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ASSESSMENT OF POTENTIAL EPIDEMIC HAZARDS CAUSED BY COMBINED FOCI WITH BACTERIAL, VIRAL, AND RICKETSIAL INFECTIONS

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The authors performed epidemiologic analysis on 2,008 case histories of dangerous feral nidal infections among Astrakhan' region population over the last 17 years. It allowed them to characterize basic categories of epidemiologic risk related to such infections under contemporary conditions and determine the most significant statistically authentic (p<0.05) criteria for assessing potential epidemic hazards caused by autonomous and combined natural foci with bacterial, viral, or ricketsial nature in the north and northwestern Caspian Lowlands. The determined criteria included a number of morbid cases among people, quantity of infection carriers and agents (fleas, ticks, and mosquitoes), contamination of rodents and infection carriers, circulating strains virulence, presence of camels, results of immunologic research performed on infection carriers and agents, immune layer among risk groups that include people and animals, ambient temperature, and average annual precipitations. The authors took epidemiological data obtained by Rospoterbnadzor's Astrakhan' Anti-plague Station, Astrakhan' Regional Center for Hygiene and Epidemiology, and A.M. Nichoga's Regional Infectious Clinical Hospital; the data were collected over 2000–2017 and were given in primary medical documentation including forms No. 027/U, No. 058/U, No. 060/U), as well as in reports with results of epizootologic examinations accomplished on the examined territories. The authors applied score assessment to work out an algorithm for determining qualitative and quantitative parameters of hazards caused for people by natural foci of plague, tularemia, leptospirosis, Crimean hemorrhagic fever, West Nile fever, and Astrakhan's ricketsial fever. This technique allows to perform scientifically substantiated epidemiologic zoning of territories with foci and to differentiate necessary prevention activities both in combined and autonomous infectious diseases foci with simultaneous reduction in expenditure.

Key words: *potential epidemic hazards, natural foci with bacterial, viral, and ricketsial infections.*

Introduction. There has been sporadic morbidity with tularemia, leptospirosis, brucellosis, Crimean hemorrhagic fever (CHF) [1, 17, 18], West Nile fever (WNF) [1-4, 21], and Astrakhan ricketsial fever (ARF) [6, 9] registered on the northern and northwestern Caspian Lowlands territories which were enzootic as per plague. In some years there was group morbidity or outbreaks of certain diseases (Crimean hemorrhagic fever in 2005-2008, West Nile fiver in 1999) [3, 10-12, 18-20]. Viral and ricketsial infections should be given special attention.

Thus, morbidity with CHF in Astrakhan region was registered every year (excluding 2014). There were three peaks detected in the overall morbidity dynamics; they occurred in 2001-2002, 2005-2007, and 2010, and all of them were followed by a drastic decrease in morbidity with the disease. But still, there is a statistically authentic (P<0.05) trend for morbidity with CHF to decline.

On the contrary, morbidity with WNF varied from 7.3 per 100,000 population in Astrakhan region in 2005 to 0.1 in 2007; in 2016 it amounted to 2.7±1.2 on average. A calculated trend that describes dynamics in morbidity with this infection in Astrakhan region indicates there is a slight decrease in it. However, a model of the 6th order polynomial approximation proves there is likely to be an outbreak of the disease in the nearest future.

Astrakhan ricketsial fever is a new infectious disease [1]. People with the infection

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were first detected in 1978 in Krasnoyarskiy distirct of Astrakhan region, and in subsequent years it was also registered in other districts of the region. In 1978-1981 32 morbid events were registered; there were 47 in 1982, and 82 in 1988 [21]. Over the last decades morbidity with ARL has been registered in all the administrative districts in Astrakhan region, excluding Chernoyarskiy district. The highest morbidity levels are detected in Privolzhskiy and Narimanovskiy districts (783.6 and 523.6 per 100,000 population respectively).

Specific areas in natural foci are apparently different as per their potential epidemic hazards; given that, it is advisable, on one hand, to reduce volumes of epizootologic research as it is the most expensive component in the whole set of epidemiologic surveillance; on the other hand, one cannot degrade safety for population groups that run elevated risks of infection. All the above mentioned underlies a differentiated approach to epizootologic monitoring over foci with different epidemiologic status [6, 13, 14].

