Perioperative Acid-Base and Electrolyte Disturbances

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KEYWORDS

• Acidosis • Alkalosis • Electrolytes • Oxygenation • Ventilation

KEY POINTS

- Acid-base and electrolyte abnormalities are common in perioperative patients, and appropriate recognition and treatment is essential to optimize outcome.
- Fluid therapy provides treatment of most metabolic acid-base disturbances.
- Respiratory support, including supplemental oxygen and occasionally mechanical ventilation, may be necessary to correct respiratory disturbances.
- Electrolyte disturbances may be corrected by fluid therapy or a variety of pharmacologic agents.
- Correction of these disorders preoperatively and intraoperatively results in a more stable anesthetic candidate.

INTRODUCTION

Obtaining and interpreting values for blood gases and electrolytes is essential in the management of many perioperative veterinary patients. Metabolic and electrolyte alterations are common in critically ill surgical patients, and can lead to alterations in cardiovascular function, neurologic status, respiratory function, and even response to various drug therapies. Several common preoperative and postoperative conditions are discussed in this article. **Box 1** contains a 6 step method for the interpretation of blood gases, a skill that is needed to diagnose some of the derangements that are discussed in this article. Normal arterial and venous blood gas values for dogs and cats are listed in **Table 1**, and the expected compensatory changes are listed in **Table 2**.

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Box 1
Interpreting blood gas results

There are 6 steps required to interpret blood gas results:

1. Determine whether sample is venous or arterial. Either sample type can be used to evaluate overall acid-base status, with the exception of severe shock and postarrest situations, which may result in large discrepancies between arterial and venous samples. Poor tissue perfusion can result in sizable increases in CO_2 and secondary decreases in pH on the venous side despite low to normal CO_2 on the arterial side.

   Although information can be gained about ventilation from a venous sample, only an arterial sample can assess oxygenation.

   If unable to obtain an arterial sample, use pulse oximetry to measure oxygen saturation and a venous sample to evaluate acid-base status and estimate ventilation.

   If the patient is intubated, end-tidal CO_2 can also be used to estimate ventilation, but, with severe pulmonary disease, end-tidal CO_2 can be much lower than $Paco_2$.

2. Assess the patient for acidemia (pH <7.35) or alkalemia (pH >7.45).

   If pH is within normal limits, the patient's body may have compensated for an underlying disturbance or a mixed disturbance may be present. See steps 3 and 4 to evaluate whether metabolic or respiratory disturbances are present despite normal pH.

3. Assess for acidosis.

   Respiratory acidosis is present if $Paco_2$ is greater than 45 mm Hg.

   Metabolic acidosis is present if base excess (BE) is less than −4 mmol/L (or HCO_3^- <19 mmol/L).

4. Assess for alkalosis.

   Respiratory alkalosis is present if $Paco_2$ is less than 35 mm Hg.

   Metabolic alkalosis is present if BE >2 mmol/L (or HCO_3^- >25 mmol/L).

5. Assess oxygenation.

   Normal Pao_2 is 90 to 100 mm Hg. If the patient is on supplemental oxygen, Pao_2 should equal approximately 5 times the fraction of inspired oxygen (Fio_2); the Fio_2 of room air is 21%.

   These rules apply to the normal values listed in **Table 1** for dogs. For cats, substitute the reported normal values for $Paco_2$ and BE from **Table 1** into steps 3 and 4.

6. Determine whether compensatory changes have occurred.

   For example, if a primary metabolic acidosis is present, a compensatory respiratory alkalosis may also exist. Remember the rules of compensation:

   A change in the respiratory or metabolic component of the acid-base status normally induces an opposite compensatory response in an effort to normalize the pH.

   The lungs can compensate quickly by adjusting minute ventilation in a matter of minutes.

   The kidneys compensate more slowly, with compensation beginning within a few hours and maximum compensation taking 4 to 5 days.

   The absence or presence and degree of compensation provide some information about the chronicity of the disturbance (see **Table 2**).

   Overcompensation does not occur.