Electrolytes Got You Puzzled? An In-house Lab Will Solve the Problem

by Jim Irwin, DVM

It’s a simple fact that the inclusion of electrolytes—sodium (Na⁺), potassium (K⁺) and chloride (Cl⁻), in particular—on every chemistry panel will add valuable information, yet practitioners commonly fail to perform them. Unfortunately, this habit serves to perpetuate a lack of understanding of the importance of electrolytes. In some cases, electrolyte abnormalities can be subtle and easily overlooked. Furthermore, electrolyte levels often change in a matter of hours in sick animals and artifacts can occur during storage and transportation, so being able to monitor electrolytes “cage-side” is critical. Ideally, samples for electrolyte analysis should be collected in lithium heparin tubes. Serum samples are acceptable, but the serum must be separated from the cells within one hour, to minimize artifacts. Performing electrolytes in-house is good medicine.

Regularly performing electrolytes will help the practitioner gain a better appreciation of their value. A good protocol to increase use of electrolytes and improve patient care is:

1. Include electrolytes on every preanesthetic panel, even spays and neuters.
2. Include electrolytes on every preventive care and geriatric screen.
3. Include electrolytes on every diagnostic panel for sick or ADR patients.
4. Include electrolytes on every therapeutic drug monitoring panel.
5. Include electrolytes on every fluid therapy case and repeat often during therapy.

Essentially, electrolytes should be run as part of your overall chemistry profiles as such a protocol will demonstrate the significant number of patients with electrolyte changes and the clinical importance of those abnormalities. Repeatedly seeing how electrolytes behave in both well and sick animals becomes a great learning tool.

While potassium levels are very important, determination of sodium and chloride levels is necessary to fully and accurately evaluate the patient’s electrolyte status and critical for evaluating certain disorders.

Potassium (K⁺)

Potassium is the major intracellular cation. Potassium is absorbed nonspecifically from the intestinal tract and regulated by the kidneys, with aldosterone helping to regulate renal excretion. Measurement of potassium is critical for assessing patients with anorexia, vomiting, diarrhea, neuromuscular weakness and those with bradycardia or arrhythmias.

Hypokalemia, or low potassium, can occur with prolonged anorexia, fluid therapy, diuretic administration, hyperaldosteronism, gastrointestinal losses and urinary losses. Hypokalemia can cause muscle weakness (including ventroflexion of the neck in cats), anorexia, lethargy, polyuria and polydipsia. Hypokalemia is relatively common in senior cats.

In the author’s practice, 924 cats presenting for an annual preventive care screening were evaluated with a chemistry panel, including electrolytes and a CBC. Hypokalemia was found in 26% of the cats. Furthermore, it was noted that 35% of the hypokalemic cats became azotemic within the following 12 months and that this percentage increased further over the next 12 months. Observing this development of hypokalemia is possible if a practice performs regular senior blood work, including electrolytes.

Sodium (Na⁺)

Sodium is the major extracellular ion, comprising 95% of the osmotically active solute. Sodium concentrations and the resultant extracellular fluid are primarily regulated by adjusting the body water balance. Vasopressin, or antidiuretic hormone, regulates renal excretion of water and the thirst mechanism regulates water intake.

Hyponatremia, or low sodium, can occur with renal failure, nephrotic syndrome, gastrointestinal losses, third-space losses, congestive heart failure, hepatic cirrhosis, diuretic administration, psychogenic polydipsia and hypoadrenocorticism. Clinical signs of hyponatremia result from both the severity of the hyponatremia and the rapidity of the decline. Signs include lethargy, weakness, vomiting and confusion. With rapidly developing or severe hyponatremia, more significant neurologic dysfunction including seizures, obtundation and coma may occur.

Hypernatremia, or high sodium, can occur with low water intake, diabetes insipidus, high insensible losses and loss of sodium-containing fluids without adequate water replacement (e.g., diabetes mellitus, osmotic diuresis, postobstructive diuresis and gastrointestinal losses). Clinical signs of hypernatremia may include polydipsia, weakness, depression, muscle fasciculations, seizures and coma, depending on the severity of the hypernatremia.

Chloride (Cl⁻)

Chloride is the most prevalent extracellular anion. Although, historically, chloride has been given little significance, it is very important for complete assessment of a patient’s electrolyte and acid-base status. Chloride is important for maintaining osmolality and participates in the regulation of acid-base status. The kidneys play a key role in the regulation of chloride levels. Chloride concentrations often parallel those of sodium, with

Reference:
1. Irwin J. Do tests first. Presurgical blood work may eliminate a variety of surprises. DVM in Focus. November 1, 2003.

