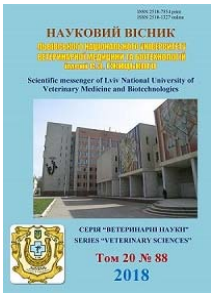

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Cross-border dissemination of lumpy skin disease: risc analysis for Ukraine

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National biosecurity is a system of organizational and technical measures that help protect humans, animals and the environment from potential and actual biological threats. That is why analysis of the main hazardous biological sources for humans and animals has been carried out. The influence of climate change on the animals' welfare as well as their predisposition to the deferred type tendency is proved. The prevalence of vector diseases of animals, mycoses and mycotoxicoses, which can manifest themselves in the form of such emergencies as outbreaks of exotic diseases, large-scale epizootics, a sharp increase of the incidence of endemic diseases, etc., are of both ecological and biological danger. Contagious vesicular (nodular) dermatitis (Lumpy skin disease, LSD) is caused by the virus belonging to the genus Capripoxvirus, the Poxviridae family and affects mainly cattle and buffaloes. The virus is distributed mainly by means of mechanical carriers (species of Stomoxys spp. and other flies). Global warming on the European continent facilitates the migration of blood-sucking insects that are carriers of vector diseases. As a result, the insects occupy new ecological niches adapting to the new biocenoses. A poorly controlled movement of large numbers of livestock also creates a risk of disease spreading. The World Organization for Animal Health (OIE) has identified LSD as highly dangerous illnesses subject to notification. The focus is made on policies dealing with the control and eradication of contagious nodular dermatitis in case of its detection. The spread of LSD can be prevented through the introduction of biosafety measures at the farm level and the introduction of restrictions on the movement of infection-susceptible animals and goods from the infected territories. Vaccination is the most effective disease control tool in endemic areas. LSD control and elimination policy in case of disease detection includes sanitary slaughter (stamping-out) of infected animals – a complex of antiepizootic measures that carry out by direction of the chief state inspector, including the slaughter of sick and infected animals of the herd, and if necessary, animals of another herd that could lead before the transmission of a pathogenic agent – the pathogen of contagious nodular dermatitis of cattle. All animals, that are susceptible to the disease, whether vaccinated or not, are clogged and their carcasses are destroyed by burning, burial with the guarantee of preventing the spread of infection through carcasses or other products of dead animals. Emergency control of outbreaks envisages the ring vaccination of buffer zones within 25–50 km from infected areas, as well as foundation of temporary or permanent slaughter places in the infected areas. Sufficient herd immunity must be created and maintained within large territories both around the infected area and at the borders with infected countries. Such immunity is achieved when 80% of the herd is covered by vaccination.

Key words: *biological security, risk analysis, pathogenic biological agents, infectious diseases, endemic vectors, nodular dermatitis.*

Introduction

Ensuring biological security is the main goal of all countries worldwide. This strategic and integrated approach comprises policies and regulatory tools for risk management analysis in the sectors of food security, life and health of animals, humans and plants and also considers environmental risks (Holovko and Klestova, 2014). A more complete definition of it was introduced by S.V. Netezov: "Biological security is a system of biomedical, organizational and technical measures and tools aimed at protecting personnel, population and environment from the influence of pathogenic biological agents" (Himicheskaja i biologicheskaja bezopasnost', 2008). Unfortunately, it's impossible to provide a 100% security. According to A.B. Kachynskiy, biological danger is a situation that is constantly present in the environment and, under certain conditions, may bring to life an undesirable event associated with a number of hazards (Kachins'kyi, 2003; Sytnyk, 2004).

Negative impact of pathogenic microorganisms is among the main sources of biological danger to humans, animals and the environment. Pathogenic microorganisms as well as their metabolic by-products cause infectious diseases resulting in enormous damage to the environment.

It is important to understand that climate changes influence the welfare of animals and have a deferred type tendency. It means that the prevalence of vector diseases of animals, mycoses and mycotoxicoses will be manifested in emergency situations such as exotic diseases, large-scale epizootics, a sharp increase in the incidence of endemic diseases, etc., thus creating grounds for ecological and biological danger. Also, special attention in this regard should be paid to natural (rodents, mites, birds, etc.) and artificial reservoirs of pathogenic microorganisms (animal burial sites, biotermic pits, museum strains of microorganisms in laboratories, research institutes, biofactories, etc.) as well as genetically modified pathogens of infectious diseases (Morse, 1995; Henderson, 1999; Fleming and Hunt, 2006).

Research purpose: analysis of biological threats in the area of veterinary medicine aimed at assessing the risk of zoonoses appearance and ensuring the country's biological security.

Materials and methods

Statistical and analytical data of World Organisation for Animal Health (OIE), FAO (Food and Agriculture Organization), risk analysis in veterinary medicine based on methodology by S.A. Dudnikova and Ye.V. Guseva (Dudnikov and Guseva, 2001), Montou (Moutou et al., 2000), use of the global biological surveillance system Biosurveillance (Huff et al., 2017).

