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ORIGINAL ARTICLE

ASSESSMENT OF THE CONSEQUENCES OF THE DETERIORATION OF THE EPIDEMIOLOGICAL SITUATION DURING HOSTILITIES

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ABSTRACT

The aim: Scientific substantiation of the methodology for predicting the consequences of the worsening of the epidemic situation on the territory of Ukraine during military operations for the timely adoption of measures for the medical protection of military personnel in conditions of biological contamination.

Materials and methods: Determination and generalization of the impact of biological contamination due to the use of biological weapons were carried out considering the main determinants of the epidemic process using the index and coefficient of medical protection. Applied methods of scientific research: epidemiological, system, and information approach.

Results: The authors proposed indicators that consider the pathogenicity of the infectious agent, contagiousness, the degree of non-specific protection of servicemen, specific protection of servicemen, and the sanitary-epidemiological state of the area of operations of troops (forces). Relevant epidemic situations were simulated, and the index and coefficient of medical protection were calculated to predict the consequences of the worsening of the epidemic situation to make timely decisions regarding the implementation of medical protection measures for military personnel in conditions of biological contamination during the repulsion of armed aggression.

Conclusions: In the conditions of biological contamination, when biological weapons and biological terrorism are used, the epidemic process in the army is intensified, which requires timely decisions regarding the implementation of medical protection measures for military personnel in conditions of biological contamination.

KEY WORDS: military medicine, biological weapons (terrorism), medical protection, forecasting the consequences of biological contamination

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INTRODUCTION

Today, in the conditions of the armed aggression of the Russian Federation against Ukraine, the use of various types of weapons, in particular weapons of mass destruction (WMD), creates prerequisites for a sharp deterioration in the sanitary and epidemiological condition of the troops [1]. In addition, the probability of the occurrence of mass infectious diseases is increasing, not only as a result of the use of biological weapons but also as a consequence of the deterioration of the sanitary and epidemic situation in the area of operations due to the activation and change of the boundaries and structure of previously studied natural foci of particularly dangerous infections (PDI), newly emerging dangerous infectious diseases and loss of control over some previously managed infections [2, 3].

In addition, when repelling Russia's armed aggression on the territory of Ukraine and defending its territory, the risk territory is the territory of operational-strategic directions of actions of the troops (forces), where the sanitary-epidemiological condition worsens because of the specified actions. Time of risk – the corresponding period of the task (within two months or more), considering the epidemiological features of the development of the epidemic process (seasonality, cyclicity, periodicity) of individual nosological forms, relative to which the specified territory is epidemically unfavorable; the risk group is servicemen of the interspecies operational and operational-tactical group of troops who are susceptible and not protected against the relevant infections. The risk factors for the development of epidemic problems in military groups are the deterioration of

the sanitary-epidemiological condition of the relevant territory of Ukraine as a result of damage to communal networks (water supply, sewage, electricity supply) during hostilities; complicating the organization of water supply, food, accommodation of personnel, population; accelerated evacuation of the population to the middle of the country from the relevant border regions of Ukraine, the territory of the enemy's active operations; conscription and replenishment of military teams to wartime states in conditions of full deployment of the Armed Forces of Ukraine with personnel who are not protected against relevant infectious diseases. In such conditions, the epidemic process in the troops is intensified, which affects their fighting capacity, and the high efficiency of medical protection measures of the troops in conditions of biological contamination is achieved only when predicting the consequences of the worsening of the epidemic situation [4-6].

This determines the relevance of measures for the medical protection of troops in the conditions of biological contamination and the scientific justification of the methodology of forecasting the consequences of the worsening of the epidemic situation (the use of biological weapons, biological terrorism) in the conditions of biological contamination during the repulsion of armed Russian aggression on the territory of Ukraine.

THE AIM

Scientific substantiation of the methodology for forecasting the consequences of the worsening of the epidemic situation (the use of biological weapons,

biological terrorism) during the repulsion of Russia's armed aggression on the territory of Ukraine to take timely measures for the medical protection of military personnel in conditions of biological contamination.

MATERIALS AND METHODS

Determination and generalization of the impact of biological contamination due to the use of biological weapons (biological terrorism) were carried out considering the main determinants of the epidemic process using the index and coefficient of medical protection. Applied methods of scientific research: epidemiological, system, and information approach.

