DOI: 10.29326/2304-196X-2022-11-3-203-209



# Respiratory diseases in young cattle

**T. S. Ermilova[1], M. A. Samburova[2], O. V. Kasharnaya[3], E. A. O. Salimzade[4]**

[1, 3, 4] FSBEI HE "Astrakhan State University", Astrakhan, Russia

[2] "BIOS" LLC, Moscow, Russia

[1] *https://orcid.org/0000-0002-8251-8545, e-mail: tatjana.br94@yandex.ru*

[2] *https://orcid.org/0000-0001-9551-0860, e-mail: samburova.m.20@mail.ru*

[3] *https://orcid.org/0000-0003-3402-2729, e-mail: olga.i.karat@yandex.ru*

[4] *https://orcid.org/0000-0002-4389-2892, e-mail: salimzade.emil@bk.ru*

**SUMMARY**

The following review considers modern scientific data on respiratory diseases in young cattle. The problem of respiratory diseases in calves does not lose its relevance, since these pathologies rank second in frequency after diseases of the digestive system. In order to compile the data, the works of domestic and foreign researchers and collectives available in the collections of scientific conferences, seminars, symposiums, as well as in peer-reviewed periodicals, materials of dissertations and abstracts were reviewed. The group of pathologies under consideration is sufficiently diverse and can be caused by high animal density in the premises, overheating, hypothermia, unbalanced feeding, micronutrient deficiency, decreased body resistance, unfavorable epidemic situation and many other factors. However, out of the major calf diseases, particular mention should be made of pneumonia, which is most often caused by viruses. In this case agents can induce bacterial infection which aggravates and complicates the course of viral diseases. Microorganisms, such as *Salmonella*, *Pasteurella* and others, contribute to secondary infection and cause mixed forms of pneumonia. Bronchopneumonia is another disease covered in the article. It is a respiratory pathology characterized by inflammation of both the bronchi and lungs. As a rule, such disease types are most common in industrial animal husbandry, they are widespread and cause significant economic damage to the dairy and beef cattle breeding industries. The article pays great attention to these pathologies, justifies the importance of comprehensive preventive measures and timely diagnosis for livestock industries. To reduce the incidence of respiratory diseases in young cattle, it is necessary to strictly follow technological and hygienic standards for animal keeping and feeding. The use of combined medicines and preparations containing microelements increases treatment effectiveness.

**Keywords:** review, young cattle, respiratory organs, respiratory diseases, pneumonia, bronchopneumonia

**For citation:** Ermilova T. S., Samburova M. A., Kasharnaya O. V., Salimzade E. A. O. Respiratory diseases in young cattle. *Veterinary Science Today*. 2022; 11 (3): 203–209. DOI: 10.29326/2304-196X-2022-11-3-203-209.

**Conflict of interest:** The authors declare no conflict of interest.

**For correspondence:** Margarita A. Samburova, Researcher, "BIOS" LLC, 105187, Russia, Moscow, ul. Vol'naya, 37, pomeshch. 1, et. 4, *e-mail: samburova.m.20@mail.ru.*

УДК 619:616.98:578.832.31:636.22./28.053.2

# Респираторные заболевания молодняка крупного рогатого скота

**Т. С. Ермилова[1], М. А. Самбурова[2], О. В. Кашарная[3], Э. А. О. Салимзаде[4]**

[1, 3, 4] ФГБОУ ВО «Астраханский государственный университет», г. Астрахань, Россия

[2] ООО «БИОС», Москва, Россия

[1] *https://orcid.org/0000-0002-8251-8545, e-mail: tatjana.br94@yandex.ru*

[2] *https://orcid.org/0000-0001-9551-0860, e-mail: samburova.m.20@mail.ru*

[3] *https://orcid.org/0000-0003-3402-2729, e-mail: olga.i.karat@yandex.ru*

[4] *https://orcid.org/0000-0002-4389-2892, e-mail: salimzade.emil@bk.ru*

**РЕЗЮМЕ**

В обзорной статье рассматриваются современные научные сведения о заболеваниях органов дыхания у молодняка крупного рогатого скота. Проблема респираторных заболеваний у телят не теряет актуальности, поскольку данные патологии занимают второе по распространенности место после болезней органов пищеварения. С целью систематизации данных проведен обзор работ отечественных и зарубежных исследователей и коллективов, доступных в сборниках научных конференций, семинаров, симпозиумов, а также в рецензируемых периодических научных изданиях, материалах диссертаций и авторефератов. Рассматриваемая группа патологий в достаточной степени разнообразна, может провоцироваться скученным содержанием животных, перегревом, переохлаждением, несбалансированным кормлением, дефицитом микроэлементов, снижением резистентности организма, неблагоприятной эпизоотической ситуацией и многими другими факторами. Однако среди основных заболеваний телят следует особо выделить пневмонию, которую чаще всего вызывают вирусы. При этом возбудители способны инициировать деятельность ряда бактерий, усугубляющих и осложняющих

