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NEWCASTLE DISEASE IS A PARTICULARLY DANGEROUS PSEUDOCUMA OF BIRDS

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Annotation. Newcastle disease is a serious infectious disease affecting the internal organs, nervous and respiratory systems. It is caused by paramyxovirus PMV-1 and has a large number of different strains that can cause various forms of the disease. These forms can sometimes "masquerade" as other diseases such as cholera, bronchitis, avian flu or laryngotracheitis. Newcastle disease can only be detected by an accurate diagnosis. Poultry of all ages and breeds are susceptible to the disease, but most often Newcastle disease is diagnosed in domestic chickens. Outbreaks of Newcastle disease are reported worldwide and can cause problems for large poultry farms. Although Newcastle disease does not directly affect humans, a flu-like condition can develop after contact with an infected person. Characteristic signs of Newcastle disease in birds include encephalitis, pneumonia and hemorrhage into internal organs due to their damage.

The last outbreak of Newcastle disease in birds in the Republic of Kazakhstan was detected in the village of Akhmet in the Nurinsky district of the Karaganda region on October 4, 2023. On October 6, the Karaganda Regional Territorial Inspection of the Veterinary Control and Supervision Committee of the Ministry of Agriculture declared quarantine in rural areas.

The study conducted in the Karaganda region of the Republic of Kazakhstan was aimed at studying the outbreak of Newcastle disease in poultry in the village of Akhmet in the Nurinsky district. During the study, veterinary and sanitary measures were carried out, including sampling for laboratory diagnostics, vaccination of livestock and the introduction of quarantine restrictions. The results of the study showed the high effectiveness of the measures taken to localize and eliminate the source of infection. The virus has been identified, which underlines the need for constant monitoring of the epizootic situation. The data obtained make it possible to recommend the expansion of vaccination programs and the strengthening of veterinary control at poultry farms to prevent the further spread of Newcastle disease.

Despite the fact that Newcastle disease has been known to veterinarians for several years, no treatment method has yet been developed. However, the control of Newcastle disease in poultry can be achieved through isolation and quarantine of infected animals, vaccination programs, biosafety measures at livestock facilities, monitoring of animal movements and surveillance.

Keywords: etiology; pathogenesis; prevention; Newcastle disease.

Introduction

Newcastle disease is one of the most serious threats to poultry farming for several reasons. Newcastle disease virus is easily transmitted from one bird to another, which leads to the rapid spread of infection in the poultry house. High mortality, especially in young animals, the disease is often acute with high mortality. Even in less acute forms, significant productivity losses are observed.

Newcastle disease is one of the most acute problems for the poultry industry not only globally, but also in Kazakhstan. Despite the preventive measures taken, outbreaks of this disease continue to be registered in various regions of the country, causing significant damage to the industry. In recent years, periodic occurrence of outbreaks of the disease has been observed in Kazakhstan, especially in regions with developed poultry farming. The strains of the virus circulating in Kazakhstan may differ in virulence and antigenic properties, which complicates the fight against infection. Outbreaks of the disease lead to significant economic losses for poultry farms due to bird mortality, decreased productivity, disinfection costs, and restrictions on trade in poultry products.

Also, Newcastle disease is currently widespread in many countries in Eurasia, Africa and America, while it has not been reported in Oceania [1]. In Europe, only rare isolated cases of the disease were reported in the 1980s [2]. However, since 1991, a series of outbreaks have occurred affecting poultry in Belgium, the Netherlands, Luxembourg, Germany, Spain, Malta and France [3]. At the end of the 20th century, Newcastle disease caused numerous outbreaks around the world. [4,5]. In the Republic of Kazakhstan, this disease has been reported in several districts of Akmola and North Kazakhstan regions, including Zerendin, Bulandin, Tselinograd, Kyzylzhar and Zhambyl regions [6,7].

This disease is considered particularly dangerous, and to prevent an unfortunate epidemic, all livestock and birds that are sick or suspected of being infected are destroyed by burning. These measures indicate a high degree of severity of the disease and its serious economic consequences [6,8]. Vaccine prevention is considered an integral part of the fight against this disease [9]. OIE specialists note that a high level of vaccination of the entire poultry population is a key factor in preventing outbreaks of Newcastle disease [10].