As preventive (anti-epidemic) activities aimed at eliminating hazardous infections are at present accomplished as per specific nosologies on various administrative territories in the RF regions, it is necessary to work out complex prevention plans for feral nidal infections taking into account occurrence of combined foci and results of epidemiologic zoning performed as per epidemic risk levels.

Our research goal was to work out a procedure for assessing potential economic hazards caused by autonomous and combined foci of bacterial, viral, and ricketsial infections; the procedure should be relevant for Astrakhan region.

Data and methods. The authors applied data collected by Astrakhan Anti-Plague Station, Rospotrebnadzor's Regional Office in Astrakhan, Astrakhan Center for Hygiene and Epidemiology, as well as results of epizootologic and epidemiologic research performed in the region.

We performed epidemiologic analysis of data on epidemic and epizootic activities occurring in autonomous natural foci of plague, tularemia, leptospirosis, Crimean hemorrhagic fever, West Nile fever, and Astrakhan ricketsial fever, detected in Astrakhan region; the data were collected over 2000-2016. Overall, we examined 2,008 case histories.

We applied score assessment in a modification developed by E.V. Kuklev [7, 8]. All the data were statistically processed with conventional techniques [16].

Results and discussion. In order to perform epidemiologic zoning in Astrakhan region and differentiate existing autonomous and combined natural foci of hazardous viral, bacterial, and ricketsial infections into separate areas as per their potential epidemic risk levels, we analyzed epizootic and epidemiologic status in natural foci of the examined infections over 2000-2016. Basing on the results of epidemiologic analysis performed on 2,008 case histories related to Astrakhan region population morbidity with hazardous feral nidal infections (plague, tularemia, leptospirosis, Crimean hemorrhagic fever, West Nile fever, Astrakhan ricketsial fever) detected in 2000-2016, we determined the most significant parameters (features) that quantitatively and qualitatively reflect specific epidemiologic peculiarities of the examined infections (Tables 1 and 2).

Our choice of these parameters is substantiated taking into account a direct statistically authentic correlation ($P<0.05$) between each such parameter and people catching the infections. This proposition is also confirmed by the results obtained in previous research and potential epidemic hazards calculated for various infections: hemorrhagic fever with nephrotic syndrome (r= + 0.76) [5], plague, cholera, malaria (r > + 0.6), arbovirus infections (CHF virus circulation value = 0.79) [8, 18], virus hepatitis of B and C type (r > + 0.7) [15], and assessment of potential hazards related to mass events (100% coincidence of qualitative and quantitative parameters of potential epidemic hazards (PEH) related to mass events) [14].

Score assessment combined with conventional variation statistics techniques turned out to be the most relevant technique for assessing different parameters.

We detected an entire assembly of features for each parameter and spotted out three gradations, high, average, and low one, depending on assembly size and confidence intervals. Each

Table 1

Parameters of potential epidemic hazards caused by combined natural foci with bacterial infections and their scores

Parameters of potential epidemic hazards caused by natural foci	Parameter symbol	Maximum score
PARAMETERS COMMON FOR ALL NATURAL FOCI		
Physical square of an area within a natural foci	S	2
Population density (urban and rural)	P	3
PLAGUE		15
Number of disease cases among people	A	7
Number of plague carriers (average over long-term period/current): primary ones, secondary ones, in settlements	B	1
Contamination of rodents with plague agent	D	2
Results of immunologic research on animals (on Ag and Ab)	M	1
Number of plague carriers (Abundance index for hair, holes, microbiotopes) (average over long-term period/current): in houses, in open biotopes	C	1
Contamination of fleas with plague agent	E	1
Virulence of plague agent strains	V	1
Presence of camels (private sector and public livestock)	L	1
TULAREMIA		15
Number of disease cases among people	A	7
Immune layers among risk groups	K	1
Number of tularemia carriers (average over long-term period/current): in open biotopes, in closed biotopes	B	1
Results of immunologic research on animals (on Ag and Ab)	M	1
Number of ticks (average over long-term period/current): in open biotopes, number of registered species	C	1
Contamination of ticks with tularemia agent	E	2
Contamination of rodents with tularemia agent	D	2
LEPTOSPIROSIS		15
Number of disease cases among people	A	7
Number of leptospirosis carriers (average over long-term period/current) in anthropurgic foci: rats, cattle, pigs, dogs	B	2
Contamination of carriers with leptospirosis agents: rats, cattle, pigs, dogs	D	4
Results of immunologic research on animals (on Ag and Ab): rats, cattle, pigs, dogs	M	2