течение вирусных заболеваний. Такие микроорганизмы, как сальмонеллы, пастереллы и другие, становятся участниками вторичного инфекционного процесса и создают смешанные формы пневмоний. Другое освещаемое в работе заболевание – бронхопневмония. Это респираторная патология, характеризующаяся воспалением одновременно бронхов и легких. В промышленном животноводстве такие формы заболеваний, как правило, встречаются наиболее часто, имеют повсеместное распространение и наносят значительный экономический ущерб отраслям молочного и мясного скотоводства. Названным патологиям в статье уделяется наибольшее внимание, обосновывается важность комплексных мер профилактики и своевременной диагностики в условиях промышленных животноводческих предприятий. Для снижения частоты возникновения респираторных заболеваний среди молодняка крупного рогатого скота необходимо четко следовать технологическим и гигиеническим нормам содержания и кормления животных. Использование комбинированных лекарственных средств и препаратов, содержащих микроэлементы, повышает эффективность лечения.

**Ключевые слова:** обзор, молодняк крупного рогатого скота, органы дыхания, респираторные заболевания, пневмония, бронхопневмония

**Для цитирования:** Ермилова Т. С., Самбурова М. А., Кашарная О. В., Салимзаде Э. А. О. Респираторные заболевания молодняка крупного рогатого скота. *Ветеринария сегодня*. 2022; 11 (3): 203–209. DOI: 10.29326/2304-196X-2022-11-3-203-209.

**Конфликт интересов:** Авторы заявляют об отсутствии конфликта интересов.

**Для корреспонденции:** Самбурова Маргарита Александровна, научный сотрудник ООО «БИОС», 105187, г. Москва, ул. Вольная, д. 37, помещ. 1, эт. 4, *e-mail: samburova.m.20@mail.ru.*

## INTRODUCTION

Respiratory system pathologies in young cattle are one of the major causes of livestock losses in dairy farming. Among calves in the first month of life, they are recorded in 17.2–23.6% of cases [1]. Respiratory diseases in calves are mostly caused by the following pathogens: parainfluenza-3 viruses, infectious rhinotracheitis, and parvo- and adenoviruses, as well as diarrhea, influenza and immunodeficiency viruses. In this regard, a comprehensive approach to the prevention and treatment of respiratory diseases in animals is required [2–4]. Thus, timely diagnosis, prevention and treatment of non-infectious respiratory diseases, among which pneumonia and bronchopneumonia causing the inflammation of the bronchi and lungs, is of crucial importance for cattle preservation and increase in livestock product manufacturing [5–7]. The pathology begins with serous exudation in the lung parenchyma, which is typical for catarrhal pneumonia. When first the bronchi are affected and then the process spreads rapidly through the bronchial tree, such a disease, occurring mainly in calves, is called bronchopneumonia [8, 9]. One of the predominant reasons triggering the disease in winter is hypothermia, in summer – overheating. Poor-quality feeding, lack of nutrients during intrauterine development and after birth has a negative impact on calves' body resistance [10, 11].

The purpose of this article is to analyze modern reported data on respiratory diseases in young cattle, their causes, as well as on methods of their prevention and therapy.

## MATERIALS AND METHODS

Methodological approaches are substantiated by the study of works of domestic and foreign researchers presented in the collections of scientific conferences, seminars, symposiums, peer-reviewed periodicals, materials of dissertations and abstracts. The obtained data as well as the research findings have been analyzed. The review presents data on the study of young cattle, conducted on the basis of farms in the Saratov, Voronezh, Nizhny Novgorod, Novosibirsk, and the south of the Tyumen Oblasts.

The respiratory system of cattle is comprised of the upper (nasal cavity, paranasal sinuses, part of the oral cavity, pharynx) and the lower (larynx, trachea, bronchi, lung alveoli) airways. The upper respiratory tract, trachea and bronchi make up the conducting zone of the respiratory system. The main function of the respiratory system is gas exchange – the delivery of oxygen to the body and the removal of carbon dioxide from it. The air entering the lungs is warmed up and disinfected in the upper respiratory tract, while gas exchange occurs in the lower respiratory tract, in the alveoli [12].

Animals can be affected by respiratory diseases of different etiologies up to several times a year. In food-producing animals, respiratory diseases account for about 35% of the total number of diseases of non–infectious etiology, while in non-food producing animals – 13–15% [13, 14]. Respiratory diseases in calves can be caused by non-infectious and infectious factors: viruses and secondary bacterial infection caused by pathogenic microflora.

Upper respiratory tract infections include pharyngitis (inflammation of the mucous membranes and lymphoid tissue of the pharynx), rhinitis (inflammation of the nasal mucosa), frontal and maxillary sinusitis (inflammation of the mucous membrane lining the sinuses), sore throat and tonsillitis (inflammation of the tonsils). Lower respiratory tract infections include bronchitis (inflammation of the bronchi), pneumonia (inflammation of the alveoli), bronchopneumonia (inflammatory process in the bronchi and alveoli, accompanied by the accumulation of exudate in the alveoli), laryngitis (inflammation of the larynx),

tracheitis (inflammation of the mucous membranes of the trachea), pleurisy (inflammation of the pleural linings), alveolitis (inflammation of the pulmonary alveoli) [15, 16].

