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Original article

COMPREHENSIVE MONITORING AND PREDICTION OF PRENATAL DISORDERS IN CALVES BORN FROM COWS WITH COMPLICATED PREGNANCY

*V.S. Samoylenko, A.A. Lapina, A.I. Zhivoderova,
S.V. Pushkin, E.V. Svetlakova*

Abstract

Background. In recent years, there has been a growing interest in modern methods for diagnosing fetoplacental insufficiency in cattle, which is due to the need to improve the reproductive health of animals and the quality of newborn offspring. The use of echographic and electrocardiographic methods makes it possible not only to assess in detail the condition of the fetus and uterus, but also to predict the course of pregnancy, which is crucial for preventing adverse outcomes. Particular attention is paid to hypoxic myocardial damage in cows, which is identified as one of the leading causes of adverse reproductive outcomes. This condition is associated with metabolic disorders, which in turn leads to the development of pathological metabolic acidosis. Acidosis has a depressing effect on enzymatic processes in the fetus, which can cause serious disturbances in its development and, as a result, negatively affect the health of newborn calves. The introduction of comprehensive monitoring, including regular ultrasound examinations and electrocardiographic monitoring, allows for timely detection of predisposition to fetoplacental insufficiency. This, in turn, creates the opportunity for early intervention and correction of identified disorders, which contributes to improving pregnancy outcomes and reducing the risk of prenatal pathologies.

Purpose. The objective of the present study is to develop methods for comprehensive monitoring in order to predict prenatal disorders in calves born from cows with complicated pregnancy.

Materials and methods. At the SPK Plemzavod Vtoraya Pyatiletka, from 2023 to 2024, the main studies on monitoring and predicting prenatal disorders in calves born to cows with fetoplacental insufficiency were carried out.

As an object of research, 200 heads of dry first-calf cows aged 24 to 48 months were selected by the blind sampling method. Thus, the first group (A) consisted of 100 animals with uncomplicated pregnancy and childbirth, while the second group (B) included 100 animals with complicated pregnancy due to feto- and uteroplacental insufficiency.

The selection of the livestock was carried out on the basis of anamnesis and physiological examination. To monitor and predict prenatal lesions in calves born to cows with feto- and uteroplacental insufficiency, a comprehensive clinical and laboratory study was conducted, namely: detection of signs of acute intrauterine fetal hypoxia during cardiographic monitoring using a Schiller AG Cardiovit AT-1 VET electrocardiograph, while assessing the heart rate (HR), morphology of the P wave, QRS complex and T wave, amplitude and duration of the P wave, QRS complex and T wave, duration of PR and QT intervals.

Determination of fetal growth deviations, echogenicity of the coruncle structure was carried out based on the results of an ultrasound examination using the Easy-Scan:Go device for cattle.

Evaluation of the decrease in blood flow and the state of the vessels in the fetal-uterine interface were determined by Dopplerography using a veterinary echograph Doppler FDC8100V from the manufacturer Shenzhen Well.D Medical Electronics.

Results. According to the obtained results of Dopplerography, 76% of cows with complicated pregnancy from group B have a decrease in blood flow through the fetal-uterine interface, which indicates a state of stress of the fetus and its underdevelopment. In addition, 54% of animals from group B have changes in blood flow pulsation and blood oxygenation. In cows of group A, the results of Dopplerography are within the normal range, only 15% of animals have increased oxygenation rates, which do not have serious consequences for the further development of the fetus.

Conclusion. Early diagnosis and timely administration of preventive and therapeutic measures are necessary to prevent the risk of developing postnatally significant diseases and improve the reproductive health of cattle. The introduction of an integrated approach to monitoring and predicting prenatal disorders can significantly improve the effectiveness of veterinary practice and ensure the well-being of both mothers and newborns.