Results and discussion

Global biological surveillance system Biosurveillance includes the collection, integration, interpretation and transfer of necessary information on all hazards, threats or diseases affecting humans, animals or the environment. This system is used to achieve early detection and prevention of infectious diseases, contributes to general situational awareness regarding human and animal health issues, as well as prompt response and decision-making at the appropriate level (Huff et al., 2017).

The conducted analysis of scientific literature and statistical data of OIE shows that the identification of the infectious disease sources and the determination of factors contributing to the emergence of infections became increasingly difficult in recent times. Pathogenic biological agents cause diseases, the spread of which is promoted by both natural and artificial factors (Table 1).

Such endemic vectors as mites, flies and mosquitoes enjoy the improvement of their living conditions resulting from the temperature rise. The number of them increases and their life cycle accelerates, which entails an increase in the number of generations. In its turn, it results in a direct increase in the incidence and spread rate of all vector infections. Nowadays the introduction of vector diseases, in particular vesicular (nodular) dermatitis of cattle is a biological threat for Ukraine.

Table 1
Infections and probable factors contributing to their appearance

Infection or pathogen	Factors contributing to the disease appearance
	Viruses
Argentinian, Bolivian hemorrhagic fever	Changes in agriculture contributing to the spread of rodents
Spongiform encephalopathy	Changes in the cattle feeding
Dengue hemorrhagic fever	Transportation, migration, urbanization
Ebola, Marburg fever	Not known (in Europe and the USA - import of monkeys)
Hantaviruses	Ecological and environmental changes, contact with rodents
Rift Valley fever	Dam construction, agriculture, irrigation, change of virulence and pathogenicity of the virus
Contagious nodular dermatitis	Transportation, vector transmission of the virus to large cattle
Shmallenberg virus	Transportation, vector transmission
	Bacteria
Brazilian purple fever (*Haemophilus influenzae, biotype aegyptius*)	New strain
Cholera	According to a recent epidemic in South America, the disease is likely to be spread by sheep from Asia, decrease in water chlorination contributed to its proliferation too. New strain (type 0139)
Helicobacter pylori	Probably, it's been spreading for a long time; was discovered recently
Hemolytic uremic syndrome	Technology of food products' mass processing allowing the meat contamination (Escherichia coli O157: H7)
Lime boreal disease (*Borrelia burgdorferi*)	Forest plants around houses and other conditions promoting the spread of mites and deers (the owner is a secondary reservoir)
Streptococcus, Group A (invasive, necrotic)	Not determined
Toxic Shock Syndrome (*Staphylococcus aureus*)	Ultra-absorbent tampons
	Parasitic
Cryptosporidium, water transmitted pathogens	Contaminated water, poor water purification
Bilharziasis	Dam construction

Contagious vesicular (nodular) dermatitis (Lumpy skin disease, LSD) is caused by the virus belonging to the genus Capripoxvirus, the Poxviridae family and affects mainly cattle and buffaloes. The virus is distributed mainly by means of mechanical carriers (species of Stomoxys spp. and other flies). Global warming on the European continent facilitates the migration of blood-sucking insects that are carriers of vector diseases. As a result, the insects occupy new ecological niches adapting to the new biocenoses. A poorly controlled movement of large numbers of livestock also creates a risk of disease spreading. The World Organization for Animal Health (OIE) has identified LSD as highly dangerous illnesses subject to notification (World Organisation for Animal Health, 2011).

Nodular dermatitis leads to significant economic losses in the dairy and meat industry and damages the skin of animals. A recent study conducted in Ethiopia showed that financial costs associated with infected herds amounted to $ 5–8 per 1 head of zebu and $ 42–73 per 1 head of Holstein-Friezian cattle. The disease may lead to a restriction or even a total prohibition of international trade of live animals and products of animal origin (Gari et al., 2011). The LSD incidence is higher during wet season, when the population of flies is more numerous (Gari et al., 2010; 2011; 2012).

Presently, LSD is spread throughout the Middle East and Europe (OIE, 2015). This disease was detected in Egypt in 1988 for the first time. In 1989, insects helped spread the infection from Egypt to Israel. Iran and the Russian Federation first reported about LSD cases in 2014 and 2015 respectively, while Turkey and Azerbaijan are constantly reporting on new cases since 2013.

69 new foci of the disease were recorded between April and July 2016 in Greece. Two new outbreaks were registered during the same period in Edirne, Turkey. Also, in April 2016, the first case of LSD was discovered in Bulgaria, with 201 outbreaks recorded by the end of June. In April 2016, LSD was identified in Macedonia and 387 outbreaks were registered. Control measures like modified stamping-out, movement control and vaccination were introduced. By the end of July 2016, there were another 198 and 53 outbreaks in Serbia and Montenegro respectively, as well as one outbreak in Albania and Kazakhstan (Tuppurajnen, 2017).