RESULTS

To ensure the protection of military personnel in conditions of biological contamination, it is necessary to take into account the multifactorial determinants of the epidemic process. The most significant factors are pathogenicity of the infectious agent, contagiousness, degree of non-specific protection of servicemen (depends on the level of equipment and training of personnel), specific protection of servicemen (depends on the type of pathogen, implementation of vaccination and its effectiveness, use of emergency prevention), lethality. Thus, for example, the degree of danger to personnel in the event of isolated cases of typhoid and paratyphoid, shigellosis, viral hepatitis A (VHA), and cholera during the implementation of the relevant actions of troops (forces) is moderate and low, respectively, several cases

Table I. Degree of the danger of infectious diseases

Nosofrom	The number of those who fell ill		
	a single case	several cases	dozens of those who fell ill
Pneumonic plague	very high	very high	very high
Viral hemorrhagic fevers (Lassa, Marburg, Ebola)	very high	very high	very high
Bubonic plague	high	high	very high
Anthrax (generalized form)	average	high	very high
Cholera	average	high	very high
Tularemia	average	high	very high
Tick-borne encephalitis	low	average	high
Brucellosis	low	average	high
Yellow fever	low	average	high
Diphtheria	average	high	very high
Meningococcal infection	low	average	high
Typhoid	low	average	high
Shigellosis	low	low	average
Hepatitis A	low	low	average

Table II. Index of medical protection taking into account the determinants of the epidemic process of infectious diseases

Nosological form	Conducting medical protection measures	Index of medical protection
Typhoid fever and paratyphoid fever	carried out promptly and in full	0,08
	carried out late and partially	0,2
Shigellosis	carried out promptly and in full	0,08
	carried out late and partially	0,2
Viral hepatitis A	carried out promptly and in full	0,072
	carried out late and partially	0,2
Cholera	carried out promptly and in full	0,24
	carried out late and partially	0,3
Meningococcal infection	carried out promptly and in full	0,045
	carried out late and partially	0,1
Diphtheria	carried out promptly and in full	0,08
	carried out late and partially	0,1
Viral hemorrhagic fevers	carried out promptly and in full	0,05525
	carried out late and partially	0,35
Yellow fever	carried out promptly and in full	0,125
	carried out late and partially	0,2
Tularemia	carried out promptly and in full	0,1125
	carried out late and partially	0,25
Tick-borne encephalitis	carried out promptly and in full	0,06
	carried out late and partially	0,25
Malaria	carried out promptly and in full	0,05
	carried out late and partially	0,25
Brucellosis	carried out promptly and in full	0,0375
	carried out late and partially	0,1
Pneumonic plague	carried out promptly and in full	0,2
	carried out late and partially	0,4
Bubonic plague	carried out promptly and in full	0,05
	carried out late and partially	0,1
Anthrax (generalized)	carried out promptly and in full	0,1
	carried out late and partially	0,2

are average, low, and high, dozens of patients - high, moderate and very high, (Table I).

In the event of single cases of brucellosis during combat operations of troops (forces), the degree of danger to personnel is low, viral hemorrhagic fevers are very high, anthrax (generalized form) is average, several cases of brucellosis are average, viral hemorrhagic fevers are very high, anthrax (generalized form) – high, a dozen patients with brucellosis – high, viral hemorrhagic fevers and anthrax (generalized form) – very high (table I).

The degree of danger for the personnel in the event of single cases of diphtheria, meningococcal infection, or pneumonic plague during the implementation of the specified forms of actions when using troops (forces) - average, low, very high, respectively, several cases - high, average, very high and a dozen sick - very high

and high, in the event of isolated cases of yellow fever, tick-borne encephalitis, malaria, the degree of danger to personnel is low, tularemia is average, bubonic plague is high, several cases of yellow fever, tick-borne encephalitis, malaria are average, tularemia is high, bubonic plague is high, a dozen patients with yellow fever, tick-borne encephalitis, malaria - high, tularemia and bubonic plague - very high, Table I.