Since 1993, the Research Institute for Biological Safety Problems (RIBSP) has developed a technology for producing an embryo vaccine against the La Sota strain of Newcastle disease. A domestic vaccine against Newcastle disease has been developed and successfully used in Kazakhstan. In 2020, based on the experience of using the vaccine in large poultry farms and on private farmsteads of citizens, adjustments were made to the regulatory and technical documentation (RTD). After amendments were made to the regulatory documents, the latter were approved in accordance with the established procedure by the Veterinary and Quarantine Control Committee of the Ministry of Agriculture of the Republic of Kazakhstan [11].

The causative agent of Newcastle disease actively reproduces in the epithelial cells of the respiratory tract, intestines and other organs. At the same time, it enters the bloodstream and spreads throughout the body, affecting various organs and tissues and has a special affinity for nervous tissue, causing degenerative changes in neurons. Therefore, proper vaccination helps maintain the health of birds and stability in poultry farms, which is important for the economy and food security of the region.

In this regard, maintaining epizootic welfare in poultry farms of the Republic of Kazakhstan requires a comprehensive approach, including not only vaccination and compliance with all necessary sanitary and hygienic measures and rules

Objective: to provide a comprehensive overview of Newcastle disease, including its etiology, pathogenesis, clinical manifestations, diagnosis, prevention and treatment, in order to increase awareness of specialists and develop effective measures to combat this infection.

Etiology

Newcastle disease is caused by an RNA-containing virus belonging to the genus of paramyxoviruses (*Paramyxoviridae* family). The Newcastle virus (APMV-1) has a spherical shape and characterized by high resistance to various influences [12].

Key properties of the virus:

Resistance to external factors: The virus remains viable in various environmental conditions:

In the litter - up to 20 days.

In the tick's body - more than 200 days.

In dried organs at low temperatures - up to 2 years.

In frozen carcasses - up to 3 years.

In a wide pH range (from 2.0 to 10.0).

In decomposing corpses - up to 30 days [13].

Resistance to physical factors:

Heat-stable: remains active at sub-zero temperatures for many years. Resistant to drying out.

Sensitivity to disinfectants: effectively inactivated by caustic soda, formaldehyde, phenol, beta propiolactone, alcohol and other disinfectants.

Wide host range: Many species of domestic and wild birds are susceptible to the virus.

Morphological features:

Spherical shape of the virion.

Presence of surface processes.

Composition of the viral particle: RNP, hemagglutinin, neuraminidase, polymerase, hemolysin, lipids and carbohydrates.

Replication of the virus: The virus replicates efficiently in developing chicken embryos. [12,13]

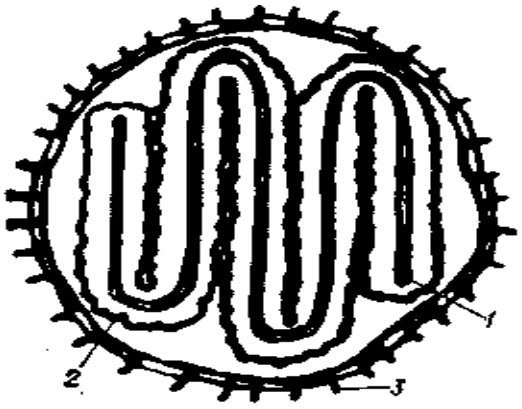

Рис. 1. Схема строения вируса ньюкаслской болезни: *1* — РНК; *2* — нуклеокапсид со спиральным типом симметрии; *3* — гемагглютинин (по Шефферу).

Figure 1 – Scheme of the structure of the virus [12].

Table 1 – Characteristics of Newcastle disease virus [12,13].

Characteristics	Newcastle disease virus
Type of nucleic acid	RNA
Family	*Paramyxoviridae*
Genus	*Paramyxovirus*
Virion shape	spherical

Virion size	120-180 nm
Surface structures	Offshoots
Virion composition	RNP, hemagglutinin, neuraminidase, polymerase, hemolysin, lipids, carbohydrates
Resistance	High resistance to drying, low temperatures, wide pH range; sensitive to disinfectants
Replication	Reproduces effectively in chicken embryos
Diseases	Newcastle disease in birds
Transmission ways	Airborne, fecal-oral, through infected objects

Transmission method

In agricultural and natural conditions, both direct horizontal contacts between birds and infected individuals and indirect contacts through the environment are observed [14].

