UDC 619:616.5-002.33-022.6:616-036.22:005.52:005.33

DOI 10.29326/2304-196X-2019-1-28-3-9

RISK OF INTRODUCING HIGHLY DANGEROUS ANIMAL VESICULAR DISEASES INTO THE RUSSIAN FEDERATION

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SUMMARY

Animal vesicular diseases are rather widespread in the world. Transboundary vesicular diseases are mainly registered in African and Asian countries. They primarily include foot and mouth disease, sheep and goat pox, peste des petits ruminants, lumpy skin disease, swine vesicular disease, vesicular stomatitis, as well as relatively new Seneca Valley virus infection. The transboundary spread of vesicular diseases is mainly caused by legal and illegal movements of animals, animal products, feeds, live vaccines; migration of wild animals across the borders from neighboring countries and passive mechanical transmission of infection. The risk of vesicular disease agent introduction with legal import of live animals into the territory of the Russian Federation is minimal. Most likely, the causative agent can be introduced when livestock products are illegally imported from the following countries: China, Turkey, India, Mongolia, Iran, Kazakhstan, etc. Violations of foreign trade regulations pose a direct threat to the epidemic situation and economic security of Russia. There is a possibility of the introduction of vesicular agents with animal feed imports into the country since some viruses can potentially survive for a long time in some ingredients. Taking into account the fact that some neighboring countries are infected with vesicular diseases, the threat of infection introduction into Russia through migration of wild animals along the North Caucasian, Central Asian and Far Eastern routes still remains.

Key words: foot and mouth disease, sheep and goat pox, peste des petits ruminants, lumpy skin disease, porcine vesicular disease, vesicular stomatitis, Seneca Valley virus infection.

INTRODUCTION

"Vesicular diseases" is the common term for infections, manifested by the formation of vesicles, papules and pustules on different organs of an infected animal. The most dangerous, highly contagious and dramatically significant for economics, food security and international trade among them is foot and mouth disease (FMD). FMD outbreaks can cover vast territories, whole countries and even continents due to a wide range of susceptible wild and domestic animal species, the variety of virus shedding routes by infected animals and its high persistence in the environment and in animal products. This disease occurs in many countries and the possibility always exists that the virus is introduced into previously free areas, including free regions of the Russian Federation. That's why the state surveillance authorities impose restrictions on import of animals and animal products from FMD infected territories.

According to the World Organization for Animal Health (OIE) the most significant diseases to be differentiated from FMD include vesicular stomatitis, swine vesicular disease, sheep and goat pox and lumpy skin disease. Pursuant to the International classification of animal infectious diseases these diseases are referred to as transboundary ones, i. e. "they have the potential for very rapid spread, irrespective of national borders, causing serious socio-economic and possibly public health consequences and may also have a significant detrimental effect on international trade in animals and animal products".

MATERIALS AND METHODS

OIE data on outbreaks of highly dangerous vesicular diseases in the world were used for the risk assessment. Additional information was searched using Federal Customs Service database, Veterinary Service reports and mass-media publications. The qualitative assessment of animal vesicular disease introduction risk to the Russian Federation is given in the paper.

Pursuant to the OIE definition (Terrestrial Animal Health Code 2017), risk assessment means the evaluation of the likelihood and the biological and economic consequences of entry, establishment and spread of a hazard within the territory of an importing country.

RESULTS AND DISCUSSION

Vesicular diseases

Vesicular diseases primarily include FMD, sheep and goat pox (SGP), peste des petits ruminants (PPR), lumpy skin disease (LSD), swine vesicular disease (SWD), vesicular stomatitis (VS) and Seneca Valley virus infection (SVVI).

According to Article 1.4.6 of the Terrestrial Animal Health Code the Russian Federation is historically free from *swine vesicular disease* and *vesicular stomatitis*, because VS has never been registered in the Russian Federation and SVD cases have not been reported since 1975 [1]. In 2015 VS and SVD were excluded from the OIE list. This was based on the absence of natural transmission of the viruses to humans and low morbidity and mortality in domestic and wild animals. SWD single cases are reported in the world (during the last decade only cases in Italy have been reported). Sporadic VS cases are registered in America.

