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# THE CURRENT SITUATION REGARDING BOVINE LEUKEMIA IN LIVESTOCK PRODUCTION AND A STRATEGIC APPROACH TO ANTI-EPIZOOTIC MEASURES IN THE POST-WAR CONTEXT

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**Summary.** The current, conditionally safe, epizootic state of livestock in Ukraine regarding bovine leukemia has been determined. The lack of comprehensive anti-leukemia health programs in the detection of single animals infected with the leukemia virus in almost every region, except for Zakarpattia and Lviv regions, is due to violations of the regulations and the scope of diagnostic tests for leukemia and measures to prevent recurrence of the epizootic. In the postwar period, it would be strategic to develop and implement regulations for serological control of livestock on each farm, depending on specific epizootic circumstances

**Keywords:** immunosuppression, immunodiffusion, ELISA, seroprevalence, serological monitoring

**Introduction.** Bovine leukemia, classified as a slow infection, is one of the most common viral infectious diseases of cattle (Constable et al., 2017; Scobie et al., 2001; Straub and Levy, 1999; Meas et al., 2002; Amborski, Lo and Seger, 1989). The financial impact of this disease can be attributed to several factors. Firstly, there are the direct costs associated with the loss of animals, which is relatively minimal given the long clinical course of the disease. Secondly, there is the loss of the gene pool, which has an impact on the future breeding potential of the livestock population. Thirdly, there are indirect costs related to the quality of dairy products, which may be affected by the disease.

The current legislation prohibits the use of milk from clinically sick animals, even after heat treatment (Jacobs, Jefferson and Suarez, 1998; Hachiya et al., 2018; SCVMU, 2007). Additionally, immunosuppression in animals infected with the leukemia virus makes it impossible to obtain a positive effect when using therapeutic and prophylactic agents. In addition, the causative agent of cattle leukemia poses a potentially dangerous medical and social threat, as it is structurally similar to the causative agents of AIDS and human T-cell leukemia (Supotnitskiy, 2009).

The implementation of government programs has resulted in the eradication of bovine leukemia in most European countries. Ukrainian livestock production is now at the final stage of recovery. In recent years, the number of locations unsafe for the above disease, which are collective livestock farms, has decreased. According to the statistical reports of the Main Department of the State Service of Ukraine for Food Safety and Consumer Protection, the number of livestock farms affected by the disease has been between 8 units and 15 units, although isolated cases of animals infected with the leukemia virus have also been recorded. The majority of cases have been identified on small farms and in private households across the country, except for the Zakarpattia and Lviv regions. This is according to the findings of research conducted by regional laboratories of the State Service of Ukraine for Food Safety and Consumer Protection.

The results of scientific research and monitoring control of veterinary medicine laboratories of the State Service of Ukraine for Food Safety and Consumer Protection have proven that violations of regulations on the scope of serological research in the presence of risks of isolated cases of leukemia virus-infected animals in previously sanitized areas inevitably lead to the recurrence of the disease epizootic (Dombrovskyi et al., 2003; Gorbatenko et al., 2014; Bashchenko et al., 2016; Kornieikov et al., 2019). In the context of military aggression, the livestock industry is facing challenges due to the implementation of martial law. These challenges include violations of anti-epizootic measures regulations, which in the case of leukemia are reflected in a decline in serological monitoring levels. This, in turn, leads to the recurrence of epizootic in previously unstable areas and the dissemination of the pathogen due to the loss of control over the epizootic status of specific animal groups.

The **aim of the study** was investigate and analyze the current situation regarding bovine leukemia in livestock of Ukraine and features of anti-epizootic measures in the post-war context.

**Materials and methods.** Two approaches were used to determine the epizootic status of the Ukrainian livestock sector concerning bovine leukemia: specialists of the Laboratory of Leukosis Study of the National Scientific Center 'Institute of Experimental and Clinical Veterinary Medicine' conducted serological monitoring in livestock farms, most of which were conditionally safe, in six regions, namely, Kharkiv, Poltava, Kirovohrad, Chernihiv, Sumy, and Cherkasy regions.