Transmission of infection can occur through direct contact with feces and respiratory secretions or through contaminated food products and raw materials (eggs, meat, bedding, feed, feathers and fluff obtained from sick birds), water, equipment and human clothing. Transmission of infection can occur through direct contact with feces and respiratory secretions or through contaminated food products and raw materials (eggs, meat, bedding, feed, feathers and down obtained from sick birds), water, equipment and human clothing. The Newcastle disease virus can be found inside the laid eggs. When such eggs are incubated, the virus causes the death of embryos with various septic changes, such as hyperemia, edema and pinpoint hemorrhages on the head and limbs. The virus on the shell surface dies 7-15 days after the start of incubation [15,16].

In addition, in captivity, the infection is transmitted by convection. Already 2 days after infection, before the manifestation of clinical signs, infected individuals, as reconstituted individuals, begin to spread the virus with secretions from the upper respiratory tract. Transfer of infection between farms occurs during transportation of infected, but also clinically healthy birds. [14].

Here it should be added about the transmission of infection by mechanical vectors (contaminated shoes, clothing of personnel in contact with sick birds, transport cages, cars and other technological devices). Also, with the help of dirt, dust, flies, vaccines, and of course dead birds [17].

By air, this virus can be transported over a distance of up to 15 km. In poultry houses containing a large batch of sick birds, the virus is released during the operation of fans that eject used air at a distance of 1600m, in windy weather at a distance of 3-5km [18].

It should be noted that there are many freely moving birds, such as street pigeons, with the combination of the above causes of infection - something can cause the spread of the disease. Also, exotic birds during transportation can become the cause of an epizootic in any farm, provided there is contact between agricultural workers and, say, a recently purchased parrot [19]. In industrial poultry farms with an intensive rearing system, pseudoplague is often stationary. This occurs due to the long-term preservation of the virus in the environment in winter, the transmission of the virus by wild birds and ticks, as well as the transfer of the virus by chickens that have recovered from the disease [18].

There is evidence of pathogen transmission by some parasites. Thus, the virus invaded *Ascaridae galli*, from which it can be isolated. Coccidia play the same role [18].

Pathogenesis and clinical symptoms

The causative agent of Newcastle disease can enter the bird's body through the respiratory tract or the digestive tract. Viral particles coated with glycoproteins specifically interact with receptors on the surface of the host cell. This initial stage is key to successful infection. Endosome formation: after binding to the receptor, the viral particle is absorbed into the cell by endocytosis, forming an intracellular vesicle - an endosome. Inside the endosome, the viral envelope fuses with the endosome membrane, releasing the viral nucleocapsid into the cell cytoplasm. Infected cells are destroyed, releasing new virions that infect neighboring cells [20].

Viremia is a key stage in the development of the infectious process. The pathogen spreads with the bloodstream throughout the body, affecting various organs and tissues. In the affected organs, the virus continues to multiply, causing damage to them [20,21].

Pathogenesis of organ damage:

The pathogen actively multiplies in red blood cells, which leads to damage to blood vessels. Their permeability increases, necrosis and petechial hemorrhages occur [16,18]. The virus enters the respiratory tract, causing inflammation of the mucous membranes and difficulty breathing.

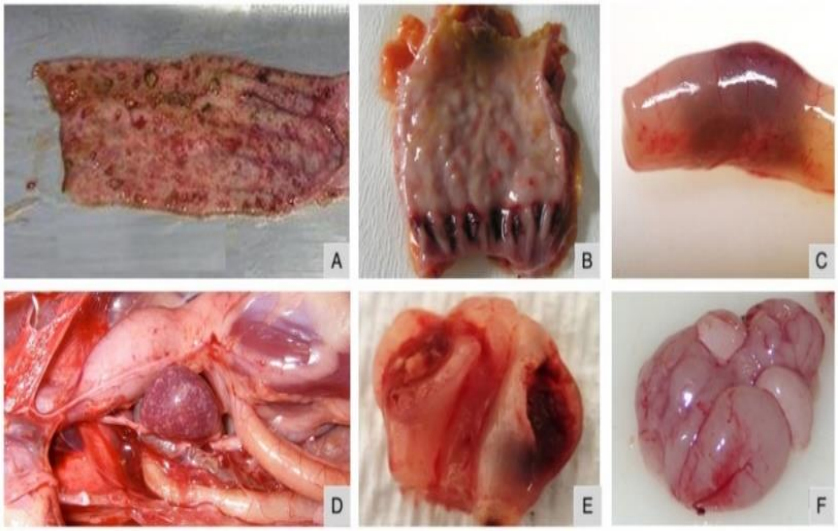

Figure 2 – Internal organs damage [15].

hemorrhages and intestinal necrosis, longitudinal section (A); hemorrhages in the mucous membrane of the forestomachs (B); intact small intestine with hemorrhages (c); enlarged and mottled spleen with multifocal necrosis (D); necrotic and hemorrhagic tonsils of the cecum (E); hyperemia and mild multifocal petechial hemorrhages in the meninges due to infection of chickens with the cormorant-adapted Newcastle disease virus (F).

