THE VETERINARY AND GEOGRAPHICAL ANALYSIS
OF RABIES SPREAD AND FORECAST IN KAZAKHSTAN

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Annotation

This work reflects the results of studies of rabies' epizootic process in the territory of the republic for the period of 2003-2013. The number of the registered outbreaks of rabies in the country shows that the rabies outbreaks are sporadic, at the same time the numbers of registrations for the period of 2003-2013 vary from 28 to 150 cases per year.

A GIS database of disadvantaged settlements was made (2003-2013), on the basis of which the work on visualization, clustering, and zoning of the territory for welfare level was performed.As a result of the risk assessment and prediction of the Monte Carlo method, the possible number of cases of rabies in the country for 2014 was found which are 128 cases, which shows possible increase in the number of disadvantaged settlements for 3%.

As a result, the prediction of rabies in 2014, it was established that the number of possible cases of rabies registration in the country was 128 cases.

110 cases of rabies have been identified in accordance with the Veterinary Service of Kazakhstan in 2014.Thus, the effectiveness of forecasting the Monte Carlo method was 86%.

Key words: animals, rabies, epidemiological situation, Kazakhstan, epizootic process, information and communication technology, geographical information system.

Introduction

The goal of the studies is to conduct the veterinary geographical analysis on the distribution and forecast of rabies in farm and wild animals in the Republic of Kazakhstan.

Despite significant advances in veterinary science and developing effective means of combating infectious diseases, it was impossible to prevent the spread of rabies, but many aspects of their epizootic manifestations remain not sufficiently studied [1,2,3].

In the last years, the rabies epizootic situation in the world and in Kazakhstan is ahead of many infections

on intensity. The rabies is one of the particularly dangerous zoonotic diseases. The uneven spread of infection in the world is sharply seen and it is registered on every continent except Australia and Antarctica [4,5,6,7,8,9].

According to some researchers, the rabies remains as a dangerous infectious disease with a complex epizootic and epidemiological situation in the world [10,11,12,13,14].

Now the rabies is registered in 113 countries around the world, the disease is characterized by an acute course, polioencephalomyelitis signs, and in the absence of timely treatment of absolute mortality due to this every year more than 55,000 people and more than 1 million animals die. Direct damage caused by rabies are about 4 billion euros per year [15,16].

Nowadays you can see the rise of cases of rabies in the world, the same pattern is observed in our country, the number of rabies recorded in animals (fox, raccoon dog, wolves, cats and cattle), tends to rise by an average of 7% per year. Annually, rabies kills up to 700 heads of farm animals and more than 50% of them are cattle, up to 25% - of small cattle [17].

In most of the regions of Kazakhstan the epizootic situation on rabies is extremely complex - natural foci of this infection are intensified, the number of cases among different animal species recorded human cases with fatal outcome [18,19]. Despite ongoing activities in the country to limit the spread and completely eliminate rabies infectionis still difficult. This fact is related to many factors, and the availability of natural foci of infection [20].

The modern epizootic science has new tasks for the study of patterns that characterize the population dynamics of disease in animals, identifying their characteristics, causes and epizootic risk factors, and improving, prevention and infection control measures [21].

In particular, much attention is paid to the system of epizootic supervision and control, as the most effective forms of anti-epizootic protection using geographic information systems, modern methods of effective vaccination, taking into account advances in molecular epizootology [22].

The information and communication technology allows to provide a comprehensive analysis of epidemiologically relevant information, especially in solving the dual analysis of numerous factors, including the geographic spread of infection, excluding socio-economic and natural and geographical factors, to make the most accurate reviews and forecasts of epidemiological/epidemiological situation [23,24].

Selecting the direction of our research is due to the prevalence of rabies, the presence of favorable conditions for epizootic and epidemic complications, the need to improve the preventive measures on epizootic control of this disease in the country.

Materials and methods

Analysis and evaluation of the epizootic situation of rabies in the country for the period of 2003-2013 by analyzing data of the Veterinary Committee for veterinary control and surveillance MoA of RK, as well as

their own research results during visiting livestock farms and settlements.

The commercial software company ESRI - ArcGIS 10.1was used for visualization of disadvantaged settlements on rabies.

To solve issues of system simulation (Monte Carlo) and space-geographic analysis, using the auto correlation Morana, applying the basic provisions of the statistical analysis. The commercial software (version 6.0 @ RiskProfessionalEdition, PalisadeCorporation ®, 1996-2013) based on Microsoft Excel 2010 was used during assessing the risk Monte Carlo.