Russia's territory is historically free from *peste des petits ruminants*, but during the last years the number of epidemiological forecasts of possible infection introduction to our country has been increasing. This is explained by

proximity of PPR infected Asian countries and close trade and economic relations with them. PPR transboundary spread can be caused also by illegal movements of infected animals and animal products, as well as migration of wild animals across the borders of neighboring countries. It means the closest attention of the RF Veterinary Service is focused on the epidemic situation in the neighboring countries like China, Mongolia, Kazakhstan and Georgia as well in geographically close countries like Turkey, Bulgaria, Afghanistan, Iran, etc. PPR global situation shows that the greatest risk of PPR occurrence exists in the North Caucasian, Southern and Volga Federal Districts, characterized by high density of susceptible animals.

Sheep and goat pox is spread in African and European countries; the disease is reported in the Russian Federation from time to time. The disease has a detrimental effect on economics, hampers the development of livestock production, decreases the performance and impedes the trade in animals and animal products. China, Mongolia, Kazakhstan, which report sheep and goat pox from year to year, border the Russian Federation thus creating the threat of the disease further spread in our country.

From 2016 to 2018 49 *lumpy skin disease* infected countries were registered: 33 African, 7 Asian and 9 European. The disease is not registered in Americas, Australia and Oceania. Since 2013 LSD has been rapidly spreading in the Middle East and Central Asia. LSD was firstly reported in the Russian Federation in July 2015.

The risk of LSD further spread in the Russian regions is high, especially in North Caucasian, Southern, Central and Volga Federal Districts. It may lead to serious social and economic consequences for domestic livestock production.

There is a great risk of LSD introduction to Eastern Europe and Balkan free countries. In this light, in order to prevent and control the infection spread, the UN Food and Agricultural Organization (FAO) calls for mass cattle vaccination, especially in the run-up to the biting insect season, when infection rates are the highest [15].

Among all vesicular diseases the biggest threat for Russia is posed by *foot and mouth disease*, which tends to spread in vast territories and is of epidemic and pandemic nature. FMD is the disease that should be the first one to be excluded in case of vesicular clinical signs. FMD virus can be introduced from endemic regions even to economically developed countries. Herewith FMD can cause great economic losses to the national livestock production.

A good example here is an FMD outbreak in Great Britain in 2001, where the disease was reported in 13 counties; 2,026 FMD outbreaks were registered and more than 6 million animals were killed. Total economic losses caused by the outbreak estimated from 5.8 to 8.6 billion pounds, equivalent to about 10.7–14 billion US dollars [20]. Outbreak in Taiwan in 1997 is an ample proof of FMD significance as of a highly dangerous infection, able to spread rapidly over vast territories. The economic losses were estimated at 379 million US dollars, because more than 4 million pigs were killed, which represented 40% of national pig population. The economic impact from the pork export ban and loss of profits pertaining to tourism was estimated at 1.6 billion US dollars [18]. A large scale FMD outbreak in Japan in 2010 caused a serious damage for livestock production and related industries. Livestock production direct costs amounted to 51.2 billion yens; indirect losses of related industries totaled 25.5 billion yens; costs of disease control measures were equal to 8.2 billion yens. Total economic impact of FMD epidemic was estimated at almost 85 billion yens or 934 million US dollars at the 2010 exchange rate [17].

Annual economic damage caused by FMD, including direct production losses and vaccination costs, amounts to 6.5–21 billion US dollars only in endemic countries. Besides, FMD outbreaks in FMD free countries and zones result in losses equal to 1.5 billion US dollars a year [20].

