BLOOD GASES, ACID-BASE BALANCE AND SERUM ELECTROLYTES CHANGES IN PNEUMONIC BUFFALO-CALVES

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ABSTRACT

The selected animals for the present study were 80 buffalo-calves of both sexes, 4-8 months old. These calves were subjected to careful clinical examinations. 60 calves showed the clinical sings of pneumonia, while the rest, 20 calves were clinically healthy. The present investigation aimed to study the extent of changes in blood gases, acid-base balance and serum electrolyte values in association with pneumonia in buffalo-calves. Blood gas tensions, acid-base measurements and serum electrolyte concentrations were determined in 10 pneumonic calves (diseased group) compared with corresponding values of 10 healthy calves (control group). Blood gas analysis revealed significant decrease ($P<0.01$) in both blood pH and oxygen tension (Po_2) while carbon dioxide tension (Pco_2) showed significant decrease ($P<0.01$). Bicarbonate (Hco_3-) levels; total carbon dioxide (Tco_2) and base excess (BE) in pneumonic calves, were insignificantly affected and still within the normal physiological levels. Significant increase ($P<0.05$) in potassium levels with significant decrease ($P<0.05$) in chloride levels were detected in diseased buffalo-calves. The obtained data revealed that pneumonia in calves was associated with disorders in blood gases, acid-base balance and electrolyte values and that analysis of blood gases and acid-base status is very useful in evaluating the diagnosis and prognosis of pneumonia in calves.

INTRODUCTION

Respiratory affections particularly pneumonia are confered to be major problems among buffalo-calves, causing severe economic losses through reduction of weight gain, high morbidity and mortality rates **(Abd El-Ghani et al., 1990; Youssef et al., 1992 and Barrett, 1998)**. These affections are a complex interactions between baeterial, viral infection and environmental stressors **(Howard, 1986)**. Pasteurella spp., Corynebacterium pyogens as well as Staph. aureus, Strept. pyogens and E.coli are claimed to be the main bacterial causes responsible for pneumonia in calves **(Al-Allawy et al., 1979 and Elyas, 1982)**. Para-influenza type 3 (PI_3), infectious bovine rhinotracheitis (IBR), and respiratory syncytical virus (RSV) are incriminated in the incidence of

enzootic pneumonic **(Pirie et al., 1981)**. Environmental conditions specially cold, damp weather, amonia, overcrowding, poor ventilation as well as poor hygienic measures play a role in predisposing of outbreaks of respiratory diseases **(Woldehiwet et al., 1990)**.

Balance of blood gases and acid-base status are critical physiological criteria for the maintenance of normal function. Blood gas analysis is one of the most important aids in the diagnosis and prognosis of respiratory complication **(El-Sebaie et al., 1987 and Abd El-Raof and Hassan, 1999)**. Acid-base balance of the body fluids is important because the chemical reactions of the body being controlled by enzymes are very greatly influenced by the changes in pH **(Tasker, 1969)**. When the pH changes, normal metabolic reactions are altered and body processes are impaired. Serious disorders of acid-base balance occur in several clinical disorders in cattle, sheep and goats **(Hills, 1974)**.

Respiratory system play an important role in regulation of acid-base balance and blood gases through the elimination of carbon dioxide through the ventilation process **(Coles, 1986 and Bouda and Jagos, 1991)**.

Electrolytes and acid-base balance are interrelated in the body in that the various anions and cations participate in physiochemical buffering of body fluids against sudden changes in blood pH **(Simmons, 1962 and Gingerich, 1981)**. Evaluation of electrolyte levels and acid-base parameters of patient provide necessary information that will lead to greater understanding of the nature of disease process and guide line to the way of therapy **(Brobest, 1975 and Robert et al., 1990)**.

The purpose of this investigation was to study the extent of changes in blood gases, acid-base balance and serum electrolytes values in association with pneumonia in buffalo-calves.

