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Changes in electrocardiographic parameters in the horses with pneumonia

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ABSTRACT

Pneumonia is caused by several factors in the horses which could lead to some changes in heart's electrocardiogram. This study was conducted for the purpose of studying the electrocardiographic changes among the horses suffering from pneumonia. The current study was carried out on 25 horses suffering from pneumonia as well as 25 healthy horses of the stables located in the outskirts of Tabriz. The sick horses were confirmed based upon the laboratory and clinical clues (Culture of nasal secretions and CBC). After getting the blood sample from all the horses, the electrocardiogram was provided and the cardiac arrhythmias were recorded accordingly. The number of heartbeats of the sick horses had got a significant increase ($p < 0.05$). Irregular heartbeat rhythm was observed in 8 horses of healthy group and 12 horses of sick group, which the cardiac arrhythmia among sick horses was significant ($p < 0.05$). Sinus tachycardia was the most common observed arrhythmia in the sick group. The difference of the average time and waves' distance between two groups didn't make any sense. Meanwhile, waves' height in regard to T and P of the averages' difference didn't make sense, however in regard to QRS wave, waves' height in the sick group had increased significantly ($p < 0.05$). In either of the groups most of the double-leveled P waves were positive; also different QRS and T waves in both groups had been recorded. The average level of serum of calcium, phosphorus, sodium, glucose in sick group indicated an increase, which was quite significant in regard to calcium, sodium and glucose ($p < 0.05$), whereas about phosphorus it was not significant. The final consequence suggested that pneumonia leads to electrocardiographic changes among horses; however the majority of the cited changes are physiological ones which could be recovered by treating the disease and eliminating the electrolyte disorders caused by it accordingly.

Keywords: Electrocardiography, Pneumonia, Horse

INTRODUCTION

Nowadays, horse industry has earned an especial position among the societies, despite the financial dimension; the emotional dimension is playing a role in this industry as well. Considering the fact that heart diseases are from the sort of common diseases in horse veterinary, thus having knowledge on electrocardiographic changes (ECG) of horses will be of high importance. Pneumonia is caused by lung infection. The infection chiefly involves airbags in lungs and to a lesser extent involves air conduit to the lungs. The infected parts of lung are filled with a liquid; the liquid consists of white blood cells which confronts the infection.

Pneumonia is made by microorganisms, which might lead to diseases. Viruses, bacteria and fungi are the sorts of masses that cause pneumonia. The cited masses could hardly be found in the lungs of healthy livestock. Sometimes the masses are transferred to the lungs by blood flow, whereas they are mostly transferred to lungs by the tiny water droplets in the breathing air (breathing droplets). The infections of upper part of respiratory system, accompanied by purulent nasal secretions as well as having an increase in the size of lymph gland in lower part of the throat, are all symptoms of pneumonia [1-4].

The reasons for different cardiac arrhythmias in horses, which appear following diseases related to digestion and respiratory system, are: direct influence of Endotoxins over Cardiomyocytes, Neurological dysfunction caused by distension of the stomach and intestines because of the decrease in digestion activities, Electrolyte imbalance as well as Acids and bases imbalance, fever and reduction of ventilation [5]. Pneumonia in horses, because of the above cited factors might lead to changes in electrocardiogram of heart. Thus, the current research was conducted, in order to study the electrocardiographic changes among the horses suffering from pneumonia.

MATERIALS AND METHODS

This research was conducted upon 25 horses suffering from pneumonia, in the stables located in the outskirts of Tabriz. The sick horses were confirmed based upon the laboratory and clinical clues (Culture of nasal secretions and CBC). Meanwhile, 25 healthy horses (negative culture), having the equal conditions in regard to their age, nutrition and management, were utilized as the healthy group. Before getting ECG, from each single horse, the blood sample was obtained; then the electrocardiogram of all the horses was provided, and types of cardiac arrhythmias were recorded accordingly. Electrocardiogram will be obtained by single-channel digital machine in base apex lead, for 30 seconds. Base apex lead, with positive electrode, was located on the tip of heart's beat (i.e. on the wall of chest, right towards the elbow on the ribs), and the negative electrode was located along the heart's base. The left or right Jugular groove or any desired place on the skin of the anterior shoulder is appropriate for locating base electrode. While studying the electrocardiograms, waves' shape and duration, waves' distances and waves' height were calculated, and their average values were compared between the sick and healthy group. In regard to serum samples, the quantities of serums of sodium and potassium were measured by flame photometer, whereas the serum quantities of calcium, glucose and phosphorus were measured by biochemical kits of "Pars Azmoon".