The standard setting of «Packet Analysis» in Microsoft Excel 2010 was used to carry out the correlation analysis. This setting contains 19 statistical procedures and 50 functions. Pearson's correlation coefficient (correlation moments works) was used. The geographic information system (GIS), the license GIS software , which consists of three applications ArcGIS 10 – ArcCatalog, ArcMap, and ArcToolbox was used to make an inventory of electronic foci permanently disadvantaged settlements, as well as study of spatial and coordinated objects (foci) in rabies in Kazakhstan. ThevectormapofKazakhstanwasthetopo graphicbasis (1:1 000 000).

GIS database is a Microsoft Excel document, containing information about a disadvantages settlements, it includes the name of the rural district, district, region, year of registration, type of animal, number of diseased animals and the name of the disease, as well as their precise geographic location, geographic coordinates expressed. To determine the geographic coordinates hand-held GPS Navigators (eTrexLegend, Global SatGH-801 and Shturman SVG-40), as well as satellite imagery Googlemap were used.

Results

Analysis of epizootic situation of rabies from 2003 to 2013 among the different species of animals suggests that the disease annually is registered and characterized by constancy.

The results of the analysis of the structure of animal rabies in the country is reflected in Figure 1, from which it follows that the disease each year is registered in all of the studied populations of animals, with the largest number of cases in cattle and dogs.

In recent years, cases of rabies registration tended to increase the number of cases of disease registration, which is primarily due to severe (snow) in winter and the lack of feed for wild animal, which are in contact with farm animals. Due to this fact, the rabies epizootic process acquires anthropourgic character.
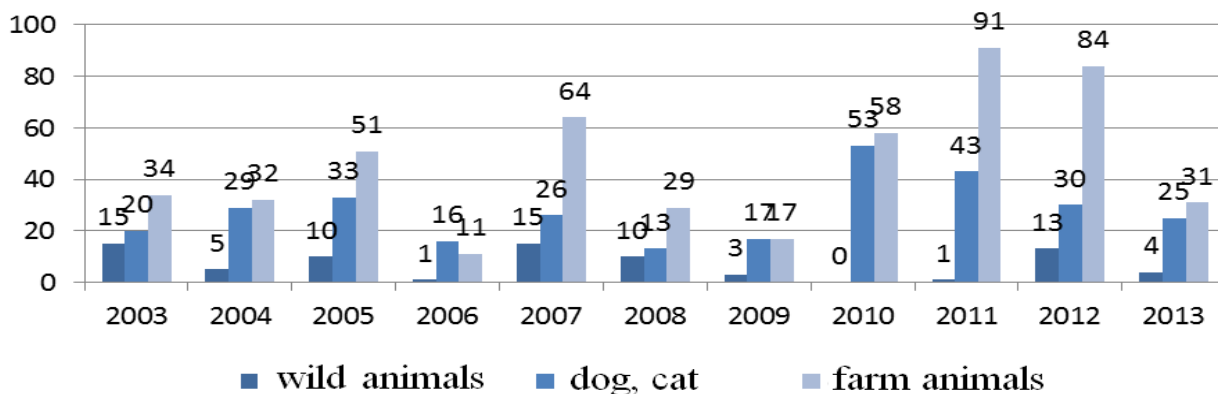
Figure 1 – Species composition ofanimalrabies in the country