Keywords: prenatal disorders; cattle; complicated pregnancy; feto- and uteroplacental insufficiency

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Научная статья

КОМПЛЕКСНЫЙ МОНИТОРИНГ И ПРОГНОЗИРОВАНИЕ ПРЕНАТАЛЬНЫХ НАРУШЕНИЙ У ТЕЛЯТ, РОЖДЕННЫХ ОТ КОРОВ С ОСЛОЖНЕННОЙ БЕРЕМЕННОСТЬЮ

*В.С. Самойленко, А.А. Лапина, А.И. Живодерова,
С.В. Пушкин, Е.В. Светлакова*

Аннотация

Обоснование. В последние годы возрос интерес к современным методам диагностики фето- и маточно-плацентарной недостаточности у крупного рогатого скота, что обусловлено необходимостью улучшения репродуктивного здоровья животных и качества новорожденного потомства. Использование эхографических и электрокардиографических методов позволяет не только детально оценить состояние плода и матки, но и прогнозировать течение беременности, что крайне важно для предотвращения неблагоприятных исходов. Особое внимание уделяется гипоксическому повреждению миокарда у коров, которое считается одной из ведущих причин неблагоприятных репродуктивных исходов. Это состояние связано с метаболическими нарушениями, которые, в свою очередь, приводят к развитию патологического метаболического ацидоза. Ацидоз оказывает угнетающее воздействие на ферментативные процессы в организме плода, что может вызвать серьезные нарушения в его развитии и, как следствие, негативно отразиться на здоровье новорожденных телят. Внедрение комплексного мониторинга, включающего регулярные ультразвуковые исследования и электрокардиографический контроль, позволяет своевременно выявить предрасположенность к фето- и маточно-плацентарной недостаточности. Это, в свою очередь, создает возможность для раннего вмешательства и коррекции выявленных нарушений, что способствует улучшению исходов беременности и снижению риска развития пренатальных патологий.

Цель. Цель настоящего исследования – разработать методы комплексного мониторинга для прогнозирования пренатальных нарушений у телят, рожденных от коров с осложненной беременностью.

Материалы и методы. В СПК «Племзавод „Вторая Пятилетка“ в 2023-2024 гг. были проведены основные исследования по мониторингу и прогно-

зированию пренатальных нарушений у телят, рожденных от коров с фето- и маточно-плацентарной недостаточностью.

В качестве объекта исследований методом слепой выборки было отобрано 200 голов сухостойных коров-первотелок в возрасте от 24 до 48 месяцев. Таким образом, в первую группу (А) вошли 100 животных с неосложненной беременностью и родами, во вторую группу (Б) – 100 животных с осложненной беременностью, обусловленной фето- и маточно-плацентарной недостаточностью.

Отбор поголовья проводился на основании анамнеза и физиологического обследования. Для мониторинга и прогнозирования пренатальных поражений у телят, рожденных от коров с фето- и маточно-плацентарной недостаточностью, было проведено комплексное клинично-лабораторное исследование, а именно: выявление признаков острой внутриутробной гипоксии плода при кардиографическом мониторинге с использованием электрокардиографа Schiller AG Cardiovit AT-1 VET с оценкой частоты сердечных сокращений (ЧСС), морфологии Р-волны, комплекса QRS и Т-волны, амплитуды и продолжительности Р-волны, комплекса QRS и Т-волны, продолжительности интервалов PR и QT.

Определение отклонений роста плода, экзогенности структуры венчика проводили по результатам ультразвукового исследования с использованием аппарата Easy-Scan:Go для крупного рогатого скота.

Оценку снижения кровотока и состояния сосудов в плодово-маточном промежутке определяли методом доплерографии с помощью ветеринарного эхографа Doppler FDC8100V от производителя Shenzhen Well.D Medical Electronics.

Результаты. Согласно полученным результатам доплерографии, у 76% коров с осложненной беременностью из группы Б отмечается снижение кровотока через плодово-маточный интерфейс, что свидетельствует о состоянии стресса плода и его недоразвитии. Кроме того, у 54% животных из группы В отмечаются изменения пульсации кровотока и оксигенации крови. У коров группы А результаты доплерографии находятся в пределах нормы, только у 15% животных повышены показатели оксигенации, что не имеет серьезных последствий для дальнейшего развития плода.

Выводы. Ранняя диагностика и своевременное проведение профилактических и лечебных мероприятий необходимы для предотвращения риска развития постнатально значимых заболеваний и улучшения репродуктивного здоровья крупного рогатого скота. Внедрение комплексного подхода к мониторингу и прогнозированию пренатальных нарушений может значительно

повысить эффективность ветеринарной практики и обеспечить благополучие как матерей, так и новорожденных.