Despite different etiology and ways of transmission, respiratory diseases share a number of common features in their pathogenesis. These features include mucus secretion in the bronchi; superficial peeling of the mucosa, the elements of which enter the bronchial lumen together with blood; decreased functional pulmonary volume; impairment of lung diffusion capacity, leading to changes in blood composition; bronchial and lung walls become less elastic, which leads to the increased energy expenditure for breathing. Severe forms of respiratory diseases may lead to animal death or emergency slaughter [17, 18].

Non-infectious factors contributing to the development of respiratory diseases include embryo developmental disorders, hypoxia, gestosis, provoking changes in the functional activity of the fetoplacental complex, adaptation disorders in the postnatal period. They may also include the increased density of animals in the premises and gas contamination [19, 20]. Exceeded levels of carbon dioxide, ammonia, methane, hydrogen sulfide cause irritation of the mucous membranes and lead to the inflammation of the respiratory tract. Violation of sanitary and hygienic standards in the premises where animals are kept leads to high contamination of the mucous membranes by opportunistic and pathogenic microorganisms. Respiratory diseases in animals may occur in case of decreased activity of antioxidant defense enzymes, insufficient intake of vitamins that act as antioxidants, since increasing free radical oxidation is a key factor in the inflammatory process [20, 21]. In addition to the lack of vitamins, non-specific resistance of calves is negatively affected by the deficiency of trace elements involved in adequate functioning of the immune system and the synthesis of antioxidant enzymes, for example, selenium, iodine and zinc.

Viruses and bacteria infect endothelial cells of the bronchi, penetrate into respiratory tract tissue, and then spread throughout the body with the blood flow. Temperature changes, high humidity in the premises, inadequate diet as well as vitamin and mineral imbalance also contribute to the disease occurrence. Viral infections, especially in case of contributing factors, spread rapidly and cause inflammatory reactions. Secondary bacterial infections cause purulent processes in the lungs, which leads to the death of animals [22].

Viral infections include infectious rhinotracheitis (herpesvirus infection), which damages the mucous membrane of the respiratory tract in young animals, and when complicated by bacterial agents, the disease proceeds in the form of purulent pneumonia. Some of the main clinical signs include: rhinitis, serous-catarrhal discharge from nasal cavity, conjunctivitis. The disease mainly affects calves of 1.5–4.0 months of age.

Lung damages are observed in calves of 3–6 months of age in case of parainfluenza-3. Clinical signs include cough and purulent sputum discharge from the nasopharynx, increased body temperature. The disease is often associated with other viral and bacterial agents, for example, *Mycoplasma bovis*, *Pasteurella multocida*, *Mannheimia haemolytica*. There is a high probability of the immunosuppressive effect of the virus [23].

Respiratory syncytial viral infection, occurring in the form of latent or acute respiratory illness, is manifested by high fever, catarrh of the upper respiratory tract, serous rhinitis. The prognosis of the disease is most often favorable.

Viral diarrhea is a disease of the mucous membranes of cattle which most often occurs as a result of intrauterine infection. The infection affects the animal's immune system and is characterized by the development of both intestinal and respiratory syndromes, formation of ulcers on the mucous membranes is observed.

Secondary bacterial infections include pasteurellosis (the causative agent *Mannheimia haemolytica* and *Pasteurella multocida*, serotype A), which cause pneumonia in the presence of contributing factors, or complicate the course of the primary viral infection.

The most common causative agent of mycoplasmosis in cattle is *Mycoplasma bovis*, which is becoming the main cause of pneumonia in young animals. The disease is often heralded by viral diarrhea, rhinotracheitis, coronavirus infection, often at an early age. Calves demonstrate decreased appetite, depression, nasal discharge, wet cough, wheezing. Other bacteria that cause secondary pneumonia in cattle are *Haemophilus*, *Klebsiella*, *Streptococcus* [22].

Pneumonia in calves occurs due to the extension of the infection from the upper respiratory tract. Pathogenic microorganisms located on the mucous membrane of the nasal cavity, paranasal sinuses, middle ear and larynx can be the cause of infection of the lower respiratory system. Rhinitis and inflammation of the paranasal sinuses are common in one-month-old calves and herald pneumonia [24]. In stressful conditions, when the body's defense mechanisms are compromised, pathogenic microflora causes the development of inflammation [25]. The inflammatory process can be localized in the alveoli, bronchi, individual lung lobes or in the entire lung. By the nature of inflammatory exudate, pneumonias can be catarrhal, fibrinous, serous, putrefactive, hemorrhagic, purulent and mixed. Catarrhal and fibrinous are the most common ones. Clinical signs of pneumonia include: increased respiratory rate with wheezing (more than 60 breaths/min); nasal (less often ocular) discharge; cough, sometimes with purulent sputum; temperature of 41–42 °C; diarrhea; dull demeanour; absence of rumination. In 4–5 months old calves pneumonia can become chronic with no distinct symptoms, while reduction in liveweight gain is observed. If the disease is caused by contributing factors and secondary bacterial infections, treatment with antibiotics is required. In case of viral and secondary bacterial infections, specific prevention is effective [22, 26].

