

**Research Article**

## **Indicators of Immune and Metabolic System in Cows during Acute Respiratory Diseases and Infections of Distal Part of Limbs Living Under Conditions of Industrial Technologies**

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**ABSTRACT.**

The problem of preserving health of cows living under conditions of industrial technologies is now extremely acute. It is necessary to create appropriate sanitary and zoo-hygienic conditions. However, even on farms with good management (feeding, zoo-hygiene, timely prevention of diseases), only about 60% of newly calved cows remain completely healthy. At the same time, it should be taken into account that simultaneously there are many more abnormalities or disorders in the metabolism, in which the diseases occur in subclinical form, and they can be identified only through laboratory biochemical, immunological, hormonal analyzes. The more we demand from the animals living under conditions of industrial technologies, the higher are their requirements for living conditions and animal welfare. With the increase of milk productivity, the metabolism increases, more quality fodders, vitamins, minerals are needed.

**Keywords:** acute respiratory viral infections, specific prevention of animal diseases, conditions of industrial technologies, interleukins.

**1. INTRODUCTION**

At the present time we have an acute problem of the occurrence of acute respiratory viral infection and wound infections of distal limbs in cattle. In this connection it is necessary to carry out researches that allow studying the peculiarities of the epizootic process in a particular territory under conditions of industrial technologies; the development of preventive and antiepzootic measures that take into account the regional epizootic characteristics of the diseases; their specificity in the manifestation of an epizootic process causing serious economic damage [1,2] . The pursuit of increasing the productivity is a factor contributing to a higher susceptibility of animals to infections. To

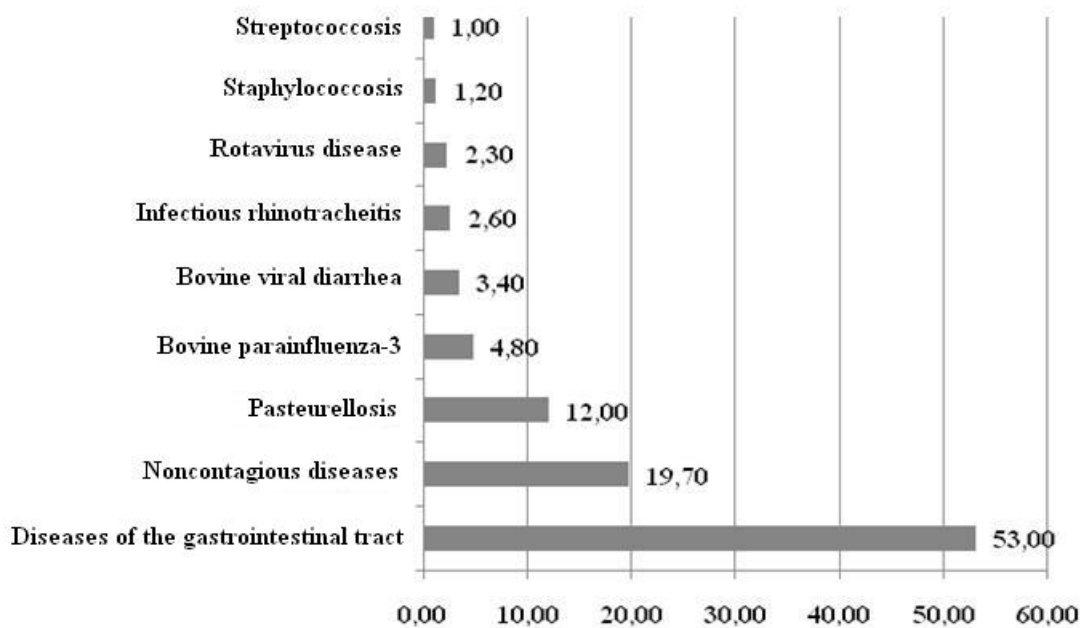
conduct effective healthcare activities to cure acute respiratory viral infection and wound infections of distal limbs in cattle, it was necessary to study the effect of pathogens in conditions of industrial technologies.

The questions above point to the relevance and necessity of conducting studies to evaluate and correct immunometabolic parameters in cows when adapting to conditions of industrial technologies, taking into account the epizootic state and early diagnosis of pathology with different technology conditions, for the timely organization of measures to correct the revealed disorders [3,4].

