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DYNAMICS OF TICK-BORNE ENCEPHALITIS MORBIDITY IN VINNYTSIA

One of the most widely spread diseases is tick-borne encephalitis. Most frequently the growth of tick-borne encephalitis cases are connected with the intense activity of these parasites in the period from April to September. Tick-borne encephalitis is spread in all the countries of the world and the morbidity level is within the 300 to 500 cases per hundred thousand population.

The object of the study in the given research is tick-borne encephalitis incidence in Vinnytsia, this disease is one of the most common viral disease. Determination of the regression dependence, describing the dynamics of tick-borne encephalitis incidence of the population in Vinnytsia is relevant scientific-engineering problem. Objective of the research is determination of the regression dependence, which describes the dynamics of the tick-borne encephalitis incidence of the population in Vinnytsia, this dependence can be used for the prediction of the incidence rate of the disease. In the course of the study method of regression analysis of the results of single-factor experiments and other paired dependences with the selection of the rational type of function from sixteen most widely used variants by the criterion of maximum value of the correlation factor was used. Regression was carried out on the base of linearized transformations which enable to reduce non-linear dependence to linear one. Determination of the coefficients of regression equations was performed, applying the method of least squares by means of the developed computer program "RegAnaliz", protected by the Certificate of the State registration of the rights to the copyright object. Adequate regression power dependence, describing the dynamics of the tick-borne encephalitis incidence of the population in Vinnytsia was obtained, the dependence can be used for the prediction of the incidence rate of the disease. Graphic interpretation of the dependence, describing the dynamics of tick-borne encephalitis incidence of the population in Vinnytsia was constructed, it enables to illustrate this dependence and show the sufficient convergence of the theoretical results with actual ones.

Key words: *incidence, incidence rate, tick-borne encephalitis, dynamics, regression analysis, regression dependence.*

Introduction

One of the most widely spread viral diseases is tick-borne encephalitis [1]. The growth of tick-borne encephalitis incidence cases is connected with the increase of these parasites activity in the period from April till September. Main factor of this phenomenon is insufficient protection of people against tick bites during rest in parks, squares, forest areas, near ponds, and during work at garden plots. Ticks are main flavivirus carriers [2]. Ticks may be dangerous, being carriers of such diseases, dangerous for humans as tick-borne encephalitis, tick-borne ixodid borreliosis, Lyme borreliosis [3 – 5]. Tick-borne encephalitis is spread in all the countries of the world and incidence level is within 300 – 500 cases per hundred thousand population. However, real number of cases may be far more greater, as many people avoid to address the doctor and try to treat themselves. This leads to underestimation of the number of cases, registered by medical establishments, especially among the adult population [1].

Problem set up

In 2018 considerable growth of tick-borne encephalitis cases were recorded in Vinnytsia – 317, compared with 130 cases in 2017, 60 % of the cases were confirmed by laboratory tests. Incidence rate level was almost 33 cases per 100 000 of population, this figure is higher than national average, which is 13 cases per hundred thousand population. That is why, determination of regression

dependence, which describes the dynamics of tick-borne encephalitis incidence rate of the population in Vinnytsia and can be used for prediction the indices of the diseases is important scientific-technical task.

Analysis of the recent studies and publications

Tick-borne encephalitis is a viral zoonotic natural-focal disease having various mechanisms of infection transmission, this disease is characterized by general intoxication syndrome, polymorphic clinical picture with possible damage to the nervous system, respiratory system and alimentary tract. Incubation period lasts 5 – 30 days (on average 10 – 14 days). Prevention of tick-borne encephalitis is performed, applying specific and non-specific measures. In the first case, vaccination of the selected groups of the population, falling under the risk of infection as a result of their professional activity or the place of residence is carried out on epidemic grounds. Measures of non-specific protection provide the usage of the protective clothes to prevent the attack of ticks, rational forest management, limitation of cattle grazing in the forested areas, disinsection, using acaricides and larvicides, milk boiling [6].

On the base of the research, carried out in the study [7], the authors made a conclusion that, although the virus of tick -borne encephalitis is seasonal and risk of disease within the limits of the city is low, but its consequences are rather serious and may lead to disability and in certain cases, even to lethal outcome.

As a result of anthropogenic load [8 – 12] and climatic changes important changes occur in modern tick populations, as a result of these changes ticks take over new places of residence, expand the area of existence, these factors lead to the increase of the number of ticks and changes of their seasonal activity in local recreational areas [13].