Bronchopneumonia is manifested by inflammation of the bronchi and lung lobes with the accumulation of exudate and desquamated epithelial cells in the alveoli [27, 28]. Opportunistic microorganisms cause inflammation of the bronchi, bronchioles and alveoli. In addition to significant pathological changes in the lungs, malfunction of the central nervous, cardiovascular and other body systems is observed [29].

According to a number of authors, bronchopneumonia occupies a leading position in terms of morbidity and transmission rates among other pathologies of non–infectious etiology in 1.5–3.5-month-old calves. According to some data, in the Voronezh, Nizhny Novgorod,

Novosibirsk Oblasts, in different years, pathologies of the respiratory system affect 29.10–59.36% of calves per year, with the mortality rate of 6–35%. Animals that have suffered from the disease demonstrate developmental and growth delays, which makes them unsuitable for further use [30]. Clinical examination of calves with this pathology reveals dull demeanour: lowered ears, decreased appetite, standing on their own away from the herd; then respiratory signs appear – increased temperature (up to 40 °C), nasal discharge, cough, dyspnea, wheezing [31]. There are three main steps in bronchopneumonia treatment: stopping bacterial growth and reproduction, removal of accumulated exudate from the bronchi and detoxification of the animal's body [30]. To prevent bronchopneumonia in calves, it is necessary to control hygiene and temperature in the premises, as well as to provide a balanced diet for animals [3].

The mineral status of the animal, which depends on its mother's diet and the feed given to young animals, has a significant impact on the occurrence of respiratory diseases. Fetal intrauterine growth restriction due to the deficiency of such trace elements as copper, selenium, zinc, cobalt, manganese leads to 2.08-fold increase in respiratory disease cases in young animals in the neonatal period, 7.14-fold increase in bronchopneumonia cases, as compared to animals from cows with the physiological course of pregnancy; this, together with other factors or complicated course of pregnancy, leads to the weakening of the antioxidant defense system and, hence, to oxidative stress [32, 33].

Results of studies by D. Shukla et al. [34] proved the role of cobalt in the antioxidant protection of the lungs; its deficiency, along with the deficiency of copper, zinc, manganese and selenium, regulating the activity of superoxide dismutase, catalase and glutathione peroxidase, is a risk factor for the development of bronchopneumonia in calves.

Intrauterine disorders due to lack of trace elements in pregnant cows contribute to the development of respiratory diseases in calves. Maternal health determines fetal growth and wellbeing, the quality of colostrum and milk [35]. Shaposhnikov I. T. et al. [36] found that in case of protein and carbohydrate metabolism disorders and calcium deficiency, antioxidant deficiency is developed in down calvers, which leads to the development of respiratory and gastrointestinal diseases in their offsprings. Other researchers [33, 37] proved the role of oxidative stress in the pathogenesis of respiratory diseases in young cattle. The authors found that antioxidant deficiency, caused, in part, by the lack of trace elements, disrupts the regulation of free radical oxidation processes and contributes to the excessive amount of toxic protein and lipid peroxidation byproducts in the bronchoalveolar fluid and blood of sick animals, which not only damages cell membranes but also inhibits the immune system.

Pneumonia and bronchopneumonia morbidity rates in calves depend on chemical, physical, biological and environmental factors. This has been confirmed by studies conducted by V. M. Aksenova et al. [27]. Failure of the lung and bronchi defense mechanisms affected by pathogenic microflora, and other factors compromising the immunity, influence the occurrence and the course of respiratory infections [38, 39]. It has been proved that hypothermia of young animals leads to reductions in total immunoglobulin levels in blood serum and to the development of respiratory system pathologies in 59–69% of calves. Imbalance in "organism – environment" system may also play a certain role in the development of lung diseases in calves. There is a correlation between emissions of carbon monoxide, hydrocarbons into the atmosphere and the incidence of respiratory diseases in animals. Increase in the mortality rate from respiratory system pathologies in young animals was recorded in cities with the increased level of air pollution [40].

Calves under one year of age are most susceptible to respiratory diseases, and it should be noted that recovered animals can get infected again [3]. Since these pathologies are widespread, the incidence rate is quite high, and there is also a risk of disease reccurence, it is necessary to develop effective treatment regimens using modern drugs [31].