**2. INDICATORS OF IMMUNE SYSTEM AND METABOLISM IN COWS WHEN TRANSFERRING THEM UNDER CONDITIOSN OF INDUSTRIAL TECHNOLOGIES**

It has been established that in the Sverdlovsk region more than 85 thousand of cattle are ill each year, mainly the animals of tie-up housing. For the period of years 2003-2013, 9507 calves were diagnosed with the infectious pathology of the respiratory tract. According to the data of the Sverdlovsk Regional Veterinary Laboratory the

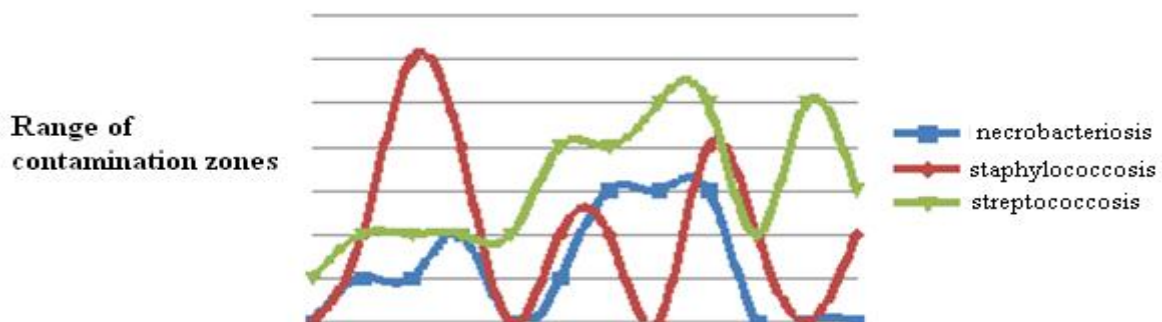
initial diagnosis was confirmed in 1887 cases. Of these, 223 are cases of pasteurellosis (11.8%), 21 cases of staphylococcus infections (1.2%), 17 cases of streptococcus infections (0.9%), 46 cases of infectious rhinotracheitis (2.6%) , 84 cases –bovine parainfluenza-3 (4.8%), 60 cases –bovine viral diarrhea (3.4%), 41 cases - rotavirus disease (2.3%). Infectious diseases of the gastrointestinal tract account for 53% and noncontagious diseases - 19.7% (Fig. 1).



**Figure 1-** Dissemination of diseases in young cattle

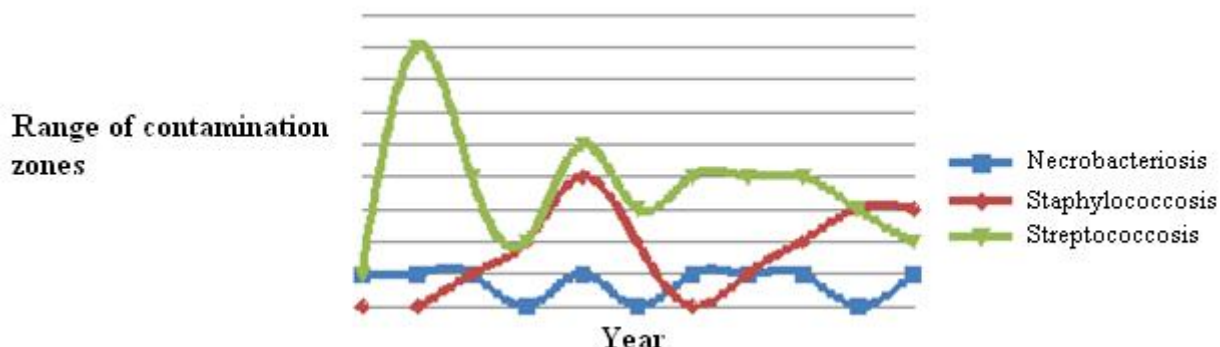
When on tie-up housing more than half of the total number of diseased and fallen youngstock animals has diseases of organs of gastrointestinal tract. The second place, which is 35% - are diseases of the respiratory system. The urgency of studying this subject is caused by the constant risk of wound infections of the distal parts of the limbs in cattle. We took into account 3 infectious nosological forms of bacterial etiology: necrobacteriosis, staphylococcosis, streptococcosis. [5]

It has been revealed that epizootic diseases in the Sverdlovsk region mostly appear on staphylococcus basis (years 2002, 2008); there is an insignificant decrease in the intensity of the epizootic process on streptococcosis relatively to necrobacteriosis; there has not been found any unhealthy zones, both on tie-up and yard housing (Fig. 2).