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increases or decreases in chloride concentrations proportional to those of sodium, reflecting alteration in body water balance. When chloride and sodium concentrations do not change in parallel, the practitioner should be alerted to the possibility of disorders causing excess sodium loss relative to chloride or excess chloride loss relative to sodium, as well as acid-base disturbances.

**Hypochloremia**, or low chloride, can occur with gastric vomiting, hypoadrenocorticism, diuretic therapy, metabolic alkalosis, chronic respiratory acidosis and salt-losing nephropathy. If the degree of hypochloremia exceeds that of the hyponatremia, it suggests selective chloride loss, such as that seen in patients with gastric vomiting.

**Hyperchloremia**, or high chloride, can occur with low water intake, diabetes insipidus, high insensible losses, diabetes mellitus, osmotic diuresis, postobstructive diuresis, chronic respiratory alkalosis and hyperchloremic metabolic acidosis (renal tubular acidosis or diarrhea with gastrointestinal loss of bicarbonate). Fluid therapy with products such as 0.9% NaCl and lactated Ringer’s solution (LRS) is another common cause of hyperchloremia in hospitalized patients. A falsely increased chloride level may also result from potassium-bromide administration.

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**Preanesthetic Screens**
Electrolytes should be a part of every preanesthetic screen, as electrolyte imbalances may provoke additional health risks, including arrhythmias, which could be greatly exacerbated by preoperative medications and anesthetic agents, potentially with fatal consequences. Because it is recommended that food and water be taken away 12 hours prior to surgery for healthy patients undergoing surgery (spay/neuter or dentals), dehydration and electrolyte imbalances may be present—especially in smaller breed dogs. For sick patients undergoing surgery (foreign body/ bowel obstruction) a more serious situation can occur, because by the time most patients arrive in your practice, it is quite likely that they have been vomiting and not eating or drinking for several days. Knowing the electrolyte status lets you choose the appropriate anesthetic agent as well as the fluid therapy for each individual patient based on their needs, which can minimize risks and help speed up the recovery process.

**Senior Preventive Care Panels**
Several benefits can be recognized by including electrolytes in senior preventive care panels. First, it will provide some understanding of normal values. Second, it allows establishment of baselines and trends for individual patients. Third, it may allow for early detection of disease. Electrolyte changes are often subtle, yet potentially significant. For example, hypokalemia can often be found on routine senior preventive care panels, especially in cats. These cats may show a deficiency of potassium before they develop azotemia. Identifying these low levels can guide the practitioner in making dietary or supplement recommendations.

**Disease**
Electrolytes can provide the clinician valuable diagnostic information as well as give essential data for monitoring the treatment protocol. For example, a high potassium level in an azotemic patient supports urinary obstruction or severe renal insufficiency. Conversely, a low potassium level may indicate a more chronic renal condition, as in a geriatric cat with chronic kidney failure. Sometimes the electrolyte changes give a strong indication of the diagnosis. Finding a low sodium along with a high potassium is highly suggestive of Addison’s disease.

Regular evaluation of electrolyte levels is extremely important in managing chronic renal disease, cardiac disorders, endocrine disorders and gastrointestinal disorders, as well as critical-care patients. Adjustment of medical and dietary therapy may hinge on the patient’s electrolyte status. In order to make informed and appropriate therapeutic decisions regarding fluid therapy, knowledge of electrolyte levels is essential. Once fluid therapy has been initiated, there is an ongoing need for electrolyte monitoring. Electrolyte levels will need to be checked repeatedly throughout the treatment period, up to several times daily, especially in critical cases. In these situations, in-house electrolyte testing is required for appropriate patient monitoring.

**Monitoring Drug Therapy**
There is significant value in monitoring electrolyte levels when utilizing certain drugs. Drugs commonly used to treat heart disease, arthritis, Addison’s disease and kidney disease all require monitoring of electrolyte levels. For example, regular determinations of potassium and sodium levels are used to adjust the dose of mineralocorticoid replacement in Addisonian dogs.

**Conclusions**
Determining electrolyte levels provides valuable information for both diagnosis and monitoring treatment. Furthermore, it will foster a better understanding and appreciation of electrolytes and their role in diagnostic and preventive care profiling. Electrolyte levels can change quickly; therefore, it is essential to monitor them frequently. Analysis done “cage-side” will be the most relative and informative. Electrolyte values received the next day from the reference laboratory have much less value.