Ключевые слова: пренатальные нарушения; крупный рогатый скот; осложненная беременность; фето- и маточно-плацентарная недостаточность

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Introduction

Comprehensive monitoring and prediction of prenatal disorders in calves born to cows with complicated pregnancy is an important and urgent task in veterinary medicine and animal husbandry. Prenatal disorders can have a significant impact on the health of both the mother and the newborn offspring, which emphasizes the need to implement effective diagnostic and preventive measures. In the conditions of modern animal husbandry, where high economic costs and product quality requirements are becoming increasingly important, early diagnosis and correction of pregnancy pathologies are becoming critically important.

Modern methods of ultrasound diagnostics and electrocardiography provide veterinary specialists with the opportunity to obtain objective information about the condition of the fetus and the cow, which is key to the timely detection and correction of pathologies.

Ultrasound diagnostics allows not only to visualize the fetus, but also to assess its viability, size, position and heartbeat, as well as to examine the condition of the uterus and placenta [1]. This method enables to detect signs of uteroplacental circulation disorders, such as increased placental thickness, edema, and impaired blood flow in large uterine vessels, which may indicate the development of fetoplacental insufficiency.

Ultrasound diagnostics is an important tool for fetal visualization, assessment of its viability, size, position, and heartbeat, as well as the condition of the uterus and placenta. Using this method, it is possible to detect signs of uteroplacental circulation disorders, such as increased placental thickness and edema [11]. In addition, fetal electrocardiography allows to assess cardiac activity and detect rhythm and conduction disorders, which may indicate fetal oxygen starvation [12].

The combined use of ultrasound and electrocardiography in pregnant cows significantly increases the accuracy of diagnostics and allows timely veterinary

measures to preserve the fetus [15]. Thus, the integration of these modern diagnostic methods into veterinary medical practice represents an important step towards improving the reproductive health of cattle and reducing the risks associated with prenatal disorders.

Purpose. The objective of the present study is to develop methods for comprehensive monitoring in order to predict prenatal disorders in calves born from cows with complicated pregnancy.

Materials and methods

At the SPK Plemzavod Vtoraya Pyatiletka, from 2023 to 2024, the main studies on monitoring and predicting prenatal disorders in calves born to cows with feto- and uteroplacental insufficiency were carried out.

As an object of research, 200 heads of dry first-calf cows aged 24 to 48 months were selected by the blind sampling method. Thus, the first group (A) consisted of 100 animals with uncomplicated pregnancy and childbirth, while the second group (B) included 100 animals with complicated pregnancy due to feto- and uteroplacental insufficiency.

The selection of the livestock was carried out on the basis of anamnesis and physiological examination. To monitor and predict prenatal lesions in calves born to cows with feto- and uteroplacental insufficiency, a comprehensive clinical and laboratory study was conducted, namely: detection of signs of acute intrauterine fetal hypoxia during cardiographic monitoring using a Schiller AG Cardiovit AT-1 VET electrocardiograph, while assessing the heart rate (HR), morphology of the P wave, QRS complex and T wave, amplitude and duration of the P wave, QRS complex and T wave, duration of PR and QT intervals.

Determination of fetal growth deviations, echogenicity of the coruncle structure was carried out based on the results of an ultrasound examination using the Easy-Scan:Go device for cattle.

Evaluation of the decrease in blood flow and the state of the vessels in the fetal-uterine interface were determined by Dopplerography using a veterinary echograph Doppler FDC8100V from the manufacturer Shenzhen Well.D Medical Electronics.

Results

Analysis of cardiographic studies in cows with complicated pregnancy

As a result of the electrocardiographic studies, 200 ECG records were obtained. The analysis of the records showed that pregnant cows from group B

with feto- and uteroplacental insufficiency show characteristic changes in cardiac activity, which indicates possible compensatory reactions of the fetus's body to this pathological condition (Table 1).

Table 1.