To ensure effective interaction between command posts and units of the medical service to take timely measures for the medical protection of servicemen in conditions of biological contamination, based on the epidemic characteristics of various nosoforms, the characteristics of non-specific protection and the effectiveness of specific protection for various infections, we simulated the corresponding epidem-

Table III. The coefficient of medical protection, considering the dynamics of the sanitary-epidemiological state of the area of operations of troops (forces)

Nosological form	Conducting medical protection measures	Coefficient of medical protection in the sanitary-epidemiological state of the district		
		unstable	unfavorable	emergency
Typhoid fever and paratyphoid fever	carried out promptly and in full	0,16	0,24	0,32
	carried out late and partially	0,4	0,6	0,8
Shigellosis	carried out promptly and in full	0,16	0,24	0,32
	carried out late and partially	0,4	0,6	0,8
Viral hepatitis A	carried out promptly and in full	0,144	0,216	0,288
	carried out late and partially	0,4	0,6	0,8
Cholera	carried out promptly and in full	0,48	0,72	0,96
	carried out late and partially	0,6	0,9	1,2
Meningococcal infection	carried out promptly and in full	0,09	0,135	0,18
	carried out late and partially	0,2	0,3	0,4
Diphtheria	carried out promptly and in full	0,16	0,24	0,32
	carried out late and partially	0,2	0,3	0,4
Viral hemorrhagic fevers	carried out promptly and in full	0,105	0,1575	0,21
	carried out late and partially	0,7	1,05	1,0
Yellow fever	carried out promptly and in full	0,25	0,375	0,5
	carried out late and partially	0,5	0,75	1,0
Tularemia	carried out promptly and in full	0,225	0,3375	0,45
	carried out late and partially	0,5	0,75	1,0
Tick-borne encephalitis	carried out promptly and in full	0,12	0,18	0,24
	carried out late and partially	0,5	0,75	1,0
Malaria	carried out promptly and in full	0,1	0,15	0,2
	carried out late and partially	0,5	0,75	1,0
Brucellosis	carried out promptly and in full	0,075	0,1125	0,15
	carried out late and partially	0,2	0,3	0,4
Pneumonic plague	carried out promptly and in full	0,4	0,6	0,8
	carried out late and partially	0,8	1,0	1,0
Bubonic plague	carried out promptly and in full	0,1	0,15	0,2
	carried out late and partially	0,2	0,3	0,4
Anthrax (generalized)	carried out promptly and in full	0,2	0,3	0,4
	carried out late and partially	0,4	0,6	0,8

ic situation and calculated index and coefficient of medical protection.

The medical protection index was calculated according to the formula: $I_{mp} = C \times (1 - P) \times E$, where I_{mp} is the medical protection index; C – index of contagion; P is the coefficient of specific protection (tension of collective immunity); E is the coefficient of emergency prevention (antibiotic prophylaxis, etc.).

Taking into account the pathogenicity of the corresponding infectious agent, its contagiousness, the degree of non-specific protection of the serviceman (depends on the degree of equipment and training of the personnel), and the specific protection of the servicemen (depends on the type of pathogen, vac-

ination, and its effectiveness, the use of emergency prevention) we determined the index of medical protection for a specific infectious nosology. Thus, in the case of the emergence and spread of infectious diseases with a fecal-oral transmission mechanism - typhoid and paratyphoid, cholera, shigellosis, and viral hepatitis A, based on the contagiousness, the effectiveness of specific protection and emergency prevention of these infections, the index of medical protection was 0,08, 0,24, 0,08 and 0,072, Table II.

If foci of infectious diseases with an airborne transmission mechanism, such as diphtheria, meningococcal infection, pneumonic, or plague, occur in the area of operation, the index of medical protection for these

infections will be 0,012, 0,045, 0,2. Taking into account the contagiousness effectiveness of specific protection and emergency prevention of such infectious diseases with the main transmission mechanism of transmission, such as yellow fever, tick-borne encephalitis, tularemia, malaria, and the bubonic form of the plague, in the conditions of their occurrence and spread, the index of medical protection of troops, primarily in endemic, natural focal areas, was 0,125, 0,06, 0,1125, 0,05 and 0,05, respectively, Table II.

When such infectious diseases with the leading contact mechanism of transmission occur in the area of action, such as brucellosis, viral hemorrhagic fevers (Lassa, Marburg, Ebola), and anthrax (generalized form), taking into account their contagiousness, the effectiveness of specific protection and emergency prevention for these infections, in the conditions their occurrence and distribution in the troops, the index of medical protection of personnel, primarily in endemic, naturally concentrated territories, was 0,0375, 0,0553, 0,1, respectively, Table II.