In case of calves recovering from bronchopneumonia, in addition to conventional therapy, including etiotropic treatment and novocaine blockade with 0.6% hydrogen peroxide in 0.9% sodium chloride at a dose of 0.4 mL/kg, it is recommended to administer 4 mL of "Antimiopathic" on the first day, which helps to correct antioxidant deficiency and acid-base balance. This product is based on vitamins and trace elements, it successfully replenishes deficient elements and helps to normalize trace element homeostasis.

To prevent the development of respiratory diseases in newborn calves, calvers should be injected with "Antimiopathic" in a single dose of 10 mL 60, 40 and 20 days before calving; this will enhance antioxidant protection in the newborn calves and reduce their oxidative stress, compensate for postnatal hypoxia, acidosis and will lead to the early formation of colostral immunity [19].

Respiratory diseases cause important economic losses in industrial animal husbandry. To increase the effectiveness of treatment of pneumonia in livestock, it is necessary to optimize young animal nutrition as well as to use combination medicines and preparations containing trace elements. Animal keeping standards must comply with the existing requirements [41]. A comprehensive approach is needed in the treatment of pneumonia and bronchopneumonia, since their etiology is multifactorial. Therefore, in modern production, veterinarians use vitamin and mineral complexes, drugs and broad-spectrum antibiotics to treat respiratory diseases [42].

## CONCLUSION

Nowadays, respiratory diseases are widespread in young cattle, they are characterized by a variety of pathoetiology, but the most common factor in the development of pathology is decreased body resistance. Therefore, it is necessary to take measures to prevent and promptly detect pneumonia, bronchopneumonia and other respiratory system diseases, which include clinical examination of animals and blood tests, as well as to introduce effective treatment and prevention regimens.

To reduce the incidence of respiratory diseases in young cattle, it is necessary to strictly follow technological and hygienic standards for animal keeping and feeding. Timely vaccination of calves and the use of vitamin and mineral premixes have a high preventive effect.

Such preventive measures contribute to the reduction of morbidity and, consequently, reduce the costs of treatment and the likelihood of early death in young animals, thus, preventing economic losses.

## REFERENCES


1. Guterbock W. M. The impact of BRD: the current dairy experience. *Anim. Health Res. Rev*. 2014; 15 (2): 130–134. DOI: 10.1017/S1466252314000140.

2. Glotov A. G., Petrova O. G., Glotova T. I., Nefedchenko A. V., Tatarchuck A. T., Koteneva S. V., et al. Rasprostranenie virusnyh respiratornyh boleznej krupnogo rogatogo skota = Spread of viral diseases of the bovine respiratory tract. *Veterinariya*. 2002; 3: 17–21. eLIBRARY ID: 22435011. (in Russ.)

3. Shulga N. N., Ryabukha V. A., Shulga I. S., Dikunina S. S., Dudkina D. V. The etiology of respiratory diseases of calves in the Far East. *Veterinaria I kormlenie*. 2014; 2: 15–16. Available at: http://vetkorm.ru/magasines/veterinariya-i-kormlenie-2-mart-aprel-2014g. (in Russ.)

4. Zimina A. P., Badova O. V. Improvement of scheme treatment bronchopneumonia in calves with free group keeping. *Molodezh' I nauka*. 2017; 3: 20. eLIBRARY ID: 29148337. (in Russ.)

5. Dikunina S. S., Plavchak L. P., Shul'ga I. S., Shul'ga N. N. Technological scheme of prevention of respiratory diseases of newborn calves. *The Bulletin of KrasGAU*. 2015; 12: 198–202. eLIBRARY ID: 25054298. (in Russ.)

6. Sivkov G. S., Domatskii V. N., Pavlov S. D., Pavlova R. P., Derkach S. V., Glazunova L. A., et al. Protection of cattle from pathogens. Tyumen: VektorBuk; 2010. 152 p. (in Russ.)

7. Gagaryn E. M., Glazunov Y. V. The effectiveness of therapeutic and preventive measures in orthopedic pathologies in cattle in modern cattle-breeding complex. *Aktual'nye voprosy nauki I khozyaistva: novye vyzovy i resheniya: sbornik materialov LII Mezhdunarodnoi studencheskoi nauchno-prakticheskoi konferentsii = Topical issues of science and economy: new challenges and solutions: collection of materials of the LII International Student Scientific and Practical Conference*. Tyumen: Northern Trans-Ural State Agricultural University; 2018; 241–245. eLIBRARY ID: 35230431. (in Russ.)

8. Plotnikov I. V., Glazunova L. A. Analysis of disposal of cattle in Tyumen Region. *Innovatsionnye tendentsii razvitiya rossiiskoi nauki: materialy X Mezhdunarodnoi nauchno-prakticheskoi konferentsiya molodykh uchenykh, posvyashchennoi Godu ekologii I 65-letiyu Krasnoyarskogo GAU = Innovative trends in the development of Russian science: materials of the X International Scientific and Practical Conference of Young Scientists dedicated to the Year of Ecology and to the 65th anniversary of the Krasnoyarsk State Agrarian University.* 2017; 80–82. eLIBRARY ID: 29213001. (in Russ.)