At the same time, the results of serological monitoring of regional laboratories of the State Service of Ukraine on Food Safety and Consumer Protection were analyzed in terms of the volume and effectiveness of research in recent years. In both cases, serological tests for leukemia were performed using the immunodiffusion (ID) and enzyme-linked immunosorbent assay (ELISA).

The reliability of the data on the epizootic situation in livestock production in Ukraine was determined by the

seroprevalence index, which is the ratio of the number of animals infected with the leukemia virus to the number of susceptible animals during the survey period, per hundred animals (%). The number of susceptible animals in farms with different types of ownership was taken into account, as well as the number of serological tests performed.

**Results.** It is well known that ELISA has significant advantages in assessing the epizootic status of cattle with regard to leukemia. In contrast to the ID, the ELISA method allows the detection of animals infected with the leukemia virus in the early stages of the infectious process, so that the use of this test guarantees higher efficiency in the implementation of measures to cleanse the herd of virus carriers. As mentioned above, both diagnostic tests were used by veterinary laboratories in the serological monitoring system, although from year to year the ELISA method was preferred. According to the results of the analysis, there was a decrease in the use of ID tests and an increase in the role of ELISA in disease control measures during 2019–2024 (Fig. 1).

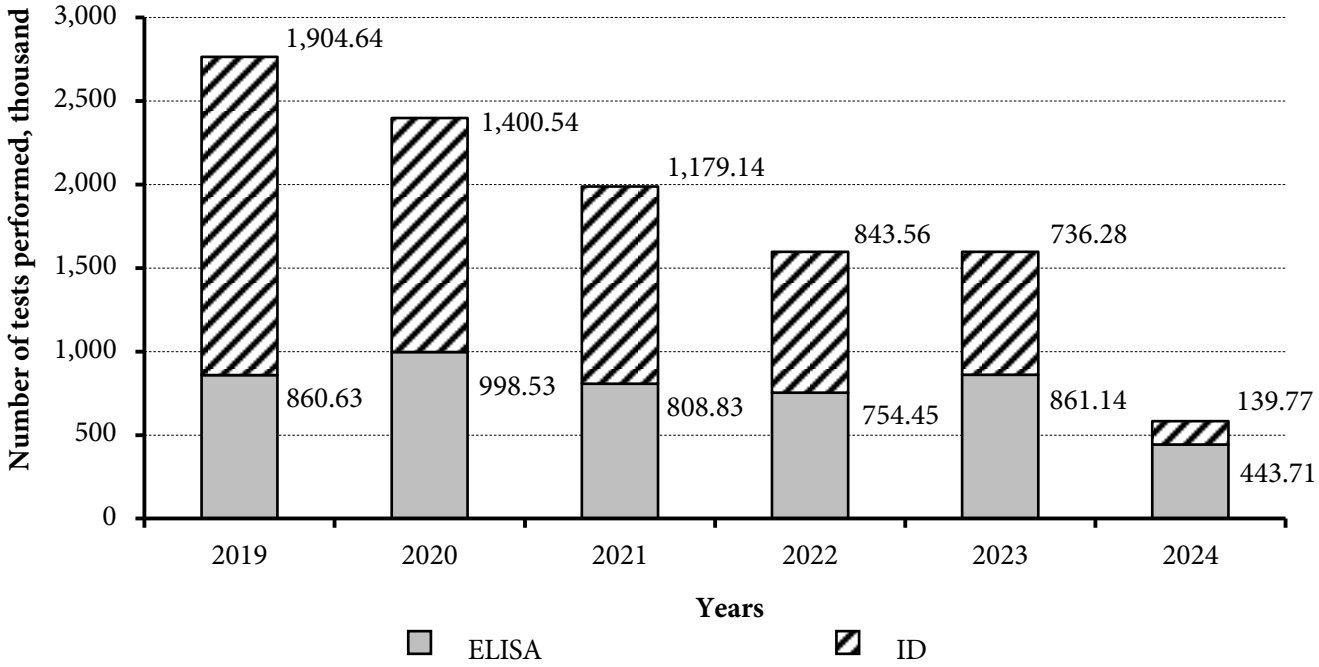


**Figure 1.** The ratio of serological tests for leukemia using ELISA and ID tests in Ukraine (according to the State Service of Ukraine on Food Safety and Consumer Protection).