Indicators of electrocardiographic studies of cows

ECG parameters	Group A – pregnancy without complications Group			Group B – complicated (pathological) pregnancy		
	Median	Min	Max	Median	Min	Max
Heart rate (bpm)	70	49	95	99	68	130
P wave duration (seconds)	0,12	0,07	0,12	0,13	0,09	0,16
P wave amplitude (mV)	0,19	0,09	0, 23	0,21	0,11	0,26
QRS complex duration (seconds)	0,08	0,07	0,13	0,14	0,12	0,19
R wave amplitude (mB)	0,09	0,04	0,41	0,28	0,21	0,56
Q-T interval duration (seconds)	0,38	0,30	0,44	0,42	0,33	0,49
S-wave amplitude (mV)	0,70	0,42	1,11	0,71	0,40	1,10
T wave duration (seconds)	0,08	0,06	0,13	0,14	0,12	0,18
T wave amplitude (mV)	0,30	0,21	0,60	0,53	0,38	0,84
P-R interval duration (seconds)	0,19	0,12	0,25	0,23	0,17	0,29

ECG – electrocardiographic; bpm – beats per minute; mV – millivolts.

Thus, from the data in Table 1 obtained during the electrocardiographic study, it was established that 74% of cows from group B with complicated pregnancy have signs of acute intrauterine fetal hypoxia, namely, the changes were characterized by an increased heart rate from 68 to 130 beats per minute with an average value of a set of indicators of 99 beats per minute and a reliable prolongation of the QRS interval with an average median of 0.13 seconds, compared to group A by 38%, where the average median was 0.08 seconds. In addition, 71% of animals with signs of intrauterine fetal hypoxia have changes in the shape and amplitude of the teeth and segments, particularly in the T wave (Fig. 1).

Thus, changes in the ECG graphs in cows with complicated pregnancy were characterized by an increase in the median duration of the P-R intervals by 21.1% and Q-T by 10.5%, are associated with a pathological state of the heart and blood circulation in the fetus and its acute hypoxia, which in turn leads to various growth disorders, oxygen starvation and contributes to a decrease in nutrients in the fetus in group B, all other ECG parameters in cows from group B did not differ ($p > 0.07$).

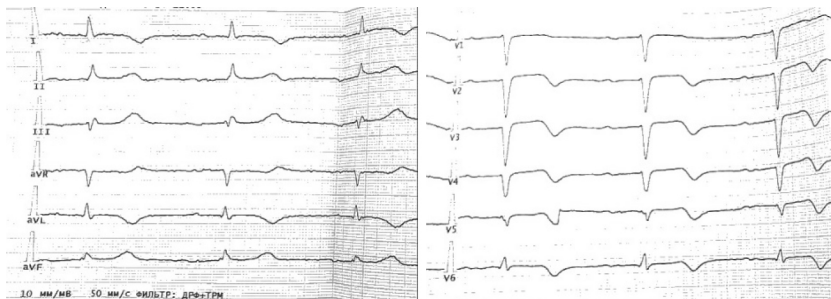


Fig. 1. Electrocardiogram of a cow from group B with uteroplacental insufficiency

Ultrasound examination assessment

At the same time, cows from group A did not have intrauterine fetal hypoxia, the duration of the P-R and Q-T intervals corresponded to the norm, the shape of the P, Q, R, S and T waves was of normal configuration, however, 32% of animals from this group had a slight increase in heart rate from 53 to 95 beats per minute with an average value of 74 beats per minute, which is typical for pregnant cows.

During the ultrasound examination conducted on cows from Group B with feto- and uteroplacental insufficiency, deviations were identified, namely, a decrease in the echogenicity of the caruncle structure was established, caused by insufficient communication between the caruncle and the placenta, which leads to insufficient supply of nutrients through the feto-uterine interface (Fig. 2).

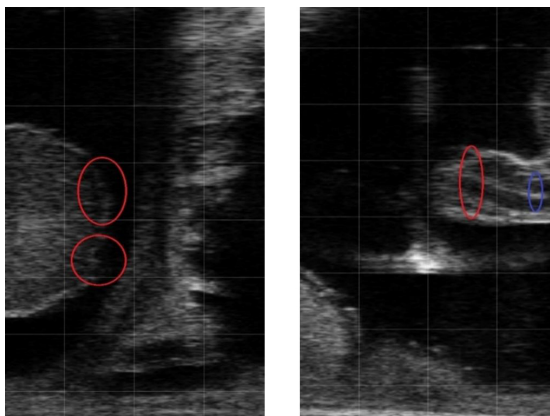


Fig. 2. Ultrasound results in complicated pregnancy.