MATERIAL AND METHODS

The selected animals for the present study were 80 buffalo-calves, 4-8 months old and of both sexes, related to a private farm in Sharkia Governorate. Clinical signs of pneumonia were observed and recorded in 60 calves, while the rest, 20 buffalo-calves were clinically healthy under the same environmental and managemental conditions. The laboratory study was carried out on 10 calves affected with pneumonia compared with 10 clinically healthy ones.

From each animal 2 ml sample of jugular venous blood was collected anaerobically into syringe whose dead space had previously filled with 1/1000 sodium heparin. These samples were immediately placed on ice-bath and processed within one hour of collection. Blood gases measurements were performed using Corning pH-blood gas analyser Model 168. The analyser directly

measured at 37°C. blood pH, carbon dioxide tension (Pco_2 mm.Hg), oxygen tension (Po2 mm.Hg). Bicarbonate (Hco_3^- mmol/L), total carbon dioxide (Tco_2 mmol/L) and base excess (BE mmol/L) were calculated automatically by the same apparatus.

Another blood sample (5 ml) was collected form each animal for obtaining clear sera for the determination of serum electrolyte concentrations. Blood serum sodium and potassium levels were determined using flame photometer (Corning Model 410) as described by **Oser (1979)**. Serum chloride level was determined according to **Freid (1972)**. The obtained data were statistically analysed according to **Snedecor and Cochran (1982)**.

RESULTS

The most prominent clinical signs of pneumonia in affected calves were mucoid nasal discharge, cough, anorexia, congested mucous membranes, accelerated respiration. Auscultation revealed abnormal chest sounds.

Results of the determinations of pH, blood gases and acid-base parameters were illustrated in Table (1). Mean levels of blood serum electrolytes in both healthy and pneumonic buffalo-calves were presented in Table (2).

DISCUSSION

Respiratory diseases constitute a major cause of morbidity and mortality in feedlot cattle. Pneumonia and other respiratory tract infections were incriminated to be the principle causes of all calf death in 41% of the herds **(Hassan, 1987 and Sayed, 1988)**. Bacteria, viruses and fungi are the main causes of such diseases. The poor hygienic environmental conditions play an important role as predisposing factors that assist in the prevalence of diseased conditions **(Bryson et al., 1978)**.

Close observation concerning clinical signs revealed mucoid nasal discharge, cough, anorexia, congested mucous membranes, accelerated respiration and abnormal lung sounds on auscultation at different areas of the lungs in the diseased buffalo-calves. These findings were similar to those recorded by **Youssef et al. (1992)**; **El-Sheikh et al. (1994)** and **Abd El-Raof and Hassan (1999)**.

The respiratory system has a role in the regulation of acid-base balance and this by removal of carbon dioxide from the blood and reduce the concentration of carbonic acid in the blood **(Donawick and Beaue, 1968** and **Carlson, 1997)**.

Diseases which are directly or indirectly affect the functions of the respiratory system alter the acid-base and electrolyte equilibrium of the body. Pneumonia interfere with main function of

the lung mechanism and consequently increase in retention of Co_2 in blood which transformed into carbonic acid resulting in respiratory acidosis **(Carlson, 1997** and **Abd El-Raof and Hassan, 1999)**.

In this investigation, the results of blood pH, blood gases and acid-base status in buffalo-calves with pneumonia (Table 1) were significant decreased ($P<0.01$) in both blood pH and oxygen tension (Po_2), while significant increase ($P<0.01$) in carbon dioxide tension (Pco_2) was recorded when compared with those healthy ones. Bicarbonate (Hco_3^-), total Co_2 (Tco_2) and base excess (BE) values were insignificantly affected but still within the normal physiological levels. These findings are in close agreement with those reported by **(Youssef, 1984; Verhoeff et al., 1985; Linden et al., 1995 and Nagy et al., 1998)**.