To take timely measures for the medical protection of servicemen in the conditions of biological contamination, we suggest using the coefficient of medical protection, which takes into account the effectiveness of medical protection measures taking account the dynamics of the sanitary and epidemiological state of the area of operations of troops (forces): $C_{mp} = I_{mp} \times A$, where C_{mp} is the coefficient of medical protection; I_{mp} - index of medical protection; A - assessment of the sanitary-epidemiological state of the area where the troops are located (unstable, unfavorable, emergency). Thus, for example, the coefficient of medical protection in the event of the occurrence and spread of typhoid and paratyphoid, cholera, shigellosis, and viral hepatitis A in the case of a healthy sanitary-epidemiological state of the area of operations, in the case of an unstable sanitary-epidemiological state of the area of operations will be 0,16, 0,48, 0,16, 0,144, with an unfavorable sanitary-epidemiological state of the area of operations, the coefficient of medical protection in the foci of the specified infections was 0,24, 0,72, 0,24, 0,216, with an extraordinary sanitary-epidemiological state of the area of operation – 0,32, 0,96, 0,32, 0,288, respectively, Table III.

The coefficient of medical protection of servicemen against diphtheria, meningococcal infection, and pneumonic plague in the case of unstable sanitary and epidemiological conditions in the area of operations will be 0,024, 0,09, 0,4, in conditions of unfavorable sanitary and epidemiological conditions in the area of operations, the index of loss of combat capability will be 0,036, 0,135, 0,6, with an extraordinary sanitary-ep-

idemiological condition in the area of operations of the troops - 0,048, 0,18, 0,8. The coefficient of medical protection of military personnel against yellow fever, tick-borne encephalitis, tularemia, malaria, and the bubonic form of the plague in the case of an unstable sanitary-epidemiological condition in the area of operations will be 0,25, 0,12, 0,225, 0,1 and 0,1, in case of an unfavorable sanitary-epidemiological condition the state of the area of operations at the appearance and spread of diseases of the personnel for yellow fever, tick-borne encephalitis, tularemia, malaria and the bubonic form of the plague, the coefficient was 0,375, 0,18, 0,3375, 0,15 and 0,15, in the case of an emergency sanitary-epidemiological state of the action area - 0,5, 0,24, 0,45, 0,2 and 0,2. The coefficient of medical protection against brucellosis, viral hemorrhagic fevers (Lassa, Marburg, Ebola), and anthrax (generalized form) in the case of unstable sanitary and epidemiological conditions in the area of operations will be 0,075, 0,105, 0,2, in the case of unfavorable sanitary and epidemiological conditions in the area of operation, the coefficient will be 0,1125, 0,1575, 0,3, in the case of an extraordinary sanitary-epidemiological state of the area of operations, the coefficient in the foci of the specified infections will be 0,15, 0,21, 0,4, Table III.

It should be noted that under the most unfavorable conditions - when implementing medical protection measures without taking into account the peculiarities of the development of the epidemic process of the specified infections, for example, if such measures as the creation of specific protection of the body of a military serviceman (immunoprophylaxis, vaccination), timely use of emergency preventive measures against the specified infections, were not carried out, then the negative impact of the conditions of biological contamination on the combat capability of personnel increases significantly, Table III.

DISCUSSION

We dare to assert that the high efficiency of measures for the medical protection of troops (forces) in the conditions of biological contamination is achieved only when forecasting the consequences of the worsening of the epidemic situation. It is also necessary to take into account the multifactorial determinant of the epidemic process when using biological weapons (biological terrorism). Important are the proposed indicators that take into account the pathogenicity of the infectious agent, contagiousness, the degree of non-specific protection of servicemen (depends on the level of equipment and training of personnel), specific protection of servicemen (depends on the type of pathogen, implementation

of vaccination and its effectiveness, use of emergency prevention) and sanitary the epidemiological state of the area of operations of the troops (forces). It should be added that relevant epidemic situations were simulated, and the index and coefficient of medical protection were calculated to predict the consequences of the worsening of the epidemic situation (the use of biological weapons, biological terrorism) to make timely decisions regarding the implementation of medical protection measures for military personnel in conditions of biological contamination during the repulsion of armed aggression of Russia on the territory of Ukraine [2].