Then it enters the central nervous system, causing inflammation of the brain and spinal cord, leading to various neurological symptoms. At the same time, it affects the intestinal mucosa, causing inflammation and bleeding. [13]. It should be noted that the virus is highly contagious: even with a blood dilution of 1:125,000,000, it retains its infectious properties [16]. The virus is released into the external environment through the respiratory system, digestive tract and eggs [21].

Clinical manifestations can be divided into four stages:

Acute form: characterized by a sudden onset, high temperature up to 44 C, birds become depressed, sedentary and show symptoms of respiratory and nervous system damage. Conjunctivitis

develops, causing the cornea to become muddy. Mucus accumulates in the mouth and nasal cavity, and the birds cough, sneeze, and make croaking sounds while breathing with an open beak. Diarrhea, sometimes with blood, is a common symptom. In case of damage to the central nervous system, paralysis, convulsions, and circular movements are observed [22].

Subacute and chronic forms: they are less acute. Characterized by nervous symptoms (convulsions, paralysis), the bird is very excitable, head trembling, neck bending, paresis are noted [22,23].

Atypical form: asymptomatic or with uncharacteristic signs, also with a low mortality rate (up to 15-30%) [22,23].

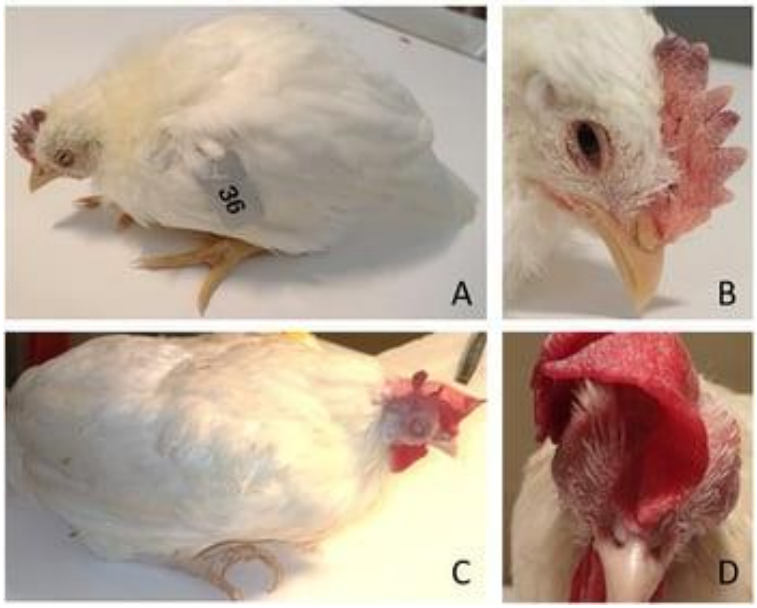

Figure 2 - Lethargy in young chicken [15].
(A); necrotic/hemorrhagic areas of the ridge in a young chicken (B); lethargy with periorbital edema in an adult chicken (C); and head swelling in an adult chicken (D).

Autopsy of dead birds reveals inflammatory processes, hemorrhages in various organs, especially in the gastrointestinal tract. Specific hemorrhages at the border of the glandular and muscular parts of the stomach are characteristic [12,22].

Diagnostics

The diagnosis is based on epizootological, clinical and pathological data with mandatory laboratory testing to isolate and identify the virus. Samples of the brain, trachea, liver and spleen are sent to a veterinary laboratory for analysis. A suspension is prepared from these tissues, which is then used to infect 30-60-day-old chickens and 9-12-day-old chicken embryos. If the bioassay is positive, the chickens will become ill in 3-5 days, and the embryos will die in 2 days [12]. Also, the modern veterinary industry offers quick tests for diagnosis (time 5-10 minutes), the material for which is serum or plasma of the bird, its eye secretions, or tracheal and cloacal washings [20]. Newcastle disease should be differentiated from avian influenza, Marek's disease, infectious chicken laryngotracheitis, infectious bronchitis, mycoplasmosis, pasteurellosis, and poisoning [9]. The final diagnosis is made on the basis of laboratory data, including virus isolation from the brain and bone marrow at the onset of the disease, at the virological stage (3-5 days after the onset of symptoms), using chicken embryos and fibroblast cell cultures. Biopsy is also performed on

30-day-old chickens, and the virus is titrated on chicken embryos. Serological identification of the virus is also used using RGA, PHA, ELISA, RSK and other methods. [12].