Changes in blood gas values in calves suffering from pneumonia revealed that a condition of hypoxia was generally noticed among affected calves together with hypercapnia. The low values of Po_2 could be attributed to disturbances of blood oxygenation process in pneumonia as a result of respiratory diseases **(Linden et al., 1995)**. From the physiological mechanisms known to cause hypoxia: hypoventilation or breathing air (or a gas mixture) with a low Po_2 **(Hinshaw and Murray, 1980)**. Hypercapnia has only one clinically important cause of alveolar hypoventilation **(Hinshaw and Murray, 1980)**. Hypoventilation occurs when not enough fresh air is breathed into alveolar spaces to raise the pulmonary capillary Po_2 to normal levels and to allow carbon dioxide to leave the blood stream **(Verhoeff et al., 1985)**. During hypoventilation, the Po_2 must decrease and the Pco_2 must increase **(Hinshow and Murray, 1980)**.

The fall in blood pH in the pneumonic calves was due to the hypoventilation and interference with gaseous exchange **(Reynolds, 1963)**. Respiratory acidosis was observed in diseased calves (lowered values of pH and increased Pco_2 values). This alteration could be attributed to decreased pulmonary ventilation and retention of excess of Co_2 in blood associated with pneumonia **(Coles, 1986 and El-Sebale et al., 1987)**. In pneumonia and bronchitis there was a marked increase in Pco_2 values in blood associated with dropping of blood pH values **(Alpern, 1967 and Brobest, 1975)**. The authors declared that such alteration mainly due to interference in the gaseous exchange and retained carbon dioxide.

Respiratory acidosis occurs as result of failure of the lungs to excrete Co_2. The continuing production of Co_2 from tissue metabolism results in increased plasma carbon dioxide and carbonic acid and the latter was ionized to produce an increased hydrogen ion concentration towards acidic medium and consequently a fall in blood pH **(Brobest, 1975)**. In a trial of the body to relief the accumulation of acids in the blood, the H^+ enters the cell and the intracellular K ions come out, which explains the increases observed in serum potassium **(Coles, 1986)**. The

non significant change in Hco_3^- values indicated metabolic compensation. **Rounghton (1964)** added that the respiratory acidosis usually accompanied with partial compensation and consequently increase in blood Hco_3^-.

Regarding the results of electrolytes values (Table 2), serum sodium levels showed insignificant decrease. Serum potassium values were significantly increased ($P<0.05$), while serum chloride levels were significantly decreased ($P<0.05$) in pneumonic calves when compared with the healthy ones. These results were similar to those reported by **El-Sheikh et al. (1994); Abd El-Raof and Hassan (1999) and El-Sebaie et al. (2002)**. The increase of serum potassium levels may be related to the accumulation of acids (H^+) in the blood, the H^+ inters the cell and the intraecllular K^+ ions come out **(Coles, 1986)**. The fall in serum chloride levels could be due to increased blood bicarbonate (Hco_3^-) **(Rounghton, 1964)**.

It was concluded that, pneumonia has a great influence on pH, Po_2 and Pco_2 values resulting in hypoxia and respiratory acidosis and analysis of blood gases and acid-base status is very useful in evaluating the diagnosis and prognosis in some diseases such pneumonia in calves.

Table (1): Blood gases and acid-base balance values in both clinically healthy and pneumonic buffalo-calves.

Variable	Healthy buffalo-calves		Pneumonic buffalo-calves	
	Mean±S.E	Range	Mean±S.E	Range
pH	7.346±0.014	7.286-7.412	7.278±0.012**	7.235-7.356
Pco_2 (mm.Hg)	46.25±1.40	39.9-52.5	55.73±2.28**	44.7-65.3
Po_2 (mm.Hg)	56.03±1.74	47.6-62.3	48.14±1.92**	42.2-59.3
Hco_3^-(mmol/L)	24.20±1.13	17.9-28.5	26.57±1.04	21.6-32.5
Tco_2 (mmol/L)	29.10±0.90	24.3-33.2	30.30±1.00	25.4-35.2
BE (mmol/L)	-0.980±0.08	-7.5-(4.3)	-1.080±0.10	-6.2-(3.6)

Table (2): Serum electrolytes values in both clinically healthy and pneumonic buffalo-calves.