Thus, the goal of the research has been achieved, scientifically based methodological approaches to forecasting the consequences of the worsening of the epidemic situation (use of biological weapons, biological terrorism) during the repulsion of armed aggression of Russia on the territory of Ukraine, directions for its improvement are proposed. The results of the work are original. In further work, it will be necessary to calculate indicators taking into account the types and methods of use of troops (forces). The implementation of the presented proposals into practice will ensure the adoption of timely measures during the combat use of troops (forces) regarding the medical protection of servicemen in conditions of biological contamination [5].

REFERENCES

1. Ustinova LA, Bogayenko VL, Havrylko EV et al. Aktualni pytannia spetsialnoi obrobky v medychnykh pidrozdilakh viiskovykh chastyn i zakladakh okhorony zdorovia Zbroinykh Syl Ukrainy v umovakh khimichnoho, biolohichnoho, radioaktyvnoho zarazhennia [Current issues of special treatment in medical units of military units and health care facilities of the Armed Forces of Ukraine in conditions of chemical, biological, radioactive contamination]. Ukrainian Journal of Military Medicine. 2022; 3(3): 83-91. (In Ukrainian).
2. Serdyuk AM et al. Dosvid orhanizatsii sanitarno-hihienichnoho ta protyepidemichnoho zabezpechennia viisk (syl) pid chas provedennia Antyterorystychnoi operatsii (Operatsii obiednanykh syl) [Experience in the organization of sanitary-hygienic and anti-epidemic provision of troops (forces) during the anti-terrorist operation (Operations of the United Forces)]. Edited by V.I. Tsimbalyuk. Kyiv: Sofia-A. 2019, p.280. (In Ukrainian).
3. Krushelnyskyi OD, Ogorodnychuk I.V. Aktualni pytannia spetsialnoi obrobky v medychnykh pidrozdilakh viiskovykh chastyn i zakladakh okhorony zdorovia Zbroinykh Syl Ukrainy v umovakh khimichnoho, biolohichnoho, radioaktyvnoho zarazhennia [Biological threats and their impact on the epidemic situation in the Armed Forces of Ukraine]. Infectious diseases. 2020; 4 (102): 56-60. (In Ukrainian).
4. Markovych IG, Markovych IF. Biolohichna bezpeka, intehralna otsinka faktoriv yii ryzyku [Biological safety, integral assessment of its risk factors]. Kyiv: Lyudmila Publishing House. 2018, p.278. (In Ukrainian).
5. Khizhnyak MI, Yakimets VM, Slabkyi GO et al. Pryntsyipy medychnoho zakhystu pry zastosuvanni bakteriologichnoi zbroi Ukraina [Principles of medical protection when using bacteriological weapons Ukraine]. The health of the nation. 2018; 4/1 (53):36-43. (In Ukrainian).
6. Litovka SL, Barkevich VA, Ivanko OM et al. Zakhody preventyvnoi medytsyny – yak vazhlyvyi element profilaktyky zakhvoriuvan osobovoho skladu [Measures of preventive medicine – as an important element of the prevention of diseases of the personnel]. Problems of military health care: coll. of science works of Ukraine military-med. Academy. 2019; 44 (2): 48-56. (In Ukrainian).

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CONCLUSIONS

1. It has been proven that the long-term armed aggression on the territory of Ukraine and the presence of a constant threat from Russia, a terrorist country, to use biological weapons and the deliberate destruction of critical infrastructure, determine the high probability of biological contamination of the territory of Ukraine.
2. In the existing conditions, the role of forecasting the consequences of the deterioration of the epidemic situation in order to achieve high efficiency of measures for the medical protection of troops (forces) in the conditions of biological contamination is increasing.
3. The need to use indicators that consider the multifactorial determinants of the epidemic process when predicting the consequences of the deterioration of the epidemic situation in the conditions of biological contamination is determined.
4. The relevant epidemic situations and calculated indicators of the effectiveness of medical protection for forecasting the consequences of the worsening of the epidemic situation (use of biological weapons, biological terrorism) when decisions are made regarding the implementation of measures for the medical protection of military personnel in conditions of biological contamination during the repulsion of armed aggression of Russia on the territory of Ukraine are simulated.

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The Authors declare no conflict of interest.

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