In the paper [14] the spread and dynamics of natural-focal zoonosis (Lyme disease) in the Carpathian region is studied, measures, aimed at its prevention are elaborated. It is established that the carriers of Lyme disease pathogens are ixodid ticks. The disease is transmitted transmissibly by suction of the tick to human body. Ticks transmit pathogenic transovarially (by tick eggs), and transphasally (by the larvae and nymphs). It was established that the incidence of the population in the mountainous areas of Lyme disease is high. The trend of the population incidence is constantly growing, in particular, in Kosiv, Verkhovynskyi and Rakhnivskyi districts. Mainly middle-aged people suffer from this disease, often they are representatives of the professional groups of risk (foresters, berry and mushrooms pickers, shepherds, hunters, etc).

In the study [15] based on complex monitoring, performed on the territory of Odesa region wide prevalence of tick-borne encephalitis virus was identified. It is noted that rapid specific diagnostics of the tick-borne encephalitis of the diseases with the signal features of arborvirus infections in Odesa region will promote timely conduction of the therapy, aimed at the reduction of the clinical severity of the disease course and at the possibility of prevention of gross residual side effects and chronification of the process. It is established that timely conduction of acaricidal measures is an efficient preventive measure to prevent tick-borne encephalitis disease among the population of Odesa region.

In the materials of the paper [16] the results of multiannual epidemiological and laboratory monitoring of the natural-focal infections associated with ixodid ticks in western regions of Ukraine are presented. It is shown that this territory is tense focal of tick-borne infections, this statement is proved by the growing level of the incidence of the population, enlargement of their areas, revealing of new nosological entities. Clinical manifestations and epidemiological features of the most important infections, in particular, tick-borne encephalitis are given.

Materials of the paper [17] are devoted to the determination of the regression power dependences of the prevalence of various classes of the diseases among the adult population of the settlements adjacent to the site of SMW disposal on the distance to the landfill, these dependences are used for the determination of the safe distance for the location of SMW landfills from the settlements by the prevalence rate of respiratory systems pathology and blood circulation system diseases.

Paper [1] contains the incidence rate of tick-borne encephalitis of the population in Vinnytsia in the period 2013 – 2018.

However, as a result of the analysis of the known publications the authors did not reveal specific mathematic dependences, which describe the dynamics of tick-borne encephalitis incidence of the population in Vinnytsia.

Objective and task of the paper

Objective of the paper is determination of the regression dependence which describes the dynamics of the tick-borne encephalitis incidence rate of the population in Vinnytsia, this dependence can be used for the prediction of the incidence rate of the disease.

Methods and materials

For the determination of the regression dependence, which describes the dynamics of tick-borne encephalitis incidence rate in Vinnytsia the following methods were used: regression analysis of the results of single-factor experiments and other paired dependences, computer simulation.

Results of the research

Table 1 contains tick-borne encephalitic incidence rate in Vinnytsia in the period 2013 – 2018 [1]. On the base of the data, contained in Table 1 it was planned to obtain paired regression dependence, which describes the dynamics of tick-borne encephalitic of the population in Vinnytsia. As the argument of the regression dependence is one year, the order of its values three times exceeds the order of the width of its change, then in order to increase the accuracy of regression dependence, it is suggested to take the year, preceding the beginning of the studied range ($x = t - 2012$) as the origin of coordinates.

Table 1

Tick-borne encephalitis incidence rate of population in Vinnytsia [1]

Year	2013	2014	2015	2016	2017	2018
Prevalence rate of tick-borne encephalitis of population, cases	53	73	46	109	130	317

Regression was carried out on the base of linearized transformations, enabling to reduce non-linear dependence to linear. Determination of the coefficients of regression equations was performed, using the least square method [18] by means of the developed computer program "RegAnaliz" [19], protected by the Certificate of state registration of the rights for copyright object and is described in details in the work [20].

Program "RegAnaliz" enables to carry out regression analysis of the results of single factor experiments and other paired dependences with the selection of the rational type of function from sixteen most widely spread variants by the criterion of maximum correlation factor, saving the results in MS Excel and Bitmap format.

Results of regression analysis are shown in Table 2, grey color indicates the cell with maximum value of the correlation factor R.

Thus, by the results of the regression analysis, on the base of the data from Table 1 the following regression dependence is taken as the most adequate:

$$П_{TE} = 61{,}89 + 0{,}003204(t - 2012)^{6{,}294} \text{ [case.]}, \quad (1)$$

where $П_{TE}$ – is prevalence of tick-borne encephalitis incidence of the population in Vinnytsia, cases;

t – year.