Variable	Healthy buffalo-calves		Pneumonic buffalo-calves	
	Mean±S.E	Range	Mean±S.E	Range
Sodium (mmol/L)	134.60±2.24	123 – 145	129.80±1.01	124-134
Potassium (mmol/L)	5.19±0.10	4.71-5.72	6.07±0.31*	5.22-6.83
Chloride (mmol/L)	102.10±2.33	93-115	92.10±2.67*	81-107

* $P<0.05$

REFERENCES

Abdel-Ghani, M.; El-Seedy, F. R.; Shokry, S. and Rida, E. M. (1990) : Incidence and bacterial causes of buffalo-calves mortality with respiratory disorders. Vet. Med. J.. Giza, 38 (2): 233.

Abdel Raof, Y. M. and Hassan, H. Y. (1999) : Ultrasonography and other aids for calf pneumonia diagnosis. 5th Sci. Cong. Egyptian Society for Cattle Diseases. Asslut. Egypt.

Al-Allawy, T. A.; Mottelib, A. A.; Nashid, S. M. and Salem, H. (1979) : A study on pneumonia in buffalo-ealves in Egypt. J. of Egyptian Vet. Med. Assoc.. 39 (2): 23-28.

Alpern, D. (1967) : Pathologic physiology. P. 153-155. Mir Publichers. Moscow.

Barrett, D. C. (1998) : Bovine Respiratory Diseases. A clinician's perspective. Cattle Practice. 6: 251-255.

Bouda, J. and Jagos, P. (1991) : Disorders in the acid-base balance. In.: Vrzgula, L., ed. Metabolic disorders and their prevention in farm animals. Amsterdam: El-Sevier, P. 248-268.

Brobest, D. (1975) : Evaluation of elinical disorders of aeid-base balance. J. Am. Vet. Med. Ass.. 166 (4): 355-364.

Bryson, D. C.; McFerran, J. B.; Ball, H. J. and Neill, S. D. (1978) : Observations on outbreak of respiratory disease in housed calves (1) Epidemiological, chemical and microbiological findings. Vet. Rec., 103 (11) : 485-509.

Carlson, G. P. (1997) : Fluid, Electrolyte and Acid-base balance. In: Kaneko, J.J.; Harvey, J.W. and Bruss, M.L. eds. Clinical Biochemistry of Domestic Animals. 5th Ed. San Diego: Academic Press, 485-516.

Coles, E. H. (1986) : A Textbook of Veterinary Clinical Pathology. 4th ed. W.B. Saunders Co., Philadelphia, London, Toronto, P. 220-260.

Donawick, W. J. and Bane, A. E. (1968) : Blood gases, Acid-base balance and Alveolar-Arterial Oxygen Gradient in Calves. Am. J. Vet. Res. 29 (3): 561-567.

El-Sebaie, A.; Amer, A.; Nafie, E.; Abd El-All, Th. And Sadiek, A. H. (1987): Clinical, haematological and acid-base changes accompanying some respiratory and alimentary manifestations among fattening buffalo-calves, Asslut Vet. Med. J. 19 (37): 147-154.

El-Sebaie, A. H.; Ali, A. A. and Sadiek, A. H. (2002) : Bronchopneumonia in buffalo-calves in Asslut Governorate: II-Studies on changes of acid-base balance, electrolytes and some antioxidants associated with the disease. Asslut Vet. Med. J. 46 (92): 156-168.

El-Sheikh, A. R.; Mohga Abd El-Razek; Esmat, M. and Asma, A. A. (1994): Clinical, biochemical and baeteriological studies on respiratory affections in buffalo-calves. 2nd Vet. Med. Cong., Zagazig University, P. 646-657.