With a view to the efficient organization of preventive and anti-epizootic measures, a GIS database (geographic information system) was created which is necessary to visualize the settlements where the disease was detected (Figure 2). GIS database is a MicrosoftExcel document, containing information about disadvantaged settlements (rural district includes the name, district, region, year of registration, type of animal, number of diseased animals and the name of the disease, as well as geographic coordinates).
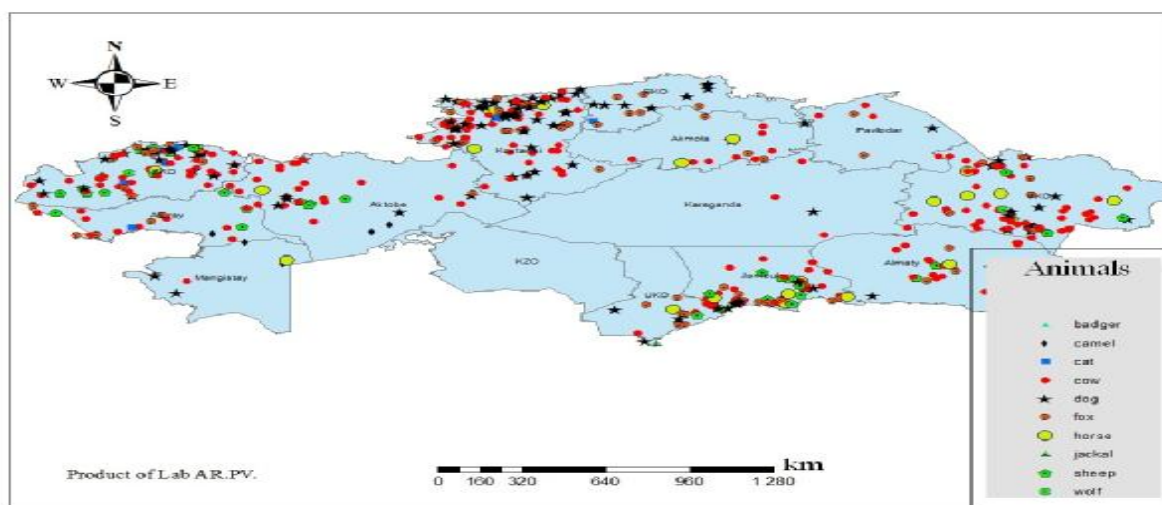

Figure 2 – Visualization of disadvantaged settlements of rabies in the country for 2003-2013

Analysis of the visualization results of the settlements where the disease was detected indicates that most of the cases of rabies are in the border areas of the Republic relating to forest and forest-steppe zones (Kostanay, East Kazakhstan and West Kazakhstan regions), as well as regions with high population density and animal.

Based on the GIS database, work on clustering and zoning of the areas on electronic mapdegree of welfare (Figures 3, 4) was carried out.
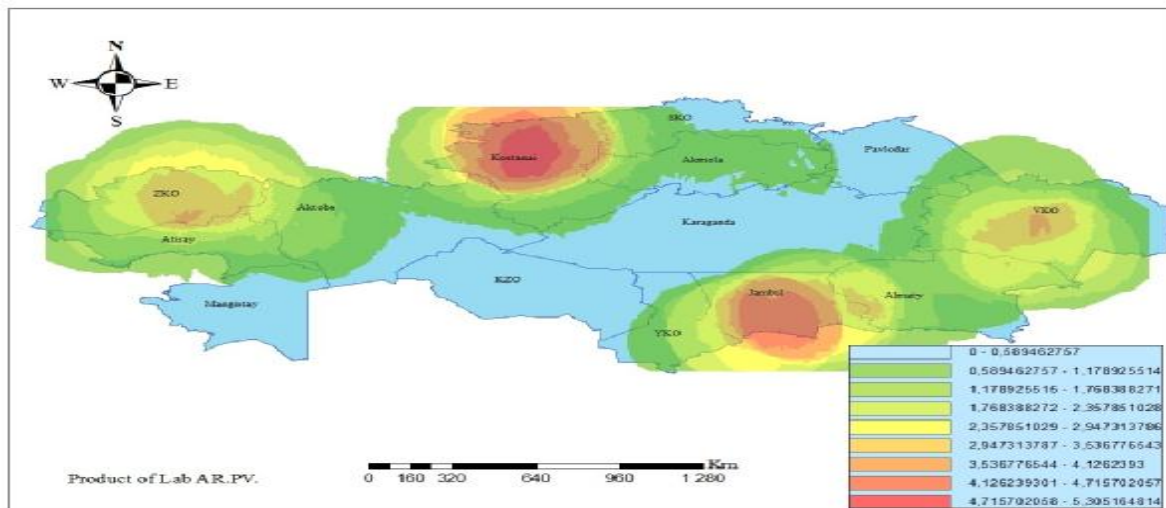
Figure 3 – Clustering of disadvantaged settlements on rabies (based on analysis of the epizootic situation in 2003 - 2013)

The determination of clusters in epizootology/epidemiology is important because it allows you to focus and purposefully carry out preventive and anti-epizootic measures, acting directly on the source of the pathogen and transmission mechanisms, taking into account the socio-economic and climatic factors.

The largest cluster on rabies are on the territories of the West Kazakhstan, Kostanai, East Kazakhstan and Zhambyl regions, the intensity of outbreaks of rabies registration for 10 years tends annual increase, despite the preventive measures.