Prevention and control measures

To prevent Newcastle disease, a general set of veterinary and sanitary measures, as well as special preventive measures, are carried out [24]. Specific prevention of Newcastle disease is currently carried out mainly using live vaccines. Vaccines based on influenza virus strains H, B1, LaSota and Bo/74/VGNKI are widely used in the Commonwealth of Independent States (CIS) countries. To prevent Newcastle disease, it is important to develop an optimal vaccination schedule for poultry. The ideal age for primary vaccination is between 10 and 14 days, while revaccination should be carried out after 5-6 weeks [18]. A disadvantage of live vaccines is their potential ability to cause reactions that can lead to a decrease in uniformity among young animals, a decrease in meat yield in broiler chickens and a decrease in egg production in adult chickens [16]. Although live vaccines predominate, inactivated vaccines also have their advantages: safety for immunocompromised birds, no risk of virulence reversion. However, they usually require more frequent revaccination and may induce a weaker immune response.

The most effective vaccination method is to develop an individual schedule taking into account specific conditions. Poultry farm veterinarians should monitor the intensity of the post-vaccination immune response using the PHA reaction [24].

To prevent Newcastle disease, poultry owners must comply with the necessary veterinary and sanitary requirements for their maintenance and care:

• twice a year disinfect poultry houses for preventive purposes.

• all newly imported poultry must be kept isolated from the rest of the livestock for a month.

Constant monitoring of the epidemiological situation is a key element in the fight against this disease.

Conclusions

Newcastle disease remains one of the most serious threats to the poultry industry. The study allowed us to deepen our understanding of the pathogenesis, diagnosis and prevention of this disease. It was found that Newcastle virus is highly variable and can quickly adapt to new conditions. Compliance with biosafety rules plays a key role in preventing the spread of infection.

The data reviewed highlight the need for continuous monitoring of virus circulation and the development of new, more effective vaccines. In addition, it is important to pay more attention to the role of wild birds in the epidemiology of Newcastle disease.

It is suggested for further research:

- To study the genetic diversity of the Newcastle virus circulating in Kazakhstan.
- To develop new methods for the early diagnosis of Newcastle disease using molecular genetic methods.
- To investigate the immune response of birds to various vaccines and evaluate their effectiveness in the field.
- To assess the economic damage caused by Newcastle disease to poultry farms in Kazakhstan.

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БОЛЕЗНЬ НЬЮКАСЛА – ОСОБО ОПАСНАЯ ПСЕВДОЧУМА ПТИЦ

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Аннотация. Болезнь Ньюкасла – это серьезное инфекционное заболевание, поражающее внутренние органы, нервную и дыхательную системы. Оно вызывается парамиксовирусом PMV-1 и имеет большое количество различных штаммов, которые могут вызывать различные формы заболевания. Эти формы иногда могут "маскироваться" под другие заболевания, такие как холера, бронхит, птичий грипп или ларинготрахеит. Болезнь Ньюкасла поможет выявить только точная диагностика. Заболеванию подвержены домашние птицы всех возрастов и пород, но чаще всего болезнь Ньюкасла диагностируется у домашних кур. Вспышки болезни Ньюкасла регистрируются по всему миру и могут создавать проблемы для крупных птицефабрик. Хотя болезнь Ньюкасла непосредственно не поражает людей, после контакта с инфицированным человеком может развиться состояние, похожее на грипп. Характерные признаки болезни Ньюкасла у птиц включают энцефалит, пневмонию и кровоизлияние во внутренние органы из-за их повреждения.

Исследование, проведенное в Карагандинской области Республики Казахстан, было направлено на изучение вспышки болезни Ньюкасла у домашней птицы в селе Ахмет Нуринского района. В ходе исследования были проведены ветеринарно-санитарные мероприятия, включающие отбор проб для лабораторной диагностики, вакцинацию поголовья и введение карантинных ограничений. Результаты исследования показали высокую эффективность принятых мер по локализации и ликвидации очага инфекции. Выявили вирус, что подчеркивает необходимость постоянного мониторинга эпизоотической ситуации. Полученные данные позволяют рекомендовать расширение программ вакцинации и усиление ветеринарного контроля на птицефабриках для предотвращения дальнейшего распространения болезни Ньюкасла.