In analyzing the data, it was noted that the examination of cattle for leukemia in cattle-breeding enterprises and large farms is primarily conducted using ELISA, while the examination of animals in small farms and households in Ukraine is predominantly done using ID tests. In recent years, there has been a notable increase in the number of cattle in enterprises and farms compared to the same indicator in private households in Ukraine.

The analysis revealed that from 2019 to 2021, the primary method for leukemia diagnosis in Ukraine was the ID test. In 2022, there was a notable shift towards a more balanced approach, with a near-equilibrium between these diagnostic methods. Subsequently, there was a notable increase in the use of enzyme-linked immunosorbent assays for cattle leukemia diagnosis.

In terms of the efficacy of these serological diagnostic methods for cattle leukemia and their influence on the prevalence of the disease in Ukraine, it can be argued that with the widespread implementation of the ELISA method into the leukemia control system in cattle breeding in Ukraine, there is initially an increase in the level of seroprevalence to the leukemia virus, followed by a gradual decrease in this indicator in subsequent years (Fig. 2).

Fig. 2 illustrates that the seroprevalence rate for BLV has remained relatively stable over the past five years. This is in contrast to the significant increase observed in the first year of ELISA implementation, which has since shown a consistent downward trend. This is due to the ID test having a much lower threshold of sensitivity than ELISA. This allows for the detection of BLV-infected cattle much earlier, reducing the risk of infection in the herd. Some discrepancy in the data occurred in 2023, which is explained by the most active phase of hostilities in Ukraine. This resulted in a decrease in the number of animals studied and the quality of leukemia control measures in Ukraine.

In terms of the overall data on the prevalence of animals with bovine leukemia virus, it can be argued that there has been a positive shift in the epizootic situation with leukemia, including due to the introduction of ELISA. During the study period, this indicator decreased from 0.65% (2020) to 0.29% (2024).

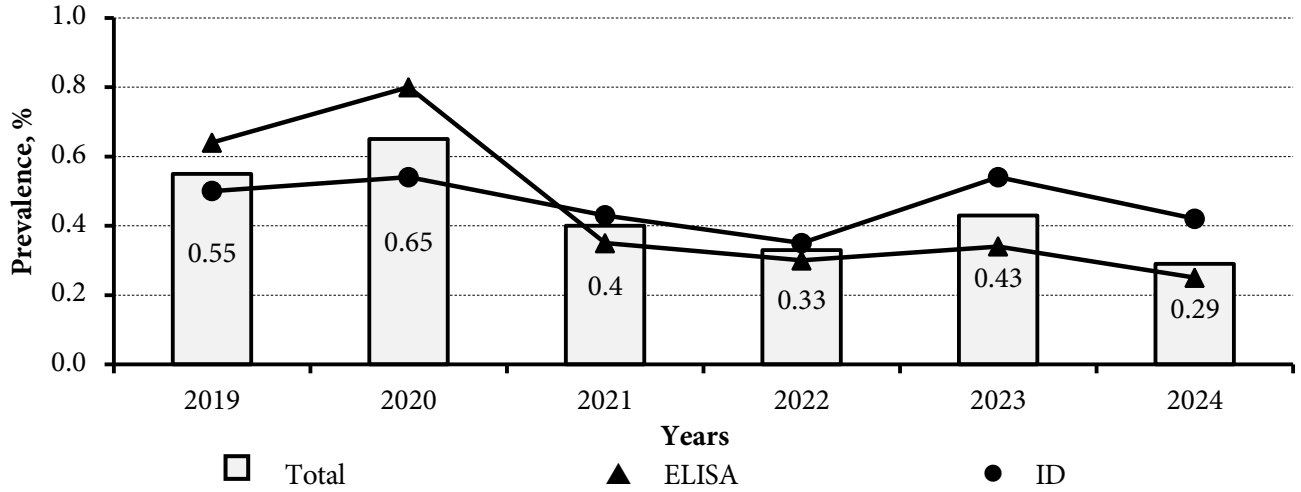


**Figure 2.** Seroprevalence to bovine leukemia virus determined by ELISA and ID methods in Ukrainian farms of different forms of ownership.