On the basis of visualization and clustering, zoning of the territory of the Republic was made according to the risk of rabies manifestations. The results of zoning are reflected in Fig. 4, the areas with a high degree of disadvantaged territories are West Kazakhstan, Aktobe, Kostanay, Zhambul and East Kazakhstan regions.
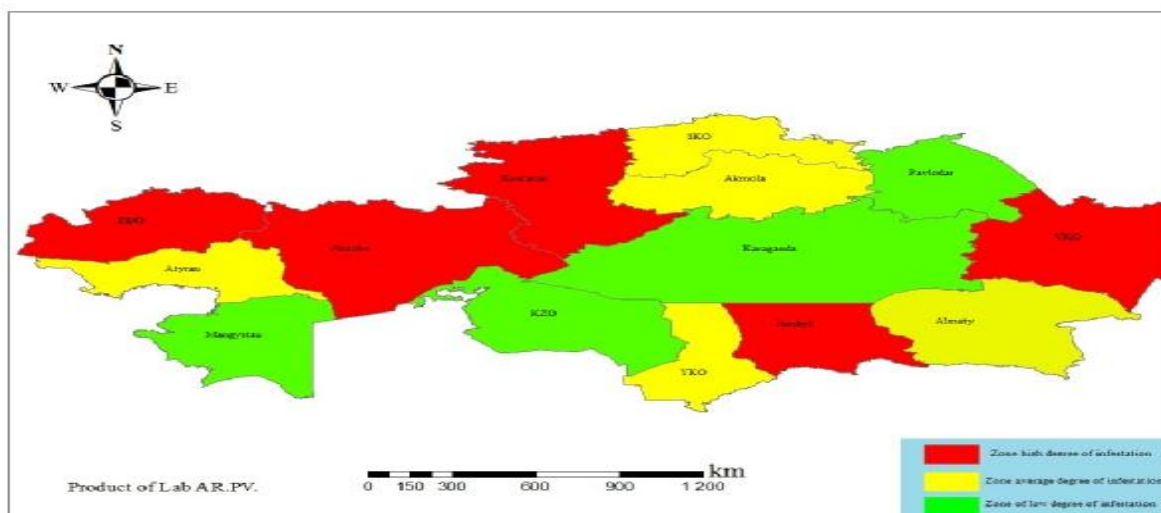
Figure 4 – Zoning ofthe territory according to the degree of well-being on rabies (based on analysis of the epizootic situation in 2003 - 2013)

In order to determine the dependence of rabies onset among the various animal populations and to identify the type of rabies («forest» or «city»), correlation analysis using the indicators characterizing the epizootic process from 2003 to 2013 was performed.

The results of correlation analysis on determination of the risk degree of "urban" type of rabies among populations of «dog» and «cattle» is reflected in Figure 5.

The correlation between the number of rabies diseased cattle and the number of sick dogs and cats is about 70% (0,6827 ...). This result shows that the relationship is quite high. This can be explained by the fact that at the moment the number of stray homeless dogs is increasing and preventive measures are carried out not effectively.

The next stage of the correlation analysis was to determine the degree of risk forest «type of rabies» , «wild animals» and «cattle» correlation between the number of rabies diseased cattle and wild animals was 15 %, as the correlation coefficient of 0,1439 .. . This result reflects a lack of correlation, therefore rabies epizootic process has anthropourgic nature and degree of transmissionrisk of the disease in wildlife is lower than the stray dogs (Figure 6).
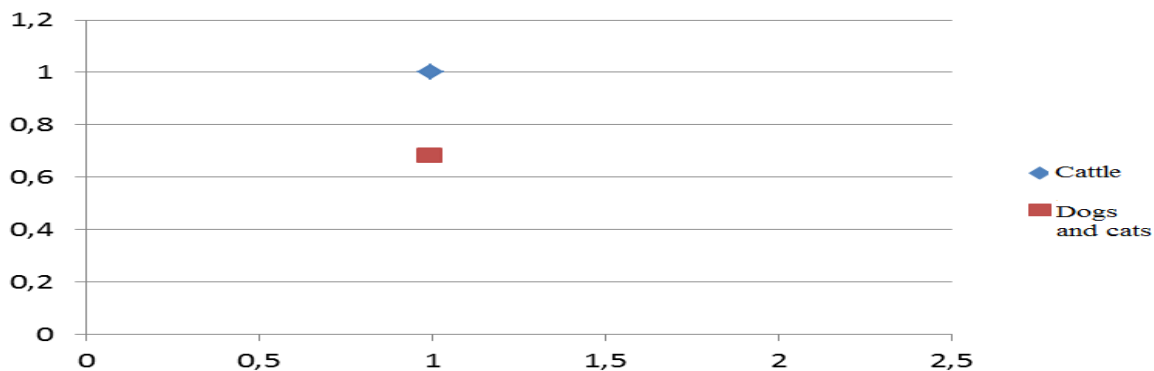