Elyas, A. H. (1982) : Mycological and Bacteriological studies on the causes of pneumonia affecting buffalo-calves. Ph. D. Thesis, Fac. Vet. Med., Assiut University.

Freid R. (1972) : Determination of blood serum chloride. J. Clin. Chem. Biochem., 10: 280.

Gingerich, D. A. (1981) : Fluid, Shock and Blood Therapy. "In current veterinary therapy". Food Animal Practice. P. 17-27 Edited by Howard and W.C. and McMullan Saunders Company, Philadelphia-London, Toronto.

Hassan, A. (1987) : Clinical and some biochemical blood changes accompanying alimentary and respiratory manifestation among fattening buffalo-calves. M.V.Sc. Thesis, Fac. Vet. Med. Assiut Univ.

Hills, G. (1974) : "Acid-base balance". Chemistry, Physiology and Pathophysiology. Williams & Wilkins Company, Baltimore. 3rd Ed.

Hinshaw, H. C. and Murray, J. F. (1980) : Diseases of the chest. Philadelphia, W.b. Saunders (Cited by Verhoeff et al., 1985). Vet. Rec. 117: 202-204.

Howard, J. L. (1986) : Current veterinary therapy, food animal practice. W.B. Saunders Company, Philadelphia, U.S.A.

Linden, A.; Desmecht, D.; Amory, H.; Daube-G.; Lecomte, S. and Lekeux, P. (1995) : Pulmonary ventilation mechanics, gas exchange and haemodynamics in calves following intratracheal inoculation of Pasteurella haemolytica. Zentralbl Veterinar Med. Assoc., 42: 531-544.

Nagy, O.; Michna, A.; Kovac, G.; Seidel, H. and Paulikova, I. (1998) : The effect of respiratory diseases in calves on the blood gas values and acid-base balance. Veterinarni Medicina, 43 (3): 69-74.

Oser, B. L. (1979) : Hawk's physiological chemistry. 14th Ed. McGraw-Hill Book Company Ltd., London.

Pirie, H. M.; Pringle, C. D.; Allan, E. M. and Kennedy, G. J. (1981) : Acute fatal pneumonia in calves due to respiratory syncytial virus. Vet. Rec., 104: 411-416.

Reynolds, E. O. R. (1963) : Brit. Med. J. 1192 (Cited by Verhoeff et al., 1985). Vet. Rec. 117: 202-204.

Robert, W.; Bunnett, Elizabethlee-Lewandrowski and Ent Lewandrowski (1990) : Electrolyte,

acid-base balance. In Textbook of Clinical Laboratory Medicine. Edited by McClatchey, D.K. 1st Ed., William and Wilkins-Blatimore, Philadelphia, Hong Kong, London, Munich, Sydney, Tokoyo. P. 331-354.

Roughton, F. J. W. (1964) : Transport of oxygen and carbon dioxide in Handbook of Physiology. 1. respiration Sec. 2. P. 767-829. Edited by Fenn, W.O. and Rahn, H.; Amerlean Physiological Society, Washington.

Sayed, A. M. (1988) : Clinleal and some blood trace elements changes following respiratory and alimentary disturbances among calves. M.V.Sc. Thesis, Fac. of Vet. Med., Assiut Univ.

Simmons, D. H. (1962) : Clinical disorders of fluid and electrolyte metabolism. Megraw-Hill Book Company, INC. New York, Toronto and London.

Snedecor, G. W. and Cochran, W. C. (1982) : Statistical Method. 7th Ed. Iowa State Univ. Press, Ames, Iowa. USA.

Tasker, J. B. (1969) : Fluid, Electrolytes and acid-base abnormalities in cattle. J.A.V. Med. Ass., 155 (12): 1906-1909.

Verhoeff, J.; Wierda, A.; Van Nieuwstadt, A. P. and Bultelaar, J. W. (1985): Spontaneous bovine respiratory syncytial virus infections in calves: Arterial blood gas. pH and bicarbonate values. Vet. Rec., 31: 202-204.