In 2017 there were registered 43 cases in the Russian Federation, from the beginning of 2018 there were 7 outbreaks in the Samara and Orenburg regions (Moroz et al., 2017).

The diagnosis of vesicular dermatitis is based on epizootological data, clinical signs, pathological changes and laboratory tests (Instruktsiia shchodo profilaktyky…, 2017; Lumpy Skin Disease, 2017). OIE recommends using different methods of LSD diagnostics (Table 2).

Table 2
Methods of nodular dermatitis laboratory diagnostics

Method	Goal					
	Infection free populations	Individual animals are free from infection before moving	During the elimination of the disease	Confirmation of clinical cases	Control over the spread of infection	Determination of the immune status of individual animals or populations after vaccination
Methods aimed at pathogen detection						
VI*	+	++	+	+++	+	–
PCR**	++	+++	++	+++	+	–
EM***	–	–	–	+	–	–
Methods aimed at pathogen antibodies detection						
NR****	++	++	++	++	++	++
ELISA*****	+	+	+	+	+	+

*Note: +++ – recommended method; ++ – suitable method; + – method can be used in individual cases, but cost, reliability or other factors considerably limit its application; – not suitable for this purpose; * – virus isolation within the cells culture, ** – polymerase chain reaction, *** – electron microscopy, **** – neutralization reaction, ***** – enzyme-linked immuno sorbent assay (ELISA)*

Biosafety center, Research Center for Biosafety and Ecological Monitoring of the Agroindustrial Resources of Ukraine performs diagnostics of the nodular dermatitis according to the ELISA method using the ID.vet kit (of French origin). This kit allows both postinfectious and post-vaccine specific antibodies to Capripoxvirus to be detected 20 days after vaccination and up to 7 months after vaccination. The possibility of cross-reaction with Parapoxvirus is excluded. Its specificity rate is 99.7% for cattle.

The spread of LSD can be prevented through the introduction of biosafety measures at the farm level and the introduction of restrictions on the movement of infection-susceptible animals and goods from the infected territories. Vaccination is the most effective disease control tool in endemic areas.

LSD control and elimination policy in case of disease detection includes sanitary slaughter (stamping-out) of infected animals – a complex of antiepizootic measures that carry out by direction of the chief state inspector, including the slaughter of sick and infected animals of the herd, and if necessary, animals of another herd that could lead before the transmission of a pathogenic agent – the pathogen of contagious nodular dermatitis of cattle. All

animals, that are susceptible to the disease, whether vaccinated or not, are clogged and their carcasses are destroyed by burning, burial with the guarantee of preventing the spread of infection through carcasses or other products of dead animals (Zakon Ukrainy, 1992).

Also it must be a combination of the following strategies:

• sanitary elimination of slaughtered animals and infected animal products to destroy the infection source;

• quarantine and control over the movement of animals, products and other potentially infected objects to prevent the spread of infection;

• disinfection of buildings, equipment and other objects in order to destroy potential infection sources and minimize the spread of the pathogen;

• control of insect carriers at the initial stages of the outbreak;

• measures of monitoring and determination of infection source and extent;

• zoning and compartmentalisation aimed at the identification of infected and infection free premises and areas;

• ring vaccination as a modified stamping-out policy (Coetzer and Tuppurainen, 2014).

Currently available vaccines against LSD include:

• Lumpy Skin Disease Vaccine – Onderstepoort Biological Products, Neethling strain);

• Lumpivax – Merck Animal Health, Intervet, attenuated field LSDV strain;

• Herbivac LS – Deltamune, LSDV Neethling strain.

Currently Ukraine is considered the LSD-free territory. There is the officially approved instruction in Ukraine that determines the ways of preventing this disease, the diagnostics procedure, measures in the event of nodular dermatitis suspicion, measures taken in the epizootic center, as well as protection and surveillance zone, the mechanism for removing quarantine restrictions and safety rules for maintenance personnel working in infected farms. Emergency control of outbreaks envisages the ring vaccination of buffer zones within 25–50 km from infected areas, as well as foundation of temporary or permanent slaughter places in the infected areas. Sufficient herd immunity must be created and maintained within large territories both around the infected area and at the borders with infected countries. Such immunity is achieved when 80% of the herd is covered by vaccination (Coetzer and Tuppurainen, 2014; Instruktsiia shchodo profilaktyky…, 2017).

Conclusions

National biosecurity is a system of organizational and technical measures that help protect humans, animals and the environment from potential and actual biological threats.

The system of global biological surveillance enables to achieve early detection and prevention of dangerous diseases on the territory of the country, contributes to the general situational awareness regarding human and animal health aspects.

Climate changes have a deferred type tendency and constitute an ecological and biological danger promoting the spread of vector animal diseases.

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