Table 2

Parameters of potential epidemic hazards caused by combined natural foci with viral and ricketsial infections and their scores

Parameters of potential epidemic hazards caused by natural foci	Parameter symbol	Maximum score
PARAMETERS COMMON FOR ALL NATURAL FOCI		
Physical square of an area within a natural foci	S	2
Population density (urban and rural)	P	3
CRIMEAN HEMORRHAGIC FEVER		15
Number of disease cases among people	A	7
Natural and climatic conditions on a specific area: average temperature (January, July), Average annual precipitation	T U	2
Number of primary CHF virus carriers: *D. marginatum* ticks	C	2

Detection of CHF virus markers: ticks, small mammals, blood serum of farm animals, human blood serum	M	4
WEST NILE FEVER		15
Number of disease cases among people	A	7
Sum of average daily temperature is higher than +10 ^{0}C	T	2
Number of primary WNF virus carriers (mosquitoes of Culex species): in open biotopes, in closed biotopes	D	3
Detection of WNF virus markers: mosquitoes, ticks, wild waterfowl, farm waterfowl, human blood serum	M	3
ASTRAKHAN RICKETSIAL FEVER		15
Number of disease cases among people	A	7
Number of primary rickettsia ticks carriers: in open biotopes, in settlements on cats and dogs	C	4
Detection of ARF virus markers: ticks, human blood serum	M	4

gradation corresponded to a quantitative score given to each parameter; 14-20 scores corresponded to high gradation, 7-13, average one, and less than 7 scores meant gradation was low. This distribution of scores is a sum of scores given to criteria common for all feral nidal infections (5 scores) and a sum of scores which are specific for this or that infection (15 scores maximum).

For example, potential epidemic hazard caused by a natural plague focus is calculated as follows:

$$ПЭО_1 = S + P + A + B + C + D + E + M + L + V =$$

$$= 2 + 1 + 0 + 0{,}5 + 0{,}5 + 0 + 1 + 0 + 1 + 0{,}5 = 6{,}5,$$

where ПЭО1 is a parameter that describes potential epidemic hazard existing in a natural plague focus, S is a physical square of an area within a natural focus, P is population density (urban and rural), A is a number of disease cases among people, B is a number of plague carriers, C is a number of plague agents, D is contamination of rodents, E is contamination of fleas, M is a results obtained in immunologic research, L is presence of camels, V is virulence of strains (for white mice or guinea pigs).

Calculated potential epidemic hazard of an area within a natural plague focus amounts to 6.5 scores and it means the hazard is low.

Parameters of potential epidemic hazards existing on territories of combined natural foci were calculated as a sum of values obtained for potential epidemic hazards as per each separate infection divided by a number of these infections:

$$PEH = (PEH_1 + PEH_2 + PEH_3 +$$

$$+ PEH_4 + PEH_5 + PEH_6) : 6,$$

where PEH is a potential epidemic hazard existing in a combined natural focus, PEH_1 is a potential epidemic hazard of a natural plague focus; PEH_2, tularemia; PEH_3, leptospirosis; PEH_4, Crimean hemorrhagic fever; PEH_5, West Nile fever; PEH_6, Astrakhan ricketsial fever.

Conclusion. We proposed the most statistically significant criteria for assessing potential epidemic hazards existing in autonomous and combined natural foci of bacterial, viral, and ricketsial infections (plague, tularemia, leptospirosis, Crimean hemorrhagic fever, West Nile fever, and Astrakhan ricketsial fever) in northwestern Caspian Lowlands. We have developed an algorithm based on score assessment for qualitative and quantitative estimation of potential epidemic hazards caused by such natural foci. If the proposed procedure is implemented, it will allow to perform scientifically substantiated epidemiologic zoning of a natural focus territory and to differentiate prevention activities thus reducing expenditure. It is recommended to apply this approach when accomplishing epidemiologic surveillance over feral nidal infections in northwestern Caspian Lowlands.

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