Thus, from the data presented in Fig. 2, it is evident that cows from Group B were found to have stenosis of the vessel feeding the fetus, while 71% of animals from this group were found to have intrauterine growth retardation, 65% had underdevelopment of organs, in particular the lungs, spinal cord and heart, and 52% had oligohydramnios, in addition, 53% of pregnant cows had thickening of the placenta, abnormal localization and changes in the structure of the placenta.

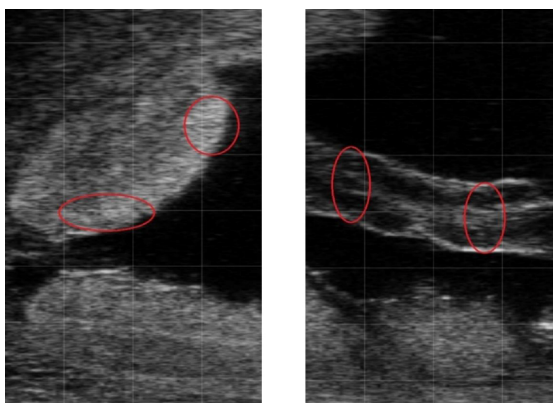


Fig. 3. Ultrasound results for physiological pregnancy.

In the same study, in cows from group A with uncomplicated pregnancy, the echogenicity of the caruncle was significantly higher, which indicates good contact with the placenta; no growth deviations in the fetus were recorded.

All pathological changes can disrupt the molecular structure of the placenta. Insufficient blood flow and reduced oxygen concentration lead to an imbalance in the processes of growth, differentiation, and secretion in placental cells (Table 2).

Table 2.

**Oxygenation level according to the results of Dopplerography
in cows from the experimental groups**

Study groups	Oxygenation level
A group – pregnancy without complications	PaO ₂ * – 25-35 mm Hg. SaO ₂ ** – 60-80%
Group B – complicated (pathological) pregnancy	PaO ₂ * – 14-22 mm Hg. SaO ₂ ** – 45-59%

* – partial pressure of oxygen in fetal arterial blood.

** – fetal blood oxygen saturation.

According to the obtained results of Dopplerography, 76% of cows with complicated pregnancy from group B have a decrease in blood flow through the fetal-uterine interface, which indicates a state of stress of the fetus and its underdevelopment. In addition, 54% of animals from group B have changes in blood flow pulsation and blood oxygenation. In cows of group A, the results of Dopplerography are within the normal range, only 15% of animals have increased oxygenation rates, which do not have serious consequences for the further development of the fetus.

Conclusion

As a result of the electrocardiographic analysis, significant changes in the cardiovascular system were revealed in cows with complicated pregnancy from group B, including an increased heart rate, varying from 68 to 130 beats per minute, with an average value of 99 beats per minute. A significant prolongation of the QRS interval to 0.13 seconds, which is 38% higher than the indicators of group A, as well as an increase in the median duration of the P-R and Q-T intervals by 21.1% and 10.5%, respectively, indicate the presence of serious disturbances in the electrophysiological state of the heart. In addition, a similar situation was observed during ultrasound examination and was characterized by stenosis of the nutrient vessel, a decrease in the echogenicity of the caruncle structure, caused by insufficient communication between the caruncle and the placenta, which leads to a deterioration in the supply of nutrients through the fetal-uterine interface and, as a consequence, a decrease in the concentration of oxygen in the blood.

Comprehensive monitoring of prenatal disorders in calves born to cows with fetoplacental insufficiency is critical to predicting the viability and productivity of newborn calves. Fetoplacental insufficiency is a serious problem that can lead to irreversible consequences, including malnutrition, stress and intrauterine infections, which negatively affect fetal development and weaken the bond between the fetus and the mother.

The long-term consequences of fetoplacental insufficiency can manifest as metabolic and immunological disorders in calves at an adult age, which increases the risk of a reduced immune response and predisposition to various diseases. In cattle, fetoplacental insufficiency can manifest itself as premature birth, which also emphasizes the importance of early diagnosis and intervention.

Fetoplacental insufficiency, a multifactorial condition, can result from hormonal and genetic disorders and manifests in two forms: early and late. The early form affects the formation of the placenta and can lead to fetal growth retardation

and embryonic death, while the late form, developing at 32-36 weeks of pregnancy, affects the functioning of the placenta and causes impaired fetal growth.