For the analysis of achieved results, the statistical software, named SPSS13 was used; accordingly the existence of arrhythmia was described in a descriptive way, and in order to make a comparison between the average values of sick group and the healthy one, the statistical approach called "T test" was utilized.

RESULTS

In the healthy horses the average quantity of heart rate was 39.25 ± 6.45 heartbeats per minute, which the heart rate was from 23 beats until 59 beats per minute. Among the horses suffering from pneumonia the average quantity of heart rate was 68.32 ± 7.06 heartbeats per minute, which the heart rate was from 39 beats until 87 beats per minute. Throughout the statistical comparison, there was a significant difference between the average quantity of heart rates of the mentioned two groups ($p=0.000$) and (Fig. 1 & table 1).

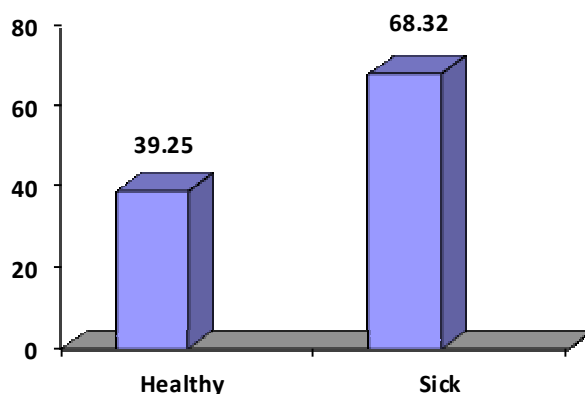


Fig. (1): The average heart rates of healthy horses and horses suffering from Pneumonia

Table (1): Comparison between the average heart rates of horses in healthy group and sick group

Group	Mean	SD	SE	Significance (P value)
Healthy	39.95	6.45	8.54	0.000
Sick	68.32	7.06	9.27	

The distribution of cardiac rhythm among healthy horses was as below. 17 horses (68%) normal rhythm, 3 horses (12%) Sinus tachycardia, 1 horse (4%) Sinus arrhythmia, 3 horses (12%) first degree atrioventricular block and 1 horse (4%) second degree atrioventricular block (table 2).

Table (2): The distribution of cardiac rhythm among healthy horses

Cardiac rhythm	Number	Percent	Average age (1-3 years old)	Average age (3-6 years old)	Average age (6 and older)
Normal rhythm	17	68	8	3	6
Sinus tachycardia	3	12	2	0	1
Sinus arrhythmia	1	4	0	0	1
atrioventricular block I	3	12	0	1	2
atrioventricular block II	1	4	0	1	0
Total	25	100	10	5	10

The distribution of cardiac rhythm among horses suffering from pneumonia is shown in table 3. 13 horses (52%) normal rhythm, 6 horses (24%) Sinus tachycardia, 1 horse (4%) Sinus bradycardia, 2 horses (8%) Supraventricular premature contraction, 2 horses (8%) Sinus arrhythmia and 1 horse (4%) second degree atrioventricular block (table 3).

Table (3): The distribution of cardiac rhythm among horses suffering from pneumonia

Cardiac rhythm	Number	Percent	Average age (1-3 years old)	Average age (3-6 years old)	Average age (6 and older)
Normal rhythm	13	52	7	3	3
Sinus tachycardia	6	24	2	3	1
Sinus bradycardia	1	4	0	1	0
Supraventricular premature beat	2	8	0	0	2
Sinus arrhythmia	2	8	1	0	1
atrioventricular block II	1	4	0	1	0
Total	25	100	10	8	7

In fig. 2 the number of horses suffering from abnormal cardiac rhythm in either of healthy and sick groups has been defined. In sick group, the number of normal cardiac rhythm has decreased, which statistically comparing, there is a significant difference between the two cited numbers in regard to the time ($p < 0.05$). It could be remarked that 'Sinus tachycardia' in sick horses and 'first degree atrioventricular block' in healthy horses, significantly were more, comparing to the other group ($p < 0.05$).