9. Plotnikov I. V., Glazunova L. A. Studying the efficiency of the modes of aerosol disinfection of cattle-breeding premises in the presence of animals. *The Bulletin of KrasGAU*. 2019; 9: 91–97. eLIBRARY ID: 41172908. (in Russ.)

10. Krapovnitskaya V. V., Glazunov Yu. V. Modern methods of treatment of bronchopneumonia at the enterprise of the south of the Tyumen Region. *Aktual'nye voprosy nauki i khozyaistva: novye vyzovy i resheniya: sbornik materialov LIV Studencheskoi nauchno-prakticheskoi konferentsii = Topical issues of science and economy: new challenges and solutions: collection of materials of the LIV Student scientific and practical conference.* Tyumen: Northern Trans-Ural State Agricultural University; 2020; 322–328. eLIBRARY ID: 44432838. (in Russ.)

11. Lee S., Kim J., Kim D. Bacterial pathogens and their antimicrobial susceptibility in calves with summer pneumonia. *J. Vet. Clin*. 2017; 34 (3): 161–164. DOI: 10.17555/jvc.2017.06.34.3.161.

12. Lopez A., Martinson S. A. Respiratory System, Mediastinum, and Pleurae. *In: Pathologic Basis of Veterinary Disease. Ed. J. F. Zachary. 6th ed*. 2017; Chapter 9: 471–560. DOI: 10.1016/B978-0-323-35775-3.00009-6.

13. Kastarnova E. S., Orobets V. A. Allergenic and irritating properties of new selective drugs based on exosomal and chitosan particles. *Nauchnaya zhizn' = Scientific Life*. 2020; 15 (7): 999–1006. DOI: 10.35679/1991-9476-2020-15-7-999-1006. (in Russ.)

14. Ryazantsev S. V., Kotserovets V. I. Etiopathogenetic therapy of upper respiratory tract and ear diseases. Methodological recommendations. Saint Petersburg: Natsional'nyi registr; 2008. 100 c. (in Russ.)

15. Markova T. P. Profilaktika i lechenie respiratornykh infektsii = Prevention and treatment of respiratory infections. *Russian Medical Journal*. 2010; 18 (2): 77–81. Available at: https://www.rmj.ru/articles/infektsionnye_bolezni/Profilaktika_i_lechenie_respiratornyh_infekciy. (in Russ.)

16. Gaskell R., Bennett M. Handbook of infectious diseases of dogs and cats. Moscow: Akvarium-Print; 2015. 200 p. (in Russ.)

17. Peek S. F., Ollivett T. L., Divers T. J. Respiratory Diseases. *In: Rebhun's Diseases of Dairy Cattle. Eds. S. F. Peek, T. J. Divers. 3rd ed*. Philadelphia: Saunders; 2018; 94–167. DOI: 10.1016/B978-0-323-39055-2.00004-8.

18. Chung K. F., Caramori G., Groneberg D. A. Airway obstruction in chronic obstructive pulmonary disease. *N. Engl. J. Med.* 2004; 351 (14): 1459–1461; DOI: 10.1056/NEJM200409303511420.

19. Kalaeva E. A., Kalaev V. N., Chernitskiy A. E., Alhamed M., Safonov V. A. Role of microelement and hematological status of mother and fetus in the formation of predisposition to the development of bronchopneumonia in calves during the neonatal period. *Problems of Productive Animal Biology*. 2019; 2: 44–53. DOI: 10.25687/1996-6733.prodanimbiol.2019.2.44-53. (in Russ.)

20. Chamberlain T. Environmental aspects of pneumonia control in calf units on British dairy farms. *Livestock*. 2015; 20 (6): 306–314. DOI: 10.12968/live.2015.20.6.306.

21. Retsky M. I., Bliznetsova G. N., Nezhdanov A. G., Safonov V. A., Ventsova I. Yu. Influence of balance of active oxygen forms and nitrogen on development obstetric complications at cows. *Transactions of the Educational Establishment "Vitebsk the Order of "the Badge of Honor" State Academy of Veterinary Medicine.* 2011; 47 (2-2): 102–104. Available at: https://repo.vsavm.by/bitstream/123456789/572/3/z-2011-47-2-2-102-104.pdf. (in Russ.)

22. Oleynik A. Strategiya profilaktiki respiratornykh boleznei telyat = Strategy of prevention of respiratory diseases in calves. *Dairy and Beef Cattle Farming*. 2009; 6: 35–36. eLIBRARY ID: 12836643. (in Russ.)

23. Albayrak H., Yazici Z., Ozan E., Tamer C., Abd El Wahed A., Wehner S., et al. Characterisation of the first bovine parainfluenza virus 3 isolate detected in cattle in Turkey. *Vet. Sci*. 2019; 6 (2):56. DOI: 10.3390/vetsci6020056.

24. Kukina O. V. The surgical treatment of calves sinusitis. *International Bulletin of Veterinary Medicine*. 2015; 3: 13–18. eLIBRARY ID: 24310214. (in Russ.)