Figure 5 – The correlation between the number of rabiesdiseased cattle and dogs and cats

The main role of epizootic disease is explained with the presence of mixed reservoir of rabies, involving the circulation of the pathogen of various animal species, and the presence of a constant interchange between «anthropourgic» and «sylvatic» centers. It must be assumed that the country has poligostal natural focus, where the wild animals are as the reservoir of various kinds, which is the most notable are the mediator foxes, i.e. after the initial importation, circulation is the causative agent in the population of stray dogs and cats.
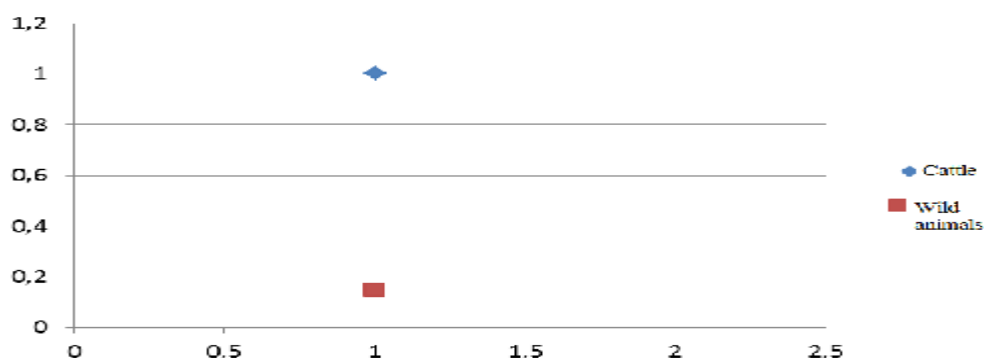
Figure 6 – The correlation between the number of rabies diseased cattle and the number of registrations of rabies among wild animals

According to the results of the correlation analysis the«forest» type of rabies in virtually does not effect on the spread of the disease among farm animals, due to the minimization of contact data populations, meanwhile, as the dependence of the «urban» type of rabies and the correlation coefficient is 0,750.

Thus, the main cause of the rabies in settlements is the involvement in epizootic process of rabies infection of uncontrolled population, neglected domestic carnivore. One of the most valuable methods for monitoring of epizootic disease process is the risk assessment and prediction of disease. To assess risk, we used the average annual number of probable cases of rabies.

Modeling of the process was carried out by Monte Carlo using commercial software (version 6.0 @ RiskProfessionalEdition, PalisadeCorporation ®) based MicrosoftExcel (MicrosoftOffice 2010).

This method is the creation of a mathematical model of the disease, through which you can theoretically evaluate the impact of the disease.

To carry out the iteration, we used the maximum, average and minimum number of disadvantaged settlements of rabies in recent years (Table 1).

Table 1 – Forecasting the number of disadvantaged settlements on rabies for 2014

The expected number of the disadvantaged settlements on rabies in RK for 2014			
	Minimum	Most probably	Maximum	Risk assessment for 2014
RK	110	124	150	128
Total number				128
2013				124
	2010	2011	2012	2013
RK	110	150	113	124

After our performed iteration Monte Carlo method, we obtained the following results:

Picture 6 shows that the vertex of the triangular distribution on the abscissa is equal to 128, a minimum value 110 and maximum 149, and the standard deviation (± 8,287).

Thus, the possible number of cases of rabies in the country for the 2014 is 128 cases, suggesting a possible increase in the number of disadvantaged settlements in 2014 compared with 2013 by 3% (Figure 7).