**Figure 2-** The dynamics of identifying contamination zones of the predominant wound infections of limbs in cattle in the Sverdlovsk region.

The analysis of the dynamics of identifying contamination zones in the Chelyabinsk region showed that epizootics for streptococcosis are recorded annually between years 2000 and 2010; there has been an increase in the number of contamination zones for necrobacteriosis and staphylococcosis in conditions of industrial technologies since year 2009 (Fig. 3)



**Figure 3** - The dynamics of identifying contamination zones for the predominant wound infections of limbs in cattle in the period from year 2000 to 2010 in the Chelyabinsk region

In the Chelyabinsk region (in contrast with the Sverdlovsk region), with the tie-up housing of cattle, there is a tendency for an increase in the number of epizootic centers of all studied diseases, including necrobacteriosis [6]. The dynamics of the incidence of wound infections of the limbs in cattle showed that the most predisposed to diseases of the limbs in cattle with tie-up housing. The purpose of this work was to clarify the level of a potent mediator of inflammation - IL-6 and IL-10 in the blood of cattle with signs of acute respiratory viral infection and wound infections with the determination of the possible pathogenetic and prognostic role of the cytokine in conditions of industrial technologies. An increase in the IL-6 cytokine content in animals of agricultural enterprises, which were contaminated with acute respiratory viral infection and wound infections of cattle, was noted with tie-up housing - 11.1% higher than in the case of yard housing. The level of IL-10 cytokines was higher with tie-up housing by 15.4% than with yard housing (Table 1).

**Table 1** – The concentration of cytokines in the blood serum of cows with tie-up and yard housing in contamination zone (n=50)

Industrial housing	IL-6	IL-10
Yard housing	141,05±1,78	192,01±0,1*
Tie-up housing	157,73±3,4	296,3±1,3*

\*difference is reliable (P< 0,05)

The results indicate a unidirectional type of immune system response to the production of IL-6, IL-10, which plays a big role in the pathogenesis of acute respiratory viral infection and the prevalent wound infections in cattle as a universal immune response of the macroorganism to the introduction and multiplication of infectious agents that affect the respiratory tract and distal part of limbs under conditions of industrial technologies [7,8]. Investigations on the immunophenotyping of bovine lymphocytes have shown that the level of T-lymphocytes in blood is 64.4 ± 1.92% in animals with yard housing, and 63.2 ± 3.74% with tie-up housing.

The CD3+ T-lymphocytes are at 45.2 ± 2.34% with yard housing, and 57.2 ± 2.42% with tie-up housing. That is indicating an increase in anti-inflammatory processes in animals with tie-up housing. The level of T-helpers and T-suppressors was determined by using monoclonal antibodies to CD4 (Tx) and CD8 (Tc) antigens. The standard level of CD4 + T-helpers is on 33-46%, CD8 + T-compressors 17-30%, the correlation is calculated by: Tx / Tc (immunoregulatory index, IRI) = 1.4-2.0. In our case, the correlation was 1.78, which is actually the standard. With tie-up housing, this index decreased to 0.17%. The level of B-lymphocytes changed to a lesser extent, with both tie-up and yard housing.

**Table 2** - Indicators of the immune status of cows in conditions of industrial technologies

Index	Yard housing (n=15)	Tie-up housing (n=15)
Lymphocytes %	64,4±1,92*	63,2±3,74
T - lymphocytes (CD3), % 109 / 1	45,2±2,34	57,2±2,42*
T - helpers (CD4),%	33,6±1,62	58,2±2,62
Cytotoxic T - lymphocytes (CD8),%	18,8±2,74*	47,2±1,46
CD4/CD8%	1,78	0,17
B – lymphocytes (CD20),% 109/1	13,8±0,92	14,6±0,77

\*P&lt;0,05

The analysis of immunological indicators revealed a deficiency of the humoral link of immunity with tie-up housing, which was compensated by the active functioning of T-cell immunity. Among immunocompetent cells, there was an increase in the number of T-series lymphocytes with tie-up housing, which indicates the presence of pathological processes in the agricultural enterprises contaminated with acute respiratory viral infection and wound infections of distal limbs in cattle. Quantitative changes were accompanied by an increase in the relative content of T-helpers (CD4) and cytotoxic T-lymphocytes (CD8), in connection with which the CD4 / CD8 immunoregulatory complex was reduced 1.5 times compared to the same value in cows with yard housing.