25. Bosch A. A., Biesbroek G., Trzcinski K., Sanders E. A., Bogaert D. Viral and bacterial interactions in the upper respiratory tract. *PLoS Pathog*. 2013; 9 (1):e1003057. DOI: 10.1371/journal.ppat.1003057.

26. Nezhdanov A. G., Shabunin S. V., Safonov V. A., Malanych E. V. Sistemnoe reshenie problemy sokhraneniya reproduktivnogo potentsiala molochnogo skota v usloviyakh promyshlennykh tekhnologii ego ekspluatatsii = Systematic approach to reproductive management in dairy cattle using industrial technologies. *Agrarnaya nauka – sel'skokhozyaistvennomu proizvodstvu Sibiri, Kazakhstana, Mongolii, Belarusi i Bolgarii: sbornik nauchnykh dokladov XX Mezhdunarodnoi nauchno-prakticheskoi konferentsii = Agrarian science – agricultural production in Siberia, Kazakhstan, Mongolia, Belarus and Bulgaria: collection of scientific reports of the XX International Scientific and Practical Conference*. Novosibirsk: SFSCA RAS; 2017; 260–262. eLIBRARY ID: 30507682. (in Russ.)

27. Aksenova V. M., Nikulina N. B., Gurova S. V. Peculiarities of hemostasis in calves suffering from bronchopneumonia (an overview). *Perm Agrarian Journal.* 2017; 2 (18): 126–131. eLIBRARY ID: 29372562. (in Russ.)

28. Arzhanova E. N., Antipov V. A., Basova N. Y. Application of politrile and immunofane at bronchopneumonia of calves. *Scientific Journal of KubSAU*. 2011; 70: 824–831. Available at: http://ej.kubagro.ru/2011/06/pdf/35.pdf. (in Russ.)

29. Magomedov M. Z., Suleimanov S. M. Strukturno-funktsional'nye izmeneniya v organakh dykhaniya u telyat pri bronkhopnevmonii = Structural and functional changes in the respiratory organs of calves with bronchopneumonia. *Aktual'nye problemy veterinarnoi patologii i morfologii zhivotnykh: materialy Mezhdunarodnoi nauchno-proizvodstvennoi konferentsii, posvyashchennoi 100-letiyu so dnya rozhdeniya professora A. A. Avrorova = Actual problems of veterinary pathology and morphology of animals: Proceedings of the International Scientific and Industrial Conference dedicated to the 100th anniversary of the birth of professor A. A. Avrorov*. Voronezh; 2006; 154–156. eLIBRARY ID: 26621279. (in Russ.)

30. Nikulin V. S. Effektivnost' terapevticheskogo primeneniya perenosnogo avtonomnogo ustroistva generatsii ozona pri lechenii bronkhopnevmonii u zhivotnykh = Effectiveness of therapeutic use of a portable ozone generator in the treatment of bronchopneumonia in animals: dis. ... Candidate Biol. Sciences. Stavropol; 2021; 11–13. Available at: http://www.stgau.ru/science/dis/avtoreferat/nikylin_2021/01.pdf. (in Russ.)

31. Shvyryaeva E. D., Kalyuzhny I. I. Diagnostics, treatment and prevention of respiratory diseases in young cattle. *Problemy i puti razvitiya veterinarnoi i zootekhnicheskoi nauk: materialy Mezhdunarodnoi nauchno-prakticheskoi konferentsii obuchayushchikhsya, aspirantov i molodykh uchenykh, posvyashchennoi pamyati zasluzhennogo deyatelya nauki, doktora veterinarnykh nauk, professora kafedry «Bolezni zhivotnykh i veterinarno-sanitarnaya ekspertiza» Kolesova Aleksandra Mikhailovicha = Problems and ways of development of veterinary and zootechnical sciences: Proceedings of the International scientific and practical conference of students, postgraduates and young scientists dedicated to the memory of the Honored Scientist, Doctor of Veterinary Sciences, Professor of the Department "Animal Diseases and Veterinary and Sanitary Examination" Kolesov Alexander Mikhailovich*. Saratov: Saratovskii istochnik; 2021; 272–275. eLIBRARY ID: 46328565. (in Russ.)

32. Safonov V., Shishkina E. Selemag and gepatoprotektory in preventive maintenance of postnatal complications at cows. *Dairy and Beef Cattle Farming*. 2011; 5: 25–26. eLIBRARY ID: 16524461. (in Russ.)

33. Bliznetsova G. N., Safonov V. A., Nezhdanov A. G., Retskii M. I. Antioksidantnyi status beremennykh i besplodnykh korov = Antioxidant status of pregnant and infertile cows. *Dairy and Beef Cattle Farming*. 2008; 7: 39–40. eLIBRARY ID: 11646353. (in Russ.)