Несмотря на то, что болезнь Ньюкасла известна ветеринарам уже не один десяток лет, но до сих пор не разработано метода ее лечения. Однако борьба с болезнью Ньюкасла у домашней птицы может быть достигнута с помощью изоляции и карантина инфицированных животных, программ вакцинации, мер биобезопасности на животноводческих объектах, мониторинга перемещений животных и эпиднадзора.

Ключевые слова: этиология; патогенез; диагностика; профилактика; болезнь Ньюкасла.

НЬЮКАСЛ АУРУЫ – ҚҰСТАРДЫҢ АСА ҚАУІПТІ ЖАЛҒАН ОБАСЫ

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Аннотация. Ньюкасл ауруы-бұл ішкі органдарға, жүйке және тыныс алу жүйелеріне әсер ететін ауыр жұқпалы ауру. Ол PMV-1 парамиксовирусынан туындайды және аурудың әртүрлі формаларын тудыруы мүмкін көптеген әртүрлі штаммдарға ие. Бұл формалар кейде тырысқақ, бронхит, құс тұмауы немесе ларинготрахеит сияқты басқа ауруларға "бүркемелеу" жасай алады. Тек дәл диагноз Ньюкаслды анықтауға көмектеседі.. Барлық жастағы және тұқымды үй құстары ауруға бейім, бірақ көбінесе Ньюкасл ауруына үй тауықтарына диагноз қойылады. Ньюкасл ауруының өршуі бүкіл әлемде тіркелуде және ірі құс фабрикалары үшін қиындықтар тудыруы мүмкін. Ньюкасл ауруы адамдарға тікелей әсер етпесе де, жұқтырған адаммен байланыста болғаннан кейін тұмауға ұқсас жағдай дамуы мүмкін. Құстардағы Ньюкасл ауруының тән белгілеріне энцефалит, пневмония және олардың зақымдалуына байланысты ішкі ағзаларға қан кету жатады.

Қазақстан Республикасының Қарағанды облысында жүргізілген зерттеу Нұра ауданы Ахмет ауылында үй құстарында Ньюкасл ауруының өршуін зерттеуге бағытталған. Зерттеу барысында зертханалық диагностика үшін сынама алуды, малды вакцинациялауды және карантиндік шектеулер енгізуді қамтитын ветеринариялық-санитариялық іс-шаралар жүргізілді. Зерттеу нәтижелері инфекция ошағын оқшаулау және жою бойынша қабылданған шаралардың жоғары тиімділігін көрсетті. Вирус анықталды, бұл эпизоотиялық жағдайды үнемі бақылау қажеттілігін көрсетеді. Нәтижелер Ньюкасл ауруының одан әрі таралуын болдырмау үшін вакцинация бағдарламаларын кеңейтуді және құс фабрикаларында ветеринарлық бақылауды күшейтуді ұсынады.Ауылға келген инспекция мамандары өлген құстардың барлығын жойды. Олар сондай-ақ аурудың таралуын болдырмау үшін үй құстарын осы аймақтан шығаруға, сондай-ақ құс еті мен жұмыртқаны сатуға тыйым салды. 9 қазаннан бастап құсқа вакцинация басталды және 16000-ға жуық тауыққа вакциналар салынды. Карантин бір айға созылып, қараша айының басында аяқталды. Осы уақыт ішінде мамандар осы аймақта қалған құстардың денсаулығы мен қауіпсіздігін қамтамасыз ету үшін жұмыс істеді.

Ньюкасл ауруы ветеринарларға бірнеше жылдан бері белгілі болғанына қарамастан, оны емдеу әдісі әлі жасалмаған. Дегенмен, құстардағы Ньюкасл ауруымен күресуге ауру жануарларды оқшаулау және карантин, вакцинациялау бағдарламалары, мал шаруашылығы өндірісіндегі объектілердегі биоқауіпсіздік шаралары, жануарлардың қозғалысын бақылау және қадағалау арқылы қол жеткізуге болады.

Түйін сөздер: этиология; патогенез; алдын алу; Ньюкасл ауруы.