Table 2

Results of regression analysis of the dependence which describes the dynamics of tick-borne encephalitis incidence rate of the population in Vinnytsia

№	Type regression	Correlation factor R	№	Type regression	Correlation factor R
1	$y = a + bx$	0.82091	9	$y = ax^b$	0.76049
2	$y = 1 / (a + bx)$	0.82711	10	$y = a + b \cdot \lg x$	0.68955
3	$y = a + b / x$	0.54466	11	$y = a + b \cdot \ln x$	0.68955
4	$y = x / (a + bx)$	0.01533	12	$y = a / (b + x)$	0.82711
5	$y = ab^x$	0.87140	13	$y = ax / (b + x)$	0.63077
6	$y = ae^{bx}$	0.87140	14	$y = ae^{b / x}$	0.62533
7	$y = a \cdot 10^{bx}$	0.87140	15	$y = a \cdot 10^{b / x}$	0.62533
8	$y = 1 / (a + be^{-x})$	0.58311	16	$y = a + bx^n$	0.98558

On the base of the Table 2 it was established that the prevalence of tick-borne encephalitis incidence of the population in Vinnytsia grew in the period of 2013 – 2018 by power dependence.

Fig. 1 shows actual and theoretical graphic dependences, describing the dynamics of tick-borne encephalitis incidence of the population in Vinnytsia in the period of 2013 – 2018.

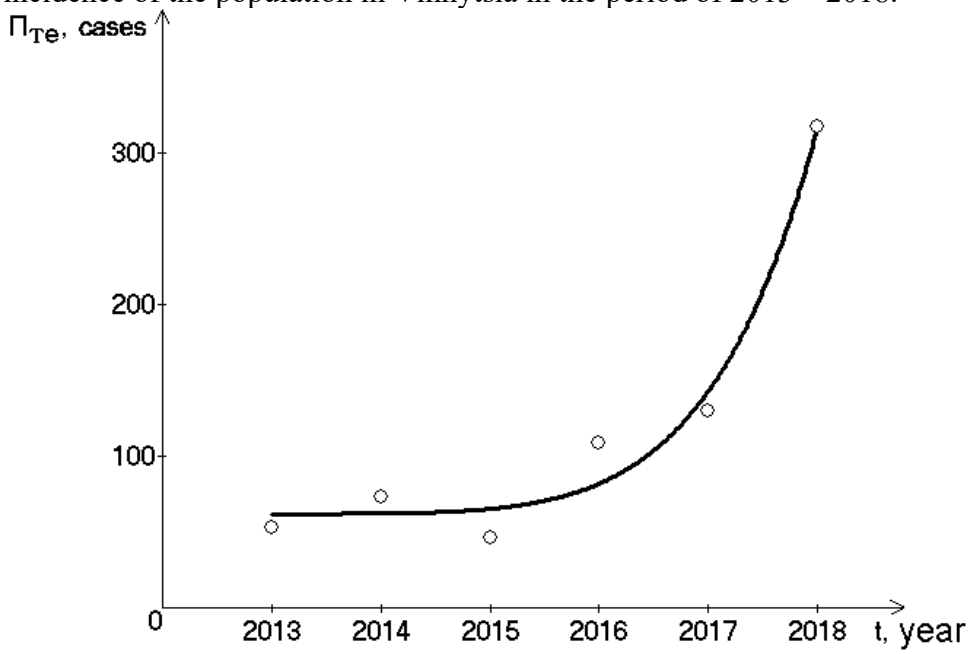

Fig. 1. Dependences, which describe the dynamics of tick-borne encephalitis incidence of the population in Vinnytsia in the period of 2013-2018: actual ○, theoretical —

Comparison of actual and theoretical values showed that theoretical prevalence of tick-borne encephalitis of the population in Vinnytsia, calculated by means of regression equation (1), does not differ greatly from the data, presented in the study [1], this proves the sufficient accuracy of the dependence, previously obtained.

Conclusions

1. Regression dependence, which describes the dynamics of tick-borne incidence of the population in Vinnytsia is determined, it can be used for the prediction of the incidence rate of the disease.

2. Graphic dependence, which describes the dynamics of tick-borne encephalitis incidence rate of the population is Vinnytsia is constructed, it enables to illustrate this dependence and show the sufficient coincidence of theoretical and actual results.

3. It is established that the prevalence of tick-borne encephalitis incidence of the population in Vinnytsia grew in the period of 2013 – 2018 by power dependence.

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