In the RSFSR territory FMD was eradicated in 1989. The eradication measures were based on preventive vaccination, stamping out policy in the outbreak area and ring vaccination. The disease reoccurred for the first time after eradication in Russia in 1993. Since that time outbreaks have been registered predominantly along the southern borders of the country. Taking into account the fact, that several neighboring countries and regions (primarily China, Mongolia, Middle East and Central Asia countries) remain FMD infected, there is still a threat of virus introduction into Russia. In order to prevent it the zone of constant animal vaccination with FMD targeted surveillance is maintained in the Russian regions, bordering FMD infected countries.

More recently (in 2007) the information about a new virus, causing a vesicular disease in animals, *Seneca Valley virus infection*, became available. Since the end of 2014 the number of SVVI outbreaks in pigs of different commercial categories has been increasing. Within three years (from November 2014 to November 2017) SVVI cases were reported in six countries: USA, Brazil, Canada, Columbia, China and Thailand. SVVI is difficult to be distinguished from FMD and other vesicular diseases in adult pigs and fattening piglets. Besides, the Seneca Valley virus is extremely stable in the environment and can survive under different conditions [23].

A high risk of SVV introduction to the Russian Federation with infected breeding pigs, slaughter products, contaminated fetal serum, trypsin and cell cultures, as well as with virus vaccines was identified [13].

Risk assessment

Domestic and global experience suggests the following most common routes and causes of most vesicular disease virus introduction to any free zones (countries):

I. Import of live animals and animal products.

II. Import of improperly produced feeds, vaccines and veterinary medicines.

III. Migration of wild animals.

IV. Mechanical route (vehicles, tourists, pilgrims, migrants, insects).

I. Import of live animals and animal products

As Russia purchases live animals and animal products from abroad, there is a risk of these agents' introduction both legally (if imported from trade partner countries) and illegally (for example illegal movement of animals in the bordering areas). Agents can also be transmitted during migration of wild animals, by contacts between domestic and wild animals at pastures and watering places. Moreover, as Russia has the longest land border, it is under the constant threat of introduction of different animal transboundary disease agents. The evidence of this is the introduction of LSD and ASF viruses to Russia from Caucasian countries.

There is a certain risk of introducing disease agents to the countries with imported susceptible animals, meat, hides, casings, bones, horns, hooves and hair.

Table 1
Import of live animals to Russia [16]

Country	Import share, %	Import share by species					
		horses, donkeys, mules	cattle	pigs	sheep, goats	poultry	others
Netherlands	27.0	0.4	68.0	–	0.1	28.2	3.3
Germany	21.1	0.7	85.8	–	0.2	13.0	0.3
Australia	15.7	–	77.2	–	22.8	–	–
Hungary	8.8	0.4	84.1	–	0	15.5	–
Denmark	7.9	0.1	99.9	–	–	–	0
Canada	3.7	0.9	1.9	97.1	–	–	0
France	3.3	3.1	14.3	–	–	69.1	13.6
USA	2.2	33.9	58.9	–	1.1	0.3	5.9
Republic of Belarus	1.5	3.0	49.3	21.8	0.1	20.6	5.2
Austria	1.3	0	72.6	–	6.8	20.6	0
Great Britain	1.2	9.4	–	–	–	61.7	29.0
Ireland	0.8	51.8	48.2	–	–	–	–
Uzbekistan	0.7	–	–	–	–	–	100.0
Ukraine	0.7	1.1	28.1	–	–	–	70.8
Belgium	0.6	2.9	–	–	–	–	97.1
Israel	0.6	0.7	–	–	–	–	99.3
Czech Republic	0.5	0.5	36.2	–	–	44.4	18.9
Finland	0.4	0.8	99.2	–	–	–	0
Estonia	0.4	0.3	99.7	–	–	–	–
Slovakia	0.4	–	10.4	–	–	–	89.6

The registration of FMD, LSD, SGP, PPR outbreaks in 2015–2018 in the countries, closely located to the Russian Federation and/or having agricultural trade relationships with it (Georgia, Mongolia, China, etc.) is a matter of some concern.