A review of the data from the State Service of Ukraine for Food Safety and Consumer Protection, specifically the leukemia test results from regional veterinary laboratories in Ukraine (Table 1), revealed that infected animals were not identified in the Zakarpattia and Lviv regions during the 2023–2024 period. It is not possible to consider the negative results obtained from the territories of the Donetsk, Luhansk, and Kherson regions reliable due to the temporary occupation of these regions due to the russian federation's military aggression.

Table 1 — Results of serological testing of blood serum from cattle in Ukraine, using different methods

| Region | 2023 | | | | 2024 (first quarter) | | | |
|---|---|---|---|---|---|---|---|---|
| | ELISA | | ID | | ELISA | | ID | |
| | Number of tests performed | Positive reactions | Number of tests performed | Positive reactions | Number of tests performed | Positive reactions | Number of tests performed | Positive reactions |
| Vinnytsia | 71,201 | 147 | 57,313 | 194 | 27,903 | 40 | 34,827 | 86 |
| Volyn | 53,857 | 9 | 50,575 | 232 | 18,848 | 54 | 18,001 | 103 |
| Dnipropetrovsk | 25,866 | 65 | 52,731 | 440 | 10,243 | 95 | 4,147 | 40 |
| Donetsk | 2,563 | 0 | 2,394 | 6 | 0 | 0 | 162 | 0 |
| Zhytomyr | 43,158 | 62 | 40,767 | 161 | 30,846 | 25 | 9,326 | 47 |
| Zakarpattia | 920 | 0 | 34,620 | 0 | 600 | 0 | 5,704 | 0 |
| Zaporizhzhia | 1,421 | 3 | 4,198 | 1 | 622 | 0 | 203 | 0 |
| Ivano Frankivsk | 14,615 | 0 | 28,717 | 0 | 8,186 | 0 | 2,470 | 0 |
| Kyiv | 89,489 | 243 | 47,978 | 214 | 39,747 | 39 | 3,781 | 2 |
| Kirovohrad | 22,286 | 159 | 25,469 | 59 | 11,823 | 8 | 948 | 2 |
| Luhansk | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lviv | 19,437 | 0 | 69,098 | 0 | 4,362 | 0 | 10,982 | 0 |
| Mykolaiv | 13,474 | 23 | 23,880 | 23 | 1,192 | 27 | 1,989 | 2 |
| Odesa | 10,431 | 601 | 38,210 | 274 | 3,103 | 30 | 7,064 | 57 |
| Poltava | 107,045 | 108 | 26,427 | 249 | 61,540 | 72 | 0 | 0 |
| Rivne | 19,764 | 115 | 35,891 | 868 | 12,174 | 25 | 11,406 | 191 |
| Sumy | 54,200 | 39 | 15,839 | 213 | 33,714 | 0 | 820 | 4 |
| Ternopil | 30,806 | 20 | 42,648 | 13 | 14,860 | 0 | 8,046 | 1 |
| Kharkiv | 35,399 | 743 | 11,046 | 359 | 15,755 | 367 | 703 | 12 |
| Kherson | 475 | 0 | 5,498 | 0 | 462 | 0 | 161 | 0 |
| Khmelnytskyi | 67,257 | 5 | 64,804 | 23 | 48,586 | 7 | 15,051 | 6 |
| Cherkasy | 93,898 | 47 | 10,307 | 61 | 46,787 | 56 | 374 | 1 |
| Chernivtsi | 6,630 | 9 | 21,149 | 3 | 4,390 | 15 | 1,989 | 0 |
| Chernihiv | 76,950 | 512 | 26,700 | 604 | 47,968 | 266 | 1,618 | 35 |
| Kyiv City | 0 | 0 | 19 | 2 | 0 | 0 | 0 | 0 |
| **Total** | **861,142** | **2,910** | **736,278** | **3,999** | **443,711** | **1,126** | **139,772** | **589** |

As illustrated in Table 1, the presence of infected animals was confirmed in each region of Ukraine. This was determined through serological examinations, including the ID test and ELISA. The results of leukemia tests for the first quarter of 2024 were not included in the analysis as they represented only a portion of the spring animal examination. However, the overall trend continued.