Woldehiwet, Z.; Mamache, B. and Rowan, T. G. (1990) : The effects of age, environmental temperature and relative humidity on the bacterial flora of the upper respiratory tract in calves. Br. Vet. J., 146: 211-218.

Youssef, M. A. (1984) : Respiratory diseases arising from air pollution inside sheep pens and methods of treatment and prophylaxis of these diseases. PH. D. Thesis Fac. Vet. Med. Zagazig University.

Youssef, M. A.; Waffaa, M.; Abd El-Razek; Hamad, A. El-Sadawy and Abdella, M. Scleim (1992) : Clinical and laboratory studies on an outbrak of bacterial respiratory troubles in buffalo-calves in Egypt. Proc. 5th Sci. Cong. Fac. Vet. Med. Assiut Univ., 92-103.

الملخص العربى

التغيرات فى غازات الدم، الاتزان الحمضى القاعدى والأليكتروليت فى العجول الجاموسى المصابة بالالتهاب الرئوى

عادل على كامل - هدى محمد لطفى عبد الله

معهد بحوث صحة الحيوان - الزقازيق

الحيوانات المختارة لهذه الدراسة كانت (٨٠) رأسا من العجول الجاموسى النامية من كلا الجنسين وتراوحت أعمارهم من ٤-٨ شهور فى احدى المزارع الخاصة بمحافظة الشرقية. تم فحص هذه الحيوانات إكلينيكيا ومعمليا فكان من بينها ٦٠ عجلا يعانون من اضطرابات تنفسية تمثلت إكلينيكيا فى الكحة الطرية، الافرازات الأنفية المخاطية مع صعوبة وسرعة فى معدل التنفس وفقدان الشهية والضعف العام مع أصوات غير طبيعية عند فحص الرئتين، أما باقى الحيوانات وعددها ٢٠ رأسا كانت سليمة صحيا . وقد استهدفت هذه الدراسة معرفة مدى تأثير الالتهاب الرئوى فى العجول على غازات الدم والاتزان الحمضى القاعدى ومستوى الالكتروليت (الصوديوم - البوتاسيوم - الكلورايد). أجريت قياسات غازات الدم والاتزان الحمضى القاعدى وكذلك مستوى الألكتروليت على عشرة رؤوس من العجول الجاموسى كانت تعانى من الالتهاب الرئوى (المجموعة المريضة) مقارنة بقيم عشرة رؤوس من العجول الجاموسى السليمة ظاهريا واكلينيكيا (المجموعة الضابطة). وقد أسفرت نتائج التحاليل عن وجود نقص معنوى فى قيم كل من الأس الهيدروجيني (pH) والضغط الجزئى للأكسجين (Po_2) بينما الضغط الجزئى لثانى أكسيد الكربون (Pco_2) كان مرتفعا معنويا فى الحيوانات المصابة بالالتهاب الرئوى عند مقارنتها بالمجموعة الضابطة. أما بالنسبة للبيكربونات الفياسية (Hco_3-) ، ثانى أكسيد الكربون الكلى (Tco_2) والزيادة القاعدية (BE) فكانت الاختلافات غير معنوية. أما بالنسبة لنتائج الألكتروليت فقد أظهرت ارتفاعاً معنويا فى مستوى البوتاسيوم وانخفاضا معنويا فى مستوى الكلورايد فى سيرم دم العجول المريضة عند مقارنتها بالسليمة. وقد خلصت الدراسة إلى أن الالتهاب الرئوى فى عجول الجاموس غالبا ما يصحبه اختلال فى غازات الدم والاتزان الحمضى القاعدى وقيم الاليكتروليت وأن تحليل غازات الدم والاتزان الحمضى القاعدى يكون هاماً ومفيداً فى تقييم التشخيص والعلاج وعاملا أساسيا فى تحسن الحالات المرضية مثل حالة الالتهاب الرئوى فى العجول.