1. Legal import of live animals

The risk of introducing vesicular disease agents to the Russian Federation with legal import of live animals is minimal, because the Federal Service for Veterinary and Phytosanitary Surveillance controls the global epidemic situation and in case of outbreaks in trade partner countries, it imposes temporary restrictions on import of goods, posing risk.

In 2017 – May, 2018 top twenty countries, exporting the largest number of live animals to Russia, included European countries, Canada, USA and Uzbekistan (Table 1).

All these countries are free from FMD, sheep and goat pox, peste des petits ruminants and lumpy skin disease. But it should be noted that cases of Seneca Valley virus infection are reported in Canada and the USA. Besides, Kazakhstan was on the list of live cattle importers to Russia in 2017–2018, though LSD case was registered there in 2016.

2. Legal import of animal products

Table 2 shows countries, which as of 2018 export animal products to the RF and are infected with vesicular diseases.

A high import share of animal products conventionally accounts for butter, cheese, curd and beef, which could be factors in spreading the infection, if animal health rules are not met.

Thus, it can be presumed, that in case of legal import the highest risk of introducing the agents of vesicular diseases to the RF is posed by the countries, where these agents are present, i.e. by China, Turkey, India, Mongolia, Iran, Kazakhstan, etc.

3. Illegal import of live animals and animal products

Illegal movements of animal products and live animals across the customs border are detected every year. Illegal imports from Kazakhstan, China, Mongolia and Kyrgyzstan jeopardize the epidemic situation in terms of vesicular diseases. Table 3 summarizes data on attempts to import potentially dangerous animal products and live animals across the RF state border in 2018 according to mass media.

Judging by the facts published by the Russian mass media, the number of international and Russian law vio-

lations in this area is not diminishing. Infringements in foreign trade pose direct threat to epidemic situation and economic security of Russia.

II. Import of feeds, live vaccines and veterinary medicines

Import of feeds for animals to the Russian Federation is also a potential threat of disease agent introduction. To be imported into the customs territory of the Eurasian Economic Union feeds and feed additives of animal origin shall be free from bovine spongiform encephalopathy and scrapie, African swine fever, horse sickness, rinderpest, classical swine fever, sheep and goat pox, psittacosis, anthrax, horse influenza, avian influenza and Newcastle disease. But the US researchers discovered that some viruses, including SVV, can potentially survive for a long time in some feed ingredients. Senecavirus A proved to be a rather resilient virus, which could persist in all tested feed components. Thus it was proved that some feed ingredients can pose risks, as they can transmit viruses between farms and different countries [22].

Vaccines, as well as live vaccines, are imported to Russia; and in case of improper manufacture, live vaccines can pose a potential threat of the disease agent introduction. The potential contamination of trypsin, serum and vaccine components, imported to our country as raw materials for domestic production, should be also taken into account.

Though live vaccines represent a small percentage among all authorized veterinary products in Russia, they can become a cause of diseases in animals, including vesicular diseases.

III. Migration of wild animals

Wild animals can become the source of infection, especially if they move across the state borders. Wild ruminants can be infected from domestic ones and, in turn, serve as a source of infectious disease agents for farmed animals. The agent circulation in wild fauna creates a risk of food producing animal infection, particularly at common pastures and watering places. If nomadic husbandry is practiced, the migration routes of wild animals can cross agricultural pastures and green fodder areas [11].

Taking into account the fact that some Russia's neighboring countries are infected with vesicular diseases, the threat of infection introduction to Russia along the following three routes remains: North Caucasian, Central Asian and Far Eastern routes. Practically every year the Russian Veterinary Service reports FMD outbreaks in the settlements, located in the proximity to the Russian-Chinese border. Scientists have repeatedly pointed out that the migration of wild animals (Mongolian gazelles, for example), inhabiting Russia, Mongolia and China, are one of the major factors, facilitating FMD spread [2, 6].