The number of animals studied and the level of seropositivity in different regions of Ukraine varied depending on the epizootic situation in the region, proximity to the combat zone, and the level of anti-leukemia health measures in previous years. In the Kharkiv region, located in the combat zone, 46,445 animals out of 79,200 cattle were tested. Of these, 1,102 heads of cattle were found to be infected with BLV, 743 by ELISA, and 359 by ID test. This equates to a prevalence rate of 2.37%. It should be noted that the infection rate of animals in a particular region may not be entirely accurate, as not all susceptible livestock are tested, and the trend is downward every year. For instance, in Kharkiv Region, the number of cattle was 59.0% compared to 2022. A similar situation is observed every year in other regions of Ukraine and the country as a whole (Fig. 3).

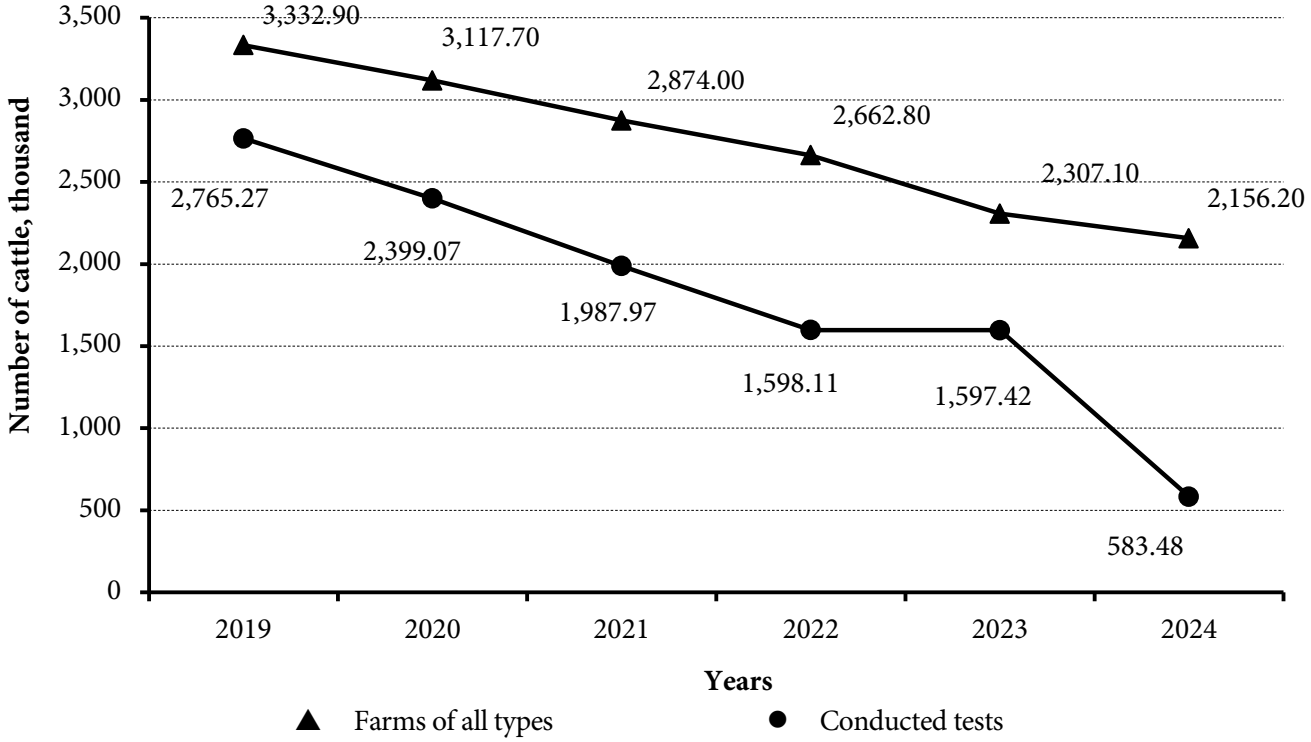


**Figure 3.** The ratio of the number of cattle in farms of all forms of ownership in Ukraine and the number of animals tested for leukemia (according to the State Service of Ukraine for Food Safety and Consumer Protection and the State Statistics Service of Ukraine).