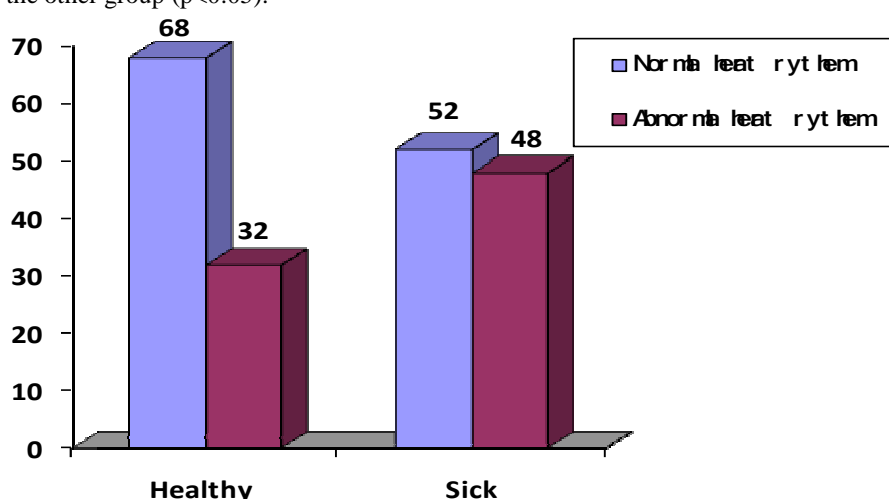


Fig. (2): The percentage of horses suffering from abnormal cardiac rhythm in both healthy group and the sick group

The average duration and distances of waves, measured in seconds in both two groups have been shown in table 4. About healthy group, it is obvious that the average duration of 'p wave' is 0.11 ± 0.03 s, the duration of 'QRS wave' is 0.14 ± 0.02 s, the distance P-R is 0.30 ± 0.04 s and the part S-T is 0.42 ± 0.06 s. The cited values about the sick group are respectively 0.11 ± 0.02 s, 0.14 ± 0.04 s, 0.12 ± 0.02 s, 0.27 ± 0.04 s, 0.48 ± 0.06 s. Through statistical comparison, the average difference between none of the above cited times, was significant.

Table (4): the average duration and distance of recorded waves in the studied horses of both healthy group and sick group

Wave or distances of waves	Group	Average	SE	Significance (P value)
P wave	Healthy	0.11	0.03	0.967
	Sick	0.11	0.02	
QRS wave	Healthy	0.14	0.02	0.985
	Sick	0.14	0.04	
The part P-R	Healthy	0.30	0.04	0.608
	Sick	0.27	0.04	
The part S-T	Healthy	0.42	0.06	0.321
	Sick	0.48	0.06	

In the healthy group, 18 of recorded electrocardiograms (72%) were double-phase positive p waves, whereas 7 of them (28%) were single-phase positive p waves. QRS complex in 14 cases (56%) was recorded as qrs, in 4 cases (16%) it was recorded as QRS and in 7 cases (28%) it was recorded as qRS. The T wave in 13 cases (52%) was recorded as negative, in 10 cases (40%) it was recorded as negative-positive, in 1 case (4%) it was recorded as positive-negative and in 1 single case (4%) it was recorded as positive (table 5).

Table (5): Shapes of recorded waves in studied horses of healthy group

Wave	Shape of wave	Number	Percent
P	double-phase positive	18	72
	single-phase positive	7	28
QRS	Qrs	14	56
	QRS	4	16
	qRS	7	28
T	Negative	13	52
	Negative-Positive	10	40
	Positive-Negative	1	4
	Positive	1	4

Different shapes of the recorded waves of horses suffering from pneumonia are shown in table 6; it is obvious that in 20 cases (80%) the P wave is double-phase and in 5 cases (20%) the P wave is single-phase. The QRS complex, in 16 cases (64%) was recorded as qrs, in 4 cases (16%) was recorded as QRS, in 2 cases (8%) it was recorded as qRS and in 3 cases (12%) it was recorded as QrS. The T wave in 11 cases (44%) was recorded as negative, in 8 cases (32%) it was recorded as negative-positive, in 2 cases (8%) was recorded as positive-negative and in 4 cases (16%) it was recorded as positive.