34. Shukla D., Saxena S., Jayamurthy P., Sairam M., Singh M., Jain S. K., et al. Hypoxic preconditioning with cobalt attenuates hypobaric hypoxia-induced oxidative damage in rat lungs. *High Alt. Med. Biol*. 2009; 10 (1): 57–69. DOI: 10.1089/ham.2008.1028.

35. Kalyuzhnyy I. I., Kalinkina Yu. V., Fedorin A. A., Chuchin V. N., Zhukov M. S. Impact of agroecosystem state on the formation of stationary disease problems in young cattle. *Veterinary, animal science and biotechnology*. 2016; 10: 35–42. eLIBRARY ID: 26693469. (in Russ.)

36. Shaposhnikov I. T., Brigadirov Yu. N., Kotsarev V. N., Morgunova V. I., Chusova G. G., Klementyeva I. F., Ermolova T. G. The influence of metabolic processes in the organism of cows on the incidence of calves with gastro-intestinal and respiratory diseases. *Transactions of the Educational Establishment "Vitebsk the Order of "the Badge of Honor" State Academy of Veterinary Medicine*. 2018; 54 (4): 137–140. Available at: https://repo.vsavm.by/bitstream/123456789/5652/1/z-2018-54-4-137-140.pdf. (in Russ.)

37. Chernitskiy A. E., Skogoreva T. S., Safonov V. A. Study of peculiarities of trace element metabolism in "mother-placenta-fetus" system in cattle. *Materialy XXIII vserossiiskogo s"ezda Fiziologicheskogo obshchestva im. I. P. Pavlova s mezhdunarodnym uchastiem = Proceedings of the XXIII Russian Pavlov Physiological Society with international participation*. Voronezh; 2017; 2480–2482. DOI: 10.13140/RG.2.2.32332.72329. (in Russ.)

38. Flasshoff J. Ein praxisrelevantes Verfahren zur Frühzeitigen Differenzierung bakterieller Bronchopneumonieerreger beim Schwein mittels Bronchiallavage (BAL). *Prakt. Tierarzt*. 1996; 77: 1020–1024. (in German)

39. Pakhomov G. A. Immunomodulyatory v korrektsii immunodefitsitnogo sostoyaniya pri bronkhopnevmonii u molodnyaka krupnogo rogatogo skota = Immunomodulators in the treatment of immunodeficiency in young cattle with bronchopneumonia. *Materialy Mezhdunarodnoi nauchno-proizvodstvennoi konferentsii po aktual'nym problemam Agropromyshlennogo kompleksa = Proceedings of the International Scientific and Production Conference on topical issues of the Agro-industrial complex*. Kazan: Kazan SAVM; 2003; Part 2: 102–104. (in Russ.)

40. Chalmers J. D., Rother C., Salih W., Ewig S. Healthcare-associated pneumonia does not accurately identify potentially resistant pathogens: a systematic review and meta-analysis. *Clin. Infect. Dis.* 2014; 58 (3): 330-339. DOI: 10.1093/cid/cit734.

41. Mukhutdinova D. M. Sravnitel'naya terapevticheskaya effektivnost' razlichnykh metodov lecheniya

telyat, bol'nykh nespetsificheskoi bronkhopnevmoniei = Comparative efficiency of some schemes of calf bronchopneumonia treatment: dis. ... Candidate of Veterinary Sciences. Kazan; 2001. 167 p. (in Russ.)

42. Aldyakov A. V., Nazarov S. D. Efficiency application of antibiotics in bronchophemony of calves. *Scientific notes Kazan Bauman State Academy of Veterinary Medicine.* 2017; 232 (4): 9–12. eLIBRARY ID: 30693468. (in Russ.)

*Received 07.06.2022*
*Revised 26.07.2022*
*Accepted 03.08.2022*

## INFORMATION ABOUT THE AUTHORS / ИНФОРМАЦИЯ ОБ АВТОРАХ

**Tatyana S. Ermilova,** Post-Graduate Student, Assistant, FSBEI HE "Astrakhan State University", Astrakhan, Russia.

**Ермилова Татьяна Сергеевна,** аспирант, ассистент, ФГБОУ ВО «Астраханский государственный университет», г. Астрахань, Россия.

**Margarita A. Samburova,** Researcher, "BIOS" LLC, Moscow, Russia.

**Самбурова Маргарита Александровна,** научный сотрудник, ООО «БИОС», г. Москва, Россия.

**Olga V. Kasharnaya,** Post-Graduate Student, Laboratory Assistant, FSBEI HE "Astrakhan State University", Astrakhan, Russia.

**Кашарная Ольга Владиславовна,** аспирант, лаборант, ФГБОУ ВО «Астраханский государственный университет», г. Астрахань, Россия.

**Emil Aflatun oglu Salimzade,** Post-Graduate Student, FSBEI HE "Astrakhan State University", Astrakhan, Russia.

**Салимзаде Эмиль Афлатун оглы,** аспирант, ФГБОУ ВО «Астраханский государственный университет», г. Астрахань, Россия.