This raises a need to strengthen the monitoring of the effectiveness of preventive and anti-epizootic measures in settlements (rural administrative districts and cities).
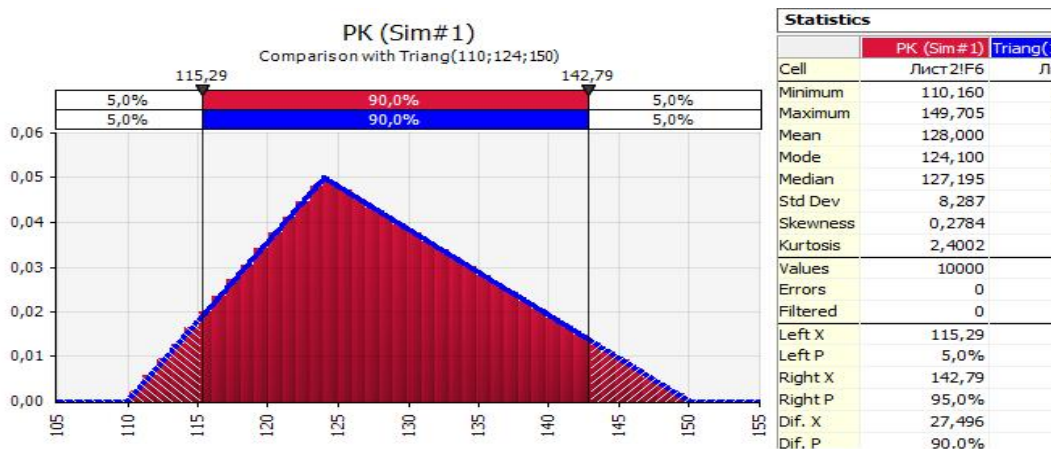

Statistics		
	PK (Sim#1)	Triang(
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Minimum	110,160	
Maximum	149,705	
Mean	128,000	
Mode	124,100	
Median	127,195	
Std Dev	8,287	
Skewness	0,2784	
Kurtosis	2,4002	
Values	10000	
Errors	0	
Filtered	0	
Left X	115,29	
Left P	5,0%	
Right X	142,79	
Right P	95,0%	
Dif. X	27,496	
Dif. P	90.0%	

Figure 7 – Possible number of disadvantaged settlements for 2014 in Kazakhstan

Among the variety of zoonotic infectious diseases the rabies takes a special place as the rabies virus affects, along with man, almost all warm-blooded animals. Therefore, the problem of rabies is the subject of joint study of the health and veterinary medicine.

According to assessment of the World Health Organization, the rabies according to the economic damage inflicted, takes the fifth place among all infectious diseases.

The risk of disease spread among animals and the risk of human cases is not decreasing in the Republic of Kazakhstan in recent years. In almost all regions of the country periodically we observe activation of natural foci of rabies, a growing number of cases in wild carnivores, epizootic process involving domestic animals (dogs, cats) and livestock.

Epizootic situation on rabies in the country remains tense, 124 cases of rabies were registered in the country registered in 2013 (including West Kazakhstan -22, -19 East Kazakhstan, Zhambyl – 18,Kostanay - 14), i.e. the disease is registered in 12 of 14 provinces (except Mangistau and Karaganda).

Analysis of the results visualization of disadvantaged settlements indicates that most of the cases of rabies registration belong to the border areas of the Republic relating to the forest and steppe zones, and areas with high density of population and animals.

In recent years, cases of rabies tended to increase the number of cases,

which is primarily due to severe (snow) in winter and the lack of feed for wild animal, which in turn are in contact with farm animals. Due to this fact, rabies epizootic process acquires anthropourgic character.

Using GIS technologies the major clusters on rabies in the country was identified.The largest clusters are located in Western Kazakhstan, Kostanay and Zhambyl regions. This fact is confirmed by the intensity of registering cases of rabies not on the territory of these areas.

It is necessary to note that for 10 years there is a trend of annual increase in the registration of rabies in these areas, despite the preventive measures. Based on the results of visualization, the clustering was performed by zoning the country on the risk level of rabies. Results of zoning showed that the zone of a high degree of distress belong to West Kazakhstan, Aktobe, Kostanay, Zhambul and East Kazakhstan regions.

The results of correlative analysis, which was conducted using a standard setting«Packet Analysis» in MicrosoftExcel, showed that the highest risk has "urban" type of rabies, rabies correlation between the number of diseased cattle and the number of sick dogs and cats, was about 70% (0,6827 ...) This result suggests that the relationship is quite high. This can be explained by the fact that at the moment the number of stray dogsis increasing and preventive measures are carried out not effectively.

Similarly, we performed a correlation analysis between the number of rabies diseased cattle and wild animals, the results of this correlation analysis was about 15%, since the correlation coefficient is 0,1439 ....