Table (6): the recorded waves' shapes of the horses suffering from pneumonia

Wave	Shape of wave	Number	Percent
P	double-phase positive	20	80
	single-phase positive	5	20
QRS	Qrs	16	64
	QRS	4	16
	qRS	2	8
	QrS	3	12
T	Negative	11	44
	Negative-Positive	8	32
	Positive-Negative	2	8
	Positive	4	16

The average height of waves in the studied horses of the healthy group, in respect to P wave was 0.26 ± 0.08 mV, about QRS wave it was 1.71 ± 0.39 mV and about T wave it was 1.12 ± 0.34 mV. Whereas in regard to the sick group the above cited values were respectively as 0.28 ± 0.05 mV, 2.15 ± 0.46 mV, 1.03 ± 0.08 mV; thus in respect to T and

P waves, the averages' difference was not significant, but about QRS wave, the waves height in sick group had significantly increased ($p=0.039$) (Table 7).

Table (7): The average height of recorded waves in horses of the healthy group and sick group

Wave	Group	Average	SE	Significance (P value)
P	Healthy	0.26	0.08	0.861
	Sick	0.28	0.05	
QRS	Healthy	1.71	0.39	0.039
	Sick	2.15	0.46	
T	Healthy	1.12	0.34	0.324
	Sick	1.03	0.08	

The average serum level of calcium, phosphorus, glucose in sick group indicated a decrease, which was significant about calcium and glucose ($p<0.05$), whereas in regard to phosphorus it was insignificant. Changes of sodium serum between two groups were significant, but the changes of potassium were insignificant.

Table (8): Comparison of average standard error, standard deviation and significance of the serum level of calcium, phosphorus, glucose, sodium and potassium in both healthy group and sick group

Measurement parameters	Group	Mean \pm SE	SE	Significance (P value)
Calcium (mg/dl)	Healthy	11.87 \pm 1.43	1.08	0.038
	Sick	10.45 \pm 1.65	0.843	
phosphorus (mg/dl)	Healthy	4.37 \pm 0.08	0.095	0.736
	Sick	4.22 \pm 0.12	0.034	
Glucose (mg/dl)	Healthy	108.25 \pm 8.60	11.37	0.005
	Sick	94.12 \pm 9.42	15.08	
Sodium (mg/dl)	Healthy	139.75 \pm 4.52	2.541	0.05
	Sick	131.60 \pm 5.23	1.730	
Potassium (mg/dl)	Healthy	4.36 \pm 0.12	0.07	0.137
	Sick	4.07 \pm 4.52	0.09	