Thus, early diagnosis and timely administration of preventive and therapeutic measures are necessary to prevent the risk of developing postnatally significant diseases and improve the reproductive health of cattle. The introduction of an integrated approach to monitoring and predicting prenatal disorders can significantly improve the effectiveness of veterinary practice and ensure the well-being of both mothers and newborns.

Conflict of interest information. The authors declare that they have no conflict of interest.

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AUTHOR CONTRIBUTIONS

The authors contributed equally to this article.

ВКЛАД АВТОРОВ

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DATA ABOUT THE AUTHORS

Victor S. Samoylenko, Candidate of Veterinary Sciences, Associate Professor of the Department of Zoology and Parasitology
North-Caucasus Federal University
1, Pushkin Str., Stavropol, 355017, Russian Federation
viktor_samoylenko_26@mail.ru
SPIN-code: 5176-3852
ORCID: <https://orcid.org/0009-0005-3291-1241>
ResearcherID: LJL-0227-2024
Scopus Author ID: 57224938169

Anastasia A. Lapina, 3rd Year Student of the Medical and Biological Faculty
North-Caucasus Federal University
1, Pushkin Str., Stavropol, 355017, Russian Federation
anastasija.la2018@yandex.ru
ORCID: <https://orcid.org/0009-0002-5655-1170>
ResearcherID: MTB-9375-2025
Scopus Author ID: 59195785900

Anastasia I. Zhivoderova, Assistant of the Department of Zoology and Parasitology
North-Caucasus Federal University
1, Pushkin Str., Stavropol, 355017, Russian Federation
nastya.zhivoderova007@mail.ru
SPIN-code: 3876-2301
ORCID: <https://orcid.org/0009-0004-8661-6099>
ResearcherID: MTB-9052-2025
Scopus Author ID: 11892467290

Sergey V. Pushkin, Candidate of Biological Sciences, Associate Professor of the Department of Zoology and Parasitology
North-Caucasus Federal University
1, Pushkin Str., Stavropol, 355017, Russian Federation
sergey-pushkin-st@yandex.ru
SPIN-code: 7252-9738
ORCID: <https://orcid.org/0000-0003-1861-0213>
ResearcherID: K-1073-2014
Scopus Author ID: 6701442048

Elena V. Svetlakova, Candidate of Biological Sciences, Associate Professor of the Basic Department of Epizootology and Microbiology of the Institute of Veterinary Medicine and Biotechnology
North-Caucasus Federal University
1, Pushkin Str., Stavropol, 355017, Russian Federation
alenska612190@mail.ru
SPIN-code: 4981-5119
ORCID: <https://orcid.org/0009-0004-9279-1870>
ResearcherID: IUM-7074-2023
Scopus Author ID: 57188729071

ДАННЫЕ ОБ АВТОРАХ

Самойленко Виктор Сергеевич, к-т вет. наук, доцент кафедры зоологии и паразитологии
ФГАОУ ВО «Северо-Кавказский федеральный университет»
ул. Пушкина, 1, г. Ставрополь, 355017, Российская Федерация
viktor_samoylenko_26@mail.ru

Лапина Анастасия Александровна, студентка Медико-биологического факультета
ФГАОУ ВО «Северо-Кавказский федеральный университет»
ул. Пушкина, 1, г. Ставрополь, 355017, Российская Федерация
anastasija.la2018@yandex.ru

Живодерова Анастасия Игоревна, ассистент кафедры зоологии и паразитологии
ФГАОУ ВО «Северо-Кавказский федеральный университет»
ул. Пушкина, 1, г. Ставрополь, 355017, Российская Федерация
nastya.zhivoderova007@mail.ru

Пушкин Сергей Викторович, кандидат биологических наук, доцент кафедры зоологии и паразитологии
ФГАОУ ВО «Северо-Кавказский федеральный университет»
ул. Пушкина, 1, г. Ставрополь, 355017, Российская Федерация
sergey-pushkin-st@yandex.ru

Светлакова Елена Валентиновна, канд. биол. наук, доцент базовой кафедры эпизоотологии и микробиологии института ветеринарии и биотехнологий
ФГАОУ ВО «Северо-Кавказский федеральный университет»
ул. Пушкина, 1, г. Ставрополь, 355017, Российская Федерация
alenka612190@mail.ru

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