This result reflects the absence of correlation; therefore the epizootic rabies process has anthropourgic nature and degree of risk of transmission of the disease in wildlife lower than of homeless dogs. Thus, according to the correlation it is shown that «forest» type of rabies in virtually no effect on the spread of the disease among farm and domestic animals, due to the minimization of contact data populations, meanwhile, as the dependence of the «urban» type of rabies and the correlation coefficient was 0,750.

Based on registration data on outbreaks of rabies in the last 4 years, we have developed a model of rabies epizootic process; the decision was made due to the fact that the situation of rabies in these past 4 years, with the number of outbreaks in the years ranges from 100 to 150. The results of modeling found that the possible number of cases of rabies in the country of registration for 2014 will be 128 cases suggesting a possible increase in the number of disadvantaged points in 2014 compared to 2013 by 3%. This result is the basis for tightening control of the preventive measures against rabies in Kazakhstan. Particular attention should be paid to the main cluster of rabies in Kazakhstan.

According to the data of the veterinary service in 2014, 110 dysfunctional rabies were registered in which 110 animals became ill and fell, including cattle – 56, sheep – 10, horses – 2, camels – 2, dogs – 14, cats – 1, and wild animals – 20.

The effectiveness of the method of risk analysis and prediction of rabies using the @Risk software was 86 %.

Discussion

Continuing unfavorable epizootic situation of rabies in the country is due to the widespread nature of rabies, unsatisfactory work to regulate the number of wild animals and the organization of their oral immunization, the increase in urban and rural areas with animals, gross violations of rules for keeping pets, poor organization of their account and registration insufficient outreach work among the population.

As it is shown in the analysis for the last years the disease of farm animals kept at a constant stable level, while key mediators of infection are street dogs.

Analysis of epizootic situation indicates the low efficiency of preventive and anti-epizootic measures against rabies. Effectiveness of oral vaccination against rabies in wild carnivores, as well as methods of their application and subsequent monitoring immunogenicity requires radical revision.

Taking into account the epizootic situation on rabies of animal, there is an urgent need to develop a comprehensive state (national) program against rabies, with the involvement of all interested bodies.

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Резюме

Статья отражает результаты исследований эпизоотического процесса бешенства на территории республики на период 2003-2013 гг. Число регистраций на период 2003-2013 гг. варьирует от 28 до 150 случаев в год.

Была создана база данных ГИС неблагополучных пунктов в период с 2003-2013 гг., на основе которых была проведена визуализация, кластеризация и зонированиепо степени эпизоотического благополучия. В результате была проведена оценка риска и прогнозированиеметодом Монте-Карло, было установлено, что возможное число случаев бешенства в стране к 2014 году будет зарегистрировано 128 случаев, что свидетельствует о возможном увеличении числа неблагополучных пунктов на 3%.

В результате прогнозирования бешенства на 2014 год, установлено количество возможных случаев регистрации бешенства на территории республики, которое составило 128 случаев.

По данным ветеринарной службы Казахстана в 2014 г. было выявлено 110 случаев бешенства. Таким образом, эффективность прогнозирования методом Монте-Карло составила 86 %.

Түйін

Мақалада республика аумағында 2003-2013 жылдар аралығы кезіңіндегі құтырық эпизоотиялық үдерісін зерттеу нәтижелері көрсетілген. Осы 2003-2013 жылдар кезеңінде тіркелу оқиғаларының саны жылына 128-ден 150-ге дейінгі аралықта ауытқыған.

Аталған 2003-2013 жж. кезенінде сау емес елді-мекендердің ГАЖ деректер базасы құрылды, оның негізінде эпизоотиялық саулығы дәрежесі бойынша визуализациялау, кластерлеу мен аймақтарға бөлу жұмыстары жүргізілді. Нәтижесінде қатерді бағалау мен Монте-Карло әдісімен болжамдау өткізілді, бұл болжамдауға сәйкес, елдегі құтырық оқиғаларының ықтималды саны 2014 жылға шыққанда 128 оқиға түрінде байқалады деп танылды, бұл сау емес елді-мекендер санының 3% жоғарылау ықтималдығы бар екенің дәлелдеп, көрсетті.

Қазақстанның ветеринариялық қызметі берген деректерге сәйкес 2014 жылы 110 құтырық оқиғасы тіркелінген, сонымен Монте-Карло әдісімен болжамдаудың тиімділігі 86 % құрады.