Reduction of immunological parameters in cows with tie-up housing indicate the conduct of immunocorrective therapy. One of the factors reducing the natural immune resistance in cattle of the agricultural enterprises of the Sverdlovsk and Chelyabinsk regions are acute respiratory viral infection and predominant wound infections. Animals, infected with acute respiratory virus infection and wound infections, are found both in breeding and in production farms, commercial and private herd. The percentage of infected animals is 40.2% with ranges from 0.4% to 87% in the commercial sector, and in the private sector - 6.8% with ranges from 0.9% to 57.8%. Out of 47 surveyed commercial farms, 27 are contaminated with acute respiratory viral infection and predominant wound infections.

In 42.8% of farms in the Chelyabinsk region, the livestock infection rate exceeds 32%; in 29.3%

of farms the rate varies from 12% to 37%; in 16.7% of farms—the rate is below 12%; and 4.4% of farms have not any infected animals with acute respiratory viral infection [9, 10].

Animals with tie-up housing, infected with acute respiratory viral infections and wound infections, have a lower content of the total protein, gamma-globulin fraction, microelements (magnesium, zinc, iron), carotene, glucose in the blood; the phagocytic activity of leukocytes is reduced; with an increase in the number of T and B lymphocytes, the functional activity of producers of immunoglobulins M has decreased in comparison with yard housing. Analysis of the results of biochemical studies of blood serum of cows, living under condition of industrial technologies, indicates that the most serious disorders in animals are recorded with tie-up housing, and outbreaks of respiratory diseases in young animals are noted. When the cows are in tie-up housing, the content of the total protein is reduced in comparison with the yard housing by 24.5% and 19.0% respectively, its fractional composition is infringed due to the reduction of the gamma-globulin fraction, the content of zinc and carotene is lowered, which indicates deficit of immunity. When studying the biochemical parameters of cows with tie-up housing, it was found that the total protein content was low at  $-60.8 \pm 1.70$  g / l, gamma-globulin -  $19.12 \pm 2.16\%$ , zinc  $-51.8 \pm 4.8$  µg / % and carotene  $-0.14 \pm 0.01$  mg / %, in comparison with yard housing -  $86.2 \pm 1.38$  g / l;  $36.8 \pm 2.24\%$ ;  $95.2 \pm 5.6$  µg / %;  $2.8 \pm 0.08$  mg / %. These infractions in animals with tie-up housing negatively affect the immune resistance and can

lead to the development of respiratory diseases and distal limbs infections. We found that in animals with tie-up housing, the natural immune resistance was lower in comparison with yard housing. This difference had a significant value ( $P < 0.05$ ) for lysozyme and bactericidal activities. Lysozyme activity in animals with tie-up housing was 2 times lower than in the case of yard housing ( $P < 0.05$ ).

It should be noted that in animals, both in tie-up and yard housing, during the period of mass morbidity of necrobacteriosis, the indices of natural immune resistance were approximately the same; they did not have significant difference in the evaluation by the criteria of Student's t-test.

A comparative study of the natural immune resistance of the cattle among animals in the Chelyabinsk region showed that it was higher in animals with yard housing (depending on their well-being for necrobacteriosis). The increase was registered according to the state of bactericidal and lysozyme activities, while the index of phagocytic activity did not change significantly.

Thus, for animals with yard housing, the intensity of bactericidal activity was  $56.71\% \pm 1.54\%$ , while for animals with tie-up housing -  $66.24\% \pm 1.47\%$  (difference is reliable,  $P < 0.05$ ).

