain or recognize the pathogenesis of the hypernatremia that may be found in the following conditions.
    a. Frozen water source
    b. Prolonged fever
    c. Central diabetes insipidus
    d. Ruminal acidosis (grain overload)
    e. Salt poisoning
167. List and recognize the two basic processes that produce a pathologic normonatremia.
168. Explain or recognize the pathogenesis of the normonatremia that may be found in the following conditions.
    a. Vomiting or diarrhea
    b. Renal disease
    c. Osmotic diuresis
    d. Furosemide or thiazide diuretics
    e. Congestive heart failure
169. Compare the edematous states that occur with hepatic cirrhosis and nephrotic syndrome; what do the disorders have in common regarding regulation of Na^+ and H_2O balance?
170. List and recognize the five basic processes that produce hyponatremia.
171. List and recognize the conditions that may produce a pseudohyponatremia (or pseudohypochloremia) and which analytical methods are or are not affected by such conditions.
172. Explain and recognize the pathogenesis of the hyponatremia that may be found in the following conditions.
    a. Vomiting or diarrhea
    b. Hypoadrenocorticism
    c. Ketonuria
    d. Sweating in horses

e. Congestive heart failure
f. Hyperglycemia (with or without ketonuria)
g. Uroperitoneum

173. List and recognize the two basic processes that produce hyperkalemia.
174. Explain and recognize the pathogenesis of the hyperkalemia that may be found in the following conditions.
    a. Inorganic metabolic acidosis
    b. Rhabdomyolysis
    c. Renal insufficiency or failure
    d. Urinary tract obstruction
    e. Hypoadrenocorticism
175. Explain why *in vitro* hemolysis may cause hyperkalemia in some animals, but not in others.
176. Explain why $[K^+]$ is typically greater in serum than in plasma. In what situation does this process result in a pseudohyperkalemia?
177. List and recognize the two basic processes that produce hypokalemia.
178. Explain and recognize the pathogenesis of the hypokalemia that may be found in the following conditions.
    a. Metabolic alkalosis
    b. Anorexia
    c. Osmotic diuresis
    d. Ketonuria
    e. Conditions that cause hypochloremic metabolic alkalosis
    f. Diarrhea
    g. Choke or dysphagia
179. Explain and recognize the reason for a decreased serum Na^+:K^+ ratio in the following conditions.
    a. Hypoadrenocorticism
    b. Renal failure
    c. Uroperitoneum
    d. Diabetes mellitus
    e. Repeated drainage of chylous thoracic effusions
180. List or recognize the four basic processes or pathologic states that produce hyperchloremia.
181. Explain and recognize the pathogenesis of the hyperchloremia that may be found in the following conditions.
    a. Frozen water source
    b. Prolonged fever
    c. Central diabetes insipidus
    d. Ruminal acidosis (grain overload)
    e. Salt poisoning
    f. Bovine esophageal obstruction that causes a metabolic acidosis
182. Explain why the presence of a normochloremia and concurrent metabolic acidosis suggests or indicates an increased anion gap.
183. List and recognize the four basic processes or pathologic states that produce hypochloremia.
184. Explain and recognize the pathogenesis of the hypochloremia that may be found in the following conditions.

a. Vomiting or diarrhea that produces hyponatremia
b. Hypoadrenocorticism
c. Persistent vomiting in monogastric mammals or displaced abomasum in ruminants
d. Ketoacidosis or lactic acidosis
e. Sweating in horses
f. Congestive heart failure
g. Hyperglycemia (with or without ketonuria)
h. Uroperitoneum

185. List and recognize the four major processes that produce an increased [HCO_3^-] or [tCO_2].
186. Explain and recognize the pathogenesis of an increased [HCO_3^-] that may be found in the following conditions.
a. Gastric or abomasal loss of H^+
b. Loop or thiazide diuretics
c. Hypokalemia
d. Contraction alkalosis
187. List and recognize the four major processes that produce a decreased [HCO_3^-] or [tCO_2].
188. Explain and recognize the pathogenesis of a decreased [HCO_3^-] that may be found in the following conditions.
a. Lactic acidosis
b. Ketoacidosis
c. Renal failure
d. Uroperitoneum
e. Diarrhea
189. Explain the relationships between the following.
a. Total body Na^+ content and total body H_2O content
b. Serum [K^+] and acid-base status
c. Serum [K^+] and total body K^+
d. Serum [Cl^-] and serum [Na^+]:
e. Serum [Cl^-] and serum [HCO_3^-]
f. Serum [Na^+] and serum [K^+]
190. If given necessary measured values:
a. Calculate an anion gap.
b. Explain the clinical significance of a normal or increased anion gap values (i.e., what does the anion gap value tell you about the animal?).
c. List or recognize common disorders that might cause an increased or decreased anion gap.
191. State the serum analyte that is the major contributor to the anion gap in a healthy mammal. State what would happen to the anion gap if the concentration of that analyte decreased.
192. Explain and recognize why animals with the following disorders have an increased anion gap.
a. Metabolic acidosis and concurrent hypochloremia
b. Metabolic acidosis and concurrent normochloremia
193. Define and recognize the definitions of osmolality, osmole, solute, solvent, and osmo. gap.
194. Briefly explain how a freezing-point osmometer measures a sample's osmolality.

195. State the relative contribution of electrolytes (Na^+, K^+, Cl^-, HCO_3^-) to total osmolality in serum of healthy animals compared to the contributions of urea, glucose, and proteins.
196. List the endogenous solutes which can cause an increased serum osmolality (e.g., > 10 mosm/kg above reference interval)
197. List the endogenous solutes which can cause a decreased serum osmolality (e.g., < 10 mosm/kg below reference interval)
198. Explain the difference between serum osmolality and effective serum osmolality. Explain how effective serum osmolality can be estimated from measured values of osmolality and certain solute concentrations.
199. If given necessary measured values,
    a. Calculate an osmo. gap.
    b. Explain the clinical significance of either normal or increased osmo. gap values (i.e., what does the osmo. gap value tell you about the animal?).
    c. List common disorders that might cause an increased osmo. gap.
200. Compare and contrast the interpretations of a measured osmolality versus a calculated osmolarity. When do increased or decreased values for both mean the same thing? When don't they? When is a calculated osmolarity useful?
201. Explain why a dehydrated animal might have:
    a. An increased serum osmolality
    b. A serum osmolality WRI
    c. A decreased serum osmolality
202. If given serum electrolyte concentrations and other relevant data (CBC, serum chemistry results, urinalysis results, and patient information), recognize data which are consistent with these disorders or conditions.
    a. Hypoadrenocorticism
    b. Dehydration (hypertonic, isotonic, or hypotonic)
    c. Gastric loss of H^+ that produces a hypochloremic metabolic alkalosis
    d. Intestinal disease that produces a metabolic acidosis
    e. Ketoacidosis
    f. Lactic acidosis
    g. Renal failure
    h. Cirrhosis
    i. Nephrotic syndrome
    j. Diabetes mellitus
    k. Uroperitoneum
    l. Renal tubular acidosis (proximal or distal)