Many wild animals are susceptible to FMD, including elks, deer, saiga antelopes, chamois, bisons, buffaloes, yaks, goitered gazelles, mouflons, roes, wild boar, etc. FMD occurs in saiga antelope populations when FMD outbreaks are present along their migration routes [3].

Table 2
Import of animal products to Russia in 2018 [14]

Country	Imported products	Disease			
		FMD	LSD	SGP	PPR
Armenia	milk, cream, butter, cheese, curd, untreated bovine hides		+		
Bulgaria	animal hair and wool		+	+	+
China	meat and offal, bristles, animal products, animal hair and wool	+		+	+
Columbia	beef, offal of cattle, pigs, sheep and goats, butter	+			
Egypt	cheese and curd	+	+	+	+
Greece	non-edible animal products		+		
India	frozen beef	+			+
Iran	milk, cream, butter, cheese and curd	+	+	+	+
South Korea	animal products, tanned leather from animal hides	+			
Kazakhstan	beef, offal of cattle, milk, cream, butter, cheese and curd, untreated bovine hides, wool		+		
Morocco	cheese and curd			+	
Mongolia	frozen beef, animal hair and wool	+		+	+
Nepal	tanned leather from bovine animal hides	+		+	+
Tunisia	cheese and curd	+		+	+
Turkey	cheese and curd, tanned leather from sheep and lamb hides, wool	+	+	+	+
SAR	animal products	+	+		

+ means infected (pursuant to the OIE Terrestrial Animal Health Code; terms for disease freedom status recovery: for FMD – 12 months, for PPR – 24 months, for LSD and SGP – 36 months of no cases reported).

Table 3
Illegal imports of live animals and animal products to Russia

Country	Product	Reference
Kazakhstan	canned fish and meat	http://www.vzsar.ru/news/2018/07/06/konservy-bez-dokymentov-razvernyli-na-granice-v-ozinkah.html
Kazakhstan	small ruminants	http://www.fsvps.ru/fsvps/news/27293.html
Kazakhstan	cheese	https://fn-volga.ru/news/view/id/86855
Kazakhstan	dairy products	http://www.fsvps.ru/fsvps/news/26991.html
Kazakhstan, Kyrgyzstan	canned meat, poultry, beef	https://fn-volga.ru/news/view/id/86855
Kyrgyzstan	fermented dairy products	https://www.alt.kp.ru/online/news/3188407/
China	meat	https://www.hab.kp.ru/online/news/3057201/
China	sausages	http://www.rshn-khv-eao.ru/novosti/46-pogranichnyj-veterinarnyj-kontrol/1412-zapreschennye-produkty-zaderzhali-na-granice
Mongolia	boiled mutton	https://www.baikal-daily.ru/news/16/322825/
Mongolia	meat products	https://www.infpol.ru/88349-v-buryatii-zaderzhali-grazhdanina-kotoryy-pytalsya-provezti-iz-mongolii-zapreshchennoe-myaso/
Mongolia	beef	https://www.baikal-daily.ru/news/16/313221/
Uzbekistan	meat and dairy products	https://www.vrn.kp.ru/online/news/3186597/
Uzbekistan Tajikistan	milk	https://ru.sputnik-tj.com/russia/20180728/1026312797/cyplyata-vnukovo-yashchur-uzbekistan-tajikistan.html

Subspecies *Saiga tatarica tatarica* of saiga antelopes migrate in Russia's Caspian area, in Kazakhstan, Uzbekistan and Turkmenistan. Mongolian saiga antelopes (*Saiga tatarica mongolica*) and Mongolian gazelles migrate massively in October-November from Mongolian territory to the neighboring Chinese regions and in May-June, during lambing time, they migrate back. Trasnboundary migration reoccurs in July-August. Currently saiga antelope habitat covers Russia (North West Caspian region: Republic of Kalmykia, Volgograd and Astrakhan Oblasts), Kazakhstan (Volga-Ural Sands, Ustyurt and Betpak-Dala) and Mongolia (Sharga and Mankhan Nature Reserves) [2].