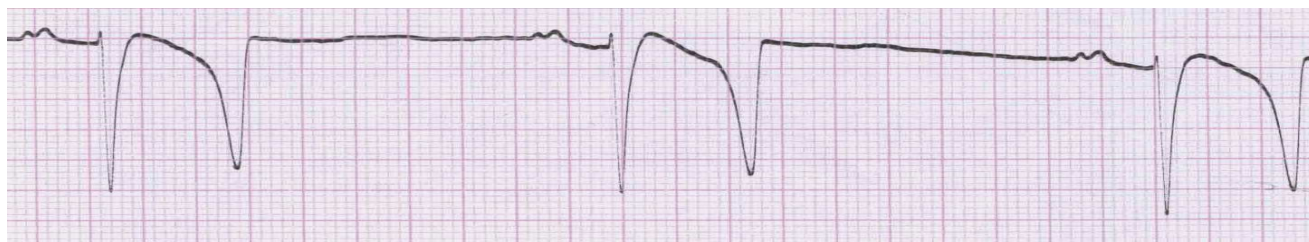


Fig. (1): Normal electrocardiogram sample of a horse

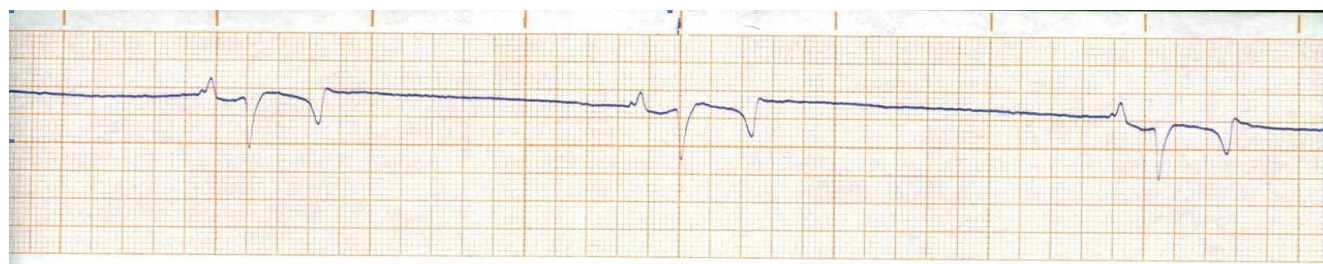


Fig. (2): Sinus bradycardia in a 7-year-old Kurdish male horse suffering from pneumonia



Fig. (3): Sinus tachycardia in a male horse (102/min)



Fig. (4): Sinus arrhythmia in a 6-year-old female horse

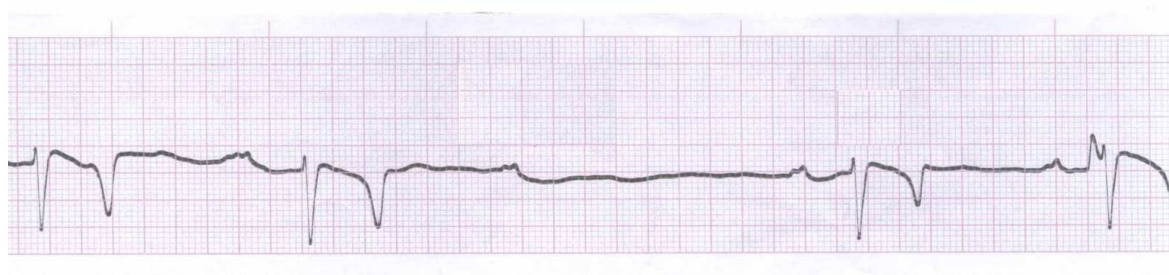


Fig. (5): Second degree atrioventricular block in a 5-year-old male horse



Fig. (6): Supraventricular premature contraction in a 14-year-old male horse suffering from pneumonia

DISCUSSION

The average heart rate in sick group indicated a significant increase ($p < 0.001$). The fever and pain caused by disease lead to an increase in heart rate. In sick group, the number of horses with normal cardiac rhythm was less comparing to the horses of healthy group, which was a significant change between two groups. Pneumonia, because of anorexia, biochemical changes of blood and because of increase in performance and cardiac contraction, makes some changes in electrocardiogram and rhythm of heart; the cited changes are considered to be physiological cases, in the current research similar result was achieved and the number of cases with normal cardiac rhythm indicated a decrease. Pneumonia caused an increase in sinus tachycardia which was a significant increase ($p < 0.05$). Sinus tachycardia, representing an increase in heart rate, is created by some factors accompanied by pain, excitement,

anxiety and other stress causing factors. Pathological tachycardia might appear as secondary, caused by general diseases or it might appear as primary, caused by specific cardiac disorders. Fever, hypoxia, bleeding, anemia are the factors that cause pathological sinus tachycardia as secondary, and other factors such as congestive heart failure, myocardial infarction cause primary pathological sinus tachycardia. In respect to single-hoofed animals and cows, it was well proved that toxication was caused by eating a lot of Oleander and accordingly by sympathetic stimulation of sinus tachycardia [6]. The caused biochemical changes of sick horses mainly suggested the following issues. There was sinus bradycardia in one of the horses suffering from pneumonia. Bradycardia has got an outer source rather than the heart itself, and factors such as medicines, the balance failure of autonomic nervous system, hypothermia, hypokalemia played considerable roles in creating bradycardia. Sinus bradycardia is also created by increased vagal activity, decreased activity of the sympathetic nervous system, or by anatomic changes in sinus node. It could be assumed that the effect of vagal, plays the most critical role in this regard [7]. About the mentioned horses, the amount of calcium, glucose and sodium serum were less than normal level, which _considering this biochemical panel_ makes the sinus bradycardia of the mentioned livestock justifiable, and it is presumed to be a physiological arrhythmia. Supraventricular premature contraction was from the sort of arrhythmias, that wasn't found in the healthy group, whereas in two horses of the sick group it was detected. Premature beats or additional systoles are caused by discharge of impulses from irritable foci that are inside myocardium; and based on their sources, they are categorized into: atrial premature beats, junctional premature beats and premature ventricular beats. It is often impossible to distinguish them by clinical examination, particularly in regard to heart beats. If the cited heartbeats do not have any impact on ventricular rhythm, it won't be possible to diagnose it through physical examination, in case the irritability caused by premature atrial contractions reaches ventricle, at the time of the irritability of ventricles, the ventricles will contract before the expected time. Because of less filling up of diastole and the decreased amplitude of arterial pulse related to this premature contractions, ventricular contractions initiated by atrial premature beats, have got less intensity [8 ,9].