Fig. 3 illustrates a clear correlation between the decline in serological tests for leukemia in Ukraine and the number of cattle over the same period. However, by calculating the percentage of livestock tested for leukemia during 2019–2024 and the number of cattle kept in livestock farms of all forms of ownership in Ukraine, we can conclude that this indicator is declining annually in Ukraine. In 2019, 82.9% of animals in Ukraine were tested for leukemia. This figure declined to 76.9% in 2020, 69.0% in 2021, 60.0% in 2022, and 69.2% in 2023. While the decline in the number of studies conducted in 2022–2023 can still be attributed to the russian aggression, this cannot be done for the period 2019–2021.

It is worth noting the effectiveness of serological tests for leukemia and the level of seroprevalence within the farms of the six regions where the program was implemented by specialists from the Laboratory of Leukosis Study of the National Scientific Center 'Institute of Experimental and Clinical Veterinary Medicine'. The level of seroprevalence was slightly higher than the average regional laboratory indicators, with figures ranging from 0.45% to 2.7%. This is because the studies were conducted exclusively on farms where anti-leukemia health measures were implemented at various stages, primarily at the final stage.

The results of the analysis of serological monitoring conducted by regional laboratories of the State Service of Ukraine for Food Safety and Consumer Protection and a scientific institution indicate that the epizootic situation in Ukraine's livestock sector regarding bovine leukemia is currently stable and in a state of conditional

well-being. The presence of a limited number of infected animals in each region, except for Zakarpattia and Lviv, indicates that the anti-leukemia health measures program, as outlined in veterinary legislation and the current 'Instruction on the Prevention and Rehabilitation of Cattle Against Leukemia', is incomplete. Regional veterinary laboratories of the State Service of Ukraine for Food Safety and Consumer Protection have reported a downward trend in the volume of serological testing of livestock over the past five years. This is not related to a decrease in the number of cattle. In 2019, 82.9% of the total number of animals were tested for leukemia. In 2019, 0.9% of the total number of animals were tested for leukemia. This figure rose to 76.9% in 2020, 69.0% in 2021, 60.0% in 2022, and 69.2% in 2023. The lack of comprehensive serological monitoring and epizootic prevention measures in cases of isolated relapse cases allows the disease to spread in previously healed areas.

The primary reason for the program's incompleteness is, as the analysis indicates, noncompliance with regulations and the scope of serological tests for leukemia on farms where even a single case of infected animals is identified or there is a risk of recurrence of the epizootic. In light of these circumstances, the strategic direction of post-war anti-epizootic measures should be the development and implementation of planned regulations on the scope and timing of serological monitoring. These regulations should take into account the epizootic circumstances in each particular farm and the timing of research, taking into account the method used. It is reasonable to conclude that the ELISA method is more effective than the ID test in regulating the epizootic status of livestock concerning leukemia. To reduce the economic burden of these measures in Ukraine, it is advisable to conduct combined studies of blood serum samples from animals. Specifically, the ID test should be used at the stages of detecting infected animals, with an interval between studies of no more than 30 days. Subsequently, if a negative result is obtained for the herd, the welfare of livestock farms should be monitored using ELISA.

**Conclusions.** 1. Current situation regarding bovine leukemia in Ukraine's livestock industry can be considered favorable overall. While in recent years, according to the statistical reports of the Main Department of the State Service of Ukraine for Food Safety and Consumer Protection, there have been 8-15 residual unfavorable locations annually, regional laboratories annually record isolated cases of leukemia virus-infected animals in livestock in each region, except for Zakarpattia and Lviv regions.

2. The state program of anti-leukemia health measures is incomplete due to violations of current veterinary legislation and the 'Instruction on the Prevention and Rehabilitation of Cattle Against Leukemia'. Specifically, there have been violations regarding the regulations for serological control of livestock on farms of various subordinations and measures to prevent the recurrence of the epizootic in previously treated epizootic foci.

3. The need to develop and implement regulations for the serological control of livestock production on each farm, depending on specific epizootic circumstances and measures to prevent the recurrence of epizootic, should be considered a strategic anti-epizootic direction in the post-war period.

**Prospects for further use of the results obtained**. Increasing the requirements for specialists of regional departments of the State Service of Ukraine for Food Safety and Consumer Protection in terms of awareness and compliance with the provisions of current legislation, guidelines for the organization and implementation of anti-epizootic measures, and emphasis on increasing the responsibility of managers and specialists of livestock farms.

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