PPR outbreaks due to migration of wild animals are most likely to occur in Russia's Siberian and Far Eastern Federal Districts, neighboring infected countries (China, Mongolia). PPR outbreaks in southern Georgia in 2016 are also of certain significance, in case PPR reoccurs in Georgia, risk of animal infection in North Caucasian and Southern Federal Districts, where animal population is dense, will increase again.

Given the SGP situation in Russia in 2010–2017 and infection endemicity in China and north-eastern aimags of Mongolia, the following border administrative subjects of the Russian Federation are under the risk of infection introduction and spread: Zabaikalsky, Khabarovsk and Primorsky Krais, Republic of Buryatia, Jewish Autonomous and Amur Oblasts [5].

IV. Mechanical route of infection transmission (vehicles, tourists, pilgrims, migrants, insects)

Currently many livestock farms employ nationals from China, Central Asia and Caucasus, who can bring the infectious agents from infected areas with live animals, animal products, as well as by mechanical route [10].

Intermediate passive carriers of FMD [4] and SGP [8] viruses can include insusceptible animals, like dogs, cats, horses and poultry, transmitting the agents mechanically outside the outbreak area. Secondary role in FMD spread is played by rats and mice, as well as by flies, ticks and other insects, being mechanical virus vectors [4]. Ticks also can transmit sheep and got pox viruses [9].

Lumpy skin disease belongs to vector-borne infections, as the agent is transmitted primarily by arthropod vectors, usually mosquitoes, midges and flies [7]. There is an evidence supporting LSD transmission by ticks and birds. It was established that lumpy skin disease virus can reproduce in *Rhipicephalus appendiculatus* and *Amblyomma hebraeum* ticks, as well as transovarial transmission in these species and in *Rhipicephalus decoloratus* ticks is also possible. For these insects, wintering outside the host is a part of their life cycle, therefore they can serve as virus reservoirs during the inter-epidemic period [12, 19]. Infected vectors can infect disease-free animal populations, travelling short, medium and long distances by different means (by wind, vehicles or birds) [21].

CONCLUSION

Thus it may be stated that basic causes of vesicular disease transboundary spread include: movements of animals (legal/illegal), animal products, feeds and vaccines; migration of wild animals across the borders from neighboring countries and passive mechanical transmission.

As Russia purchases live animals and animal products from abroad, there is a risk of vesicular disease agents' introduction to the Russian Federation with such products. The highest risk of vesicular disease introduction with le-

gal imports is presented by the following countries, where such diseases are present: China, Turkey, India, Mongolia, Iran, Kazakhstan, etc.

Infringements in foreign trade also jeopardize the epidemic situation and economic security in Russia. Illegal movements of animal products across the customs border are detected every year. Illegal imports from Kazakhstan, China, Mongolia, Kyrgyzstan can be referred to as highly dangerous in terms of vesicular diseases.

Wild animals can become the source of infection, especially if they move across the state borders. Viruses can be transmitted by contacts between wild and domestic animals at common pastures and watering places. The fact that some Russia's neighboring countries are infected with vesicular diseases creates a constant threat of infection introduction to Russia along the following three routes: North Caucasian, Central Asian and Far Eastern routes.

Import of feeds for animals to the Russian Federation is also a potential threat of disease agent introduction. The stability of Seneca Valley virus, surviving for long periods in certain feed ingredients, is especially alarming. Up to date Seneca Valley virus infection cases have been registered in the USA, Brazil, Canada, Columbia, China and Thailand.

Given the presented facts, it should be concluded that the enhanced surveillance in foreign and domestic trade is needed with special attention paid by the state veterinary service to the epidemic situation in Russia's neighboring and closely located countries. In order to timely detect infectious disease agents, circulating among migrating animal populations, systematic diagnostic tests are required.

Conflict of interests. The authors claim no conflict of interests.

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Submitted on 13.12.18
Approved for publication on 09.01.19