In one of the horses of the healthy group and two of the horses of the sick group, sinus arrhythmia was detected, which not a significant change was recorded in this regard. Sinus arrhythmia is from physiological arrhythmias in which the coming out impulses from atrial sinus node continuously become slow and fast; in some of the livestock such as horses, the cited arrhythmia is considered to be related to animal's breathing (inspiratory and expiratory) and the vagal tone [10]. In respect to healthy group, in 3 horses there was first degree atrioventricular block, in one horse there was second degree atrioventricular block; on the other hand, in respect to sick group, merely in one horse there was second degree atrioventricular block. First and second degree atrioventricular block are assumed to be from physiological arrhythmias in horses. Nevertheless, in case the cited two atrioventricular block(s) cause problem for the ability of the animal to exercise, they will be assumed as pathology in horses, although because of the fact that the animal hasn't got any problem in regard to its ability to exercise, thus it could be said that all the recorded atrioventricular block cases throughout the current research are assumed to be physiological; and their occurrence could be related to electrolyte changes, as 3 of the recorded cases had hypercalcemia. Nowadays the existence of second degree block in horses which is constant in regular obtain of ECG, is considered to be abnormal; and it is believed that it is a matter to draw attention to, anyhow it is beyond doubt that the causes of A-V second degree block are: Atrioventricular conduction disturbance which is resulted from the imbalance of electrolytes, exceeding prescription of calcium salts, poisoned with digitalin and low amount of oleander, cardiomyopathies and myocarditis accompanied with nutrition disorders as well as infectious diseases. In two cases of arrhythmia, in suffering sheep, sarcosporidiosis was detected (Robert and Sonneblick). Throughout a research, which has been conducted lately, from 50 horses that had undergone exploratory celiotomy, Electrocardiography was obtained: 8 horses (23%) were suffering from ventricular premature beats, 4 horses (11%) were suffering from sudden ventricular tachycardia and 11 horses (31%) were suffering from supraventricular premature beats [4]. In the opinion of the researchers of the above cited research, the main causes of these secondary arrhythmias are the impact of endotoxin on cardiomyocytes, autonomic neuropathy, acid base disorders and electrolyte imbalance [11].

The average time duration and the recorded waves' distances about the horses of either of groups which the study was carried out on them, indicated insignificant changes. In respect to P wave in the healthy group, 18 cases were double-phase positive, whereas in the sick group, 20 cases were double-phase positive, and the rest of the cases were single-phase positive. In huge livestock, like horse, P wave in most of the cases is double-phase, which is not considered to be arrhythmia; whereas, if you encounter the same change of P wave about small livestock, it will be assumed as premature atrial contraction or atrial tachycardia, and in advanced cases it will presumed as atrial fibrillation [12]. The shapes of QRS complex were different in two groups, which was consistent with the other

researches' results. Fregin (1982) announced the average time duration of QRS as 0.130s for Thoroughbred races and Standardbred races in derivation II [13].

T wave in regard to being positive or negative, in either of healthy and sick groups indicated different shapes. The positive or negative T wave is not considered as arrhythmia and could be recorded in any shape about horses. The average height of waves, in regard to p wave as well as T wave, didn't indicate a significant change between two groups; whereas, in sick group the height of QRS wave showed a significant increase. The change of QRS wave's height might be relevant to the increased ventricular contractile force, which is resulted from the increased pulmonary vascular resistance caused by disease. Fregin, within a research, has reported the QRS wave's height as 1.86mV in Thoroughbred horses [13].

In conclusion the result indicate that pneumonia leads to electrocardiographic changes in horses, and the majority of the cited changes is physiological changes, which by treatment and eliminating the electrolyte imbalances caused by them, could be eradicated.

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