Clinical Pathology Review: Bovine Blood Gas Analysis

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Blood-gas analysis can provide valuable insight into the acid-base changes taking place in disease processes of animals. Selection of appropriate treatement depends upon an understanding of expected changes. It must be emphasized that alterations in blood chemistry reflect changes brought about by some underlying primary pathological condition toward which treatment must be first and foremost directed. Properly done, blood-gas analysis can aid in establishing the primary diagnosis and assist in the selection of appropriate supportive therapy.

As a brief review, one must consider both the respiratory and metabolic contributin to the acid-base status of the animal. The respiratory component is evlauated by the PCO_2. Hypoventilation causes increased carbon dioxide levels thus lowering blood pH while hyperventilation leads to respiratory alkalosis. The metabolic component is best evaluated by the base excess which is an in vitro evaluation of the titratable acidity of the blood. Reduced blood bicarbonate, increased lactic, acetoacetic and β hydroxybuturic acids and increased chloride concentrations are but a few of the factors responsible for a metabolic acidosis. The kidneys play a major role in the regulation of the metabolic component of the acid-base balance.

The following bovine cases are presented to further your knowledge and interest in blood-gas analysis and to demonstrate its practical significance. In all cases blood was drawn from the auricular artery. The authors suggest that the reader identify the problem(s) in each case, consider probable pathogenesis, and reflect briefly on the principles to consider in selection of therapy before proceeding to the discussion.

Table 1. Acid-base data on 5 selected bovine clinical cases.

	Normal Range*	Case 1	Case 2	Case 3	Case 4	Case 5
pH	7.39-7.51	7.512	7.200	7.306	7.584	7.237
PO_2 mmHg	86.1-110.9	77.4	98.7	60.6	45.3	61.4
PCO_2 mmHg	33.4-47.0	45.9	32.4	28.0	65.2	71.1
HCO_3^- mEq/l	21.8-32.6	36.2	12.2	13.7	62.6	29.6
Base Excess mEq/l	−1.4-+9.0	+13.0	−14.8	−10.6	+36.1	+0.4

*Normal values and ranges computed from unpublished research, Drs. A. E. Ledet and E. D. Lassen, Department of Veterinary Pathology, Iowa State University.

Case 1. Six year old, female, Holstein. Cow entered hospital with a history of not having eaten or passed feces in 4 days. She had calved 9 days previously and had been treated for metritis. A gas-filled vesicular structure was auscultated on the right side.

Case 2. Ayrshire, 20 months, female. Heifer was admitted to the hospital with bloody stools, tenesmus and extreme dehydration.

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Case 3. Four year old, Holstein cow. This cow had been bloating and salivating profusely for several days. Dysphagia and apparent pharyngeal paralysis was observed. However, a stomach tube was passed with ease.

Case 4. Four year old, Holstein cow. The cow had calved 2 weeks previously and entered the hospital with signs of anorexia and decreased milk production. Surgery for a left displacement of the abomasum was performed, the cow responded favorably for one day but subsequently refused all feed.

Case 5. This ten month old steer had to

be splenectomized for experimental purposes. The spleen was removed via a transthoracic approach, resulting in violation of the integrity of the diaphragm. Gas anesthesia was administered via an endotracheal tube and positive pressure ventilation was used for the duration of the procedure. A progressive increase in heart rate was noted during surgery.

Discussion

Case 1. Laboratory data indicates the animal is moderately alkalotic based upon blood pH. Base excess of 13.0 indicates a metabolic alkalosis with a mild compensatory respiratory acidosis (elevated PCO_2). A right displacement of the abomasum was diagnosed and corrective surgery was performed. Based upon further clinical pathology data a state of hypochloremic alkalosis was established. Rationale for selection for supportive therapy included return of proper chloride balance. Twelve liters of isotonic saline were administered during the immediate post operative period and the animal recovered uneventfully.

Case 2. This heifer is moderately to severely acidotic. Base excess and PCO_2 values indicate a metabolic acidosis with mild compensatory repsiratory alkalosis. The clinical history of severe diarrhea provides a likely pathogenesis for the excessive loss of bicarbonate ions. Therapy in this case should be directed toward the replacement of fluids and base.

Case 3. This animal, like Case 2, had a metabolic acidosis. The pathogenesis, however, was due to a loss of bicarbonate in saliva rather than from loss from intestinal fluids. Rationale for supportive therapy was similar to Case 2. Considerable improvement in the clinical status of this cow was noted following fluid therapy. However, the animal remained unable to swallow and euthanasia was performed. Extensive periesophageal inflammation was observed on postmortem examination. The fluorescent antibody test for rabies was negative.

Case 4. This cow had a metabolic alkalosis with a moderate compensatory respiratory acidosis. Treatment with chloride containing fluids resulted in a rapid, dramatic improvement in appetite and milk production. The cow relapsed the following day. Blood-gas analyses were again performed with results similar to prior results. A second regimen of treatement resulted in marked improvement. The cow then recovered uneventfully. This cow has similarities to Case 1. The alkalotic state resulted from abomasal atony following successful corrective surgery. Hypochloremic alkalosis resulting from abomasal atony should certainly be considered as a possible complicating factor in any disturbance of the bovine upper digestive tract.

Case 5. This steer has a respiratory acidosis with an insignificant metabolic compensatory response. In this situation, treatment with alkalinizing fluids would do little to correct the acidotic state and may be detrimental. Correction of acid-base balance should be directed toward adequate pulmonary ventilation and reduction of blood carbon dioxide levels.

The preceding 5 cases represent a few simple, but common, situations in which an appreciation and understanding of the basic concepts of acid-base balance can facilitate the selection of appropriate and beneficial supportive therapy.

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