The lysozyme activity in cows increased sharply with yard housing. Studies have shown that between the incidence with necrobacteriosis and some indicators of immune resistance, there was a correlation. The incidence is associated with lysozyme activity of blood serum and the intensity of bactericidal activity. The increase of these indicators helps to reduce the incidence. Such indicators of immune resistance, like lysozyme and bactericidal activity, change with tie-up and yard housing. They are the most high in the case of yard housing; with tie-up housing they are decreasing. Phagocytic activity of blood changes to a lesser degree. In the households, both with tie-up and yard housings, that are contaminated with necrobacteriosis, the indicators of immune resistance of animals (lysosome activity and intensity of bactericidal activity) are lower in comparison with those that are free from this infection. The

dynamics of indicators of natural immune resistance and morbidity in condition of industrial technologies has the opposite tendency, i.e., with a decrease of the indicators of immune resistance, the incidence increases and, on the contrary, when the immune resistance increases, the incidence decreases.

It is a fact, that intensive dairy farming creates extremely tense conditions for the organisms of cows. It can cause acidosis, laminitis, ketosis.

During rumen acidosis in cows, the immune and endocrine systems are affected by infectious diseases.

There is a link between acidosis, ketosis and loss of immunity, the emergence of viral-bacterial infections, pasteurellosis, bovine chlamydiosis, infectious bovine rhinotracheitis, parainfluenza type 3, bovine viral diarrhea-mucosal disease, bovine respiratory syncytial virus infection. With an excess of concentrates in the body of animals, lectins are formed – these are heterogeneous group of proteins that have the property of causing dysfunction of the digestive tract and intoxication of the body.

Scientific research of recent years in the Russia convincingly proves that it is the toxicity of lectins and their ability to bind digestive enzymes, which are the main causes of digestive disorders and decrease in immunity in animals, and the appearance of diseases.

According to the results of our observations in the Ural region, insufficient attention is paid to their content in feeds; and neutralization of their harmful effects on the body is practically not applied, although the effective and affordable methods already exist.

Rapid growth of animal productivity in the last 7 years in many farms of the Ural region in conditions of industrial technologies was achieved due to a large share of mixed fodders in rations.

Specialists of farms are forced to include energy-rich concentrates in the diet of animals. In practice, dairy cows are given more acidic fodder (silage, haylage, concentrates) and minimal - hay and straw. The conservation of silage and haylage is carried out with a high degree of grinding to 5-7 mm and humidity exceeding 75-80%. As a result, the rumen microflora is disrupted, which leads to a number

of negative consequences and the onset of acidosis. Hidden acidosis occurs during the herd staging for winter-stabling, as well as with tie-up housing, and they end only in the spring on the pasture.

Studies, conducted by regional laboratories of the Sverdlovsk and Chelyabinsk Regions, noted that discharged highly productive cows often had lesions of the limbs (22.3-25.6%), metabolic disorders (24-24.9%), diseases of reproductive organs (9.7-14.5%), diseases of digestion tract (15-16.5%), mastitis (9.5%), infectious pathology (19.5%) As a result of acidosis, excessive lactic acid production occurs (more than 9-11 kg). The appetite decreases, the inflammation of limbs is observed, the feces are more liquid with the remains of food.

The immune system focuses on fighting acidosis; and hence the increase in inflammation of the udder, the emergence of infectious pathology. The content of fat in milk decreases and becomes below the level of protein. There is a stoppage of the chewing process and forced culling of the animal. To estimate the state of the immune system of animals, living under different conditions, immunohematological research was carried out in 3 farms on two groups of cows with tie-up and yard housings. Studies have revealed a tendency of decreasing the immune resistance of cows with tie-up housing. The level of T-lymphocytes in cows was significantly lower by 34%, tetracycline neutrophils - by 15%, hemoglobin by 10%, erythrocytes - by 10%.

Indicators of dairy productivity and productive longevity of cows in many ways characterize the efficiency of dairy cattle breeding industry. They include a milk yield per cow for one lactation, and periods of economic use of animals.

To estimate these indicators, depending on different living conditions at the population level, the statistical data of farms for years 2004-2012 were studied. In the case of yard housing, there is a tendency of increasing of milk yield by one forage-fed cow. Thus, in agricultural enterprises for the period of years 2004-2012 the productivity of animals increased from 4,626 kg to 6,062 kg; the increase in milk productivity per cow amounted to 1,436 kg. Simultaneously,

there was an increase in the period of economic use of animals from 3.2 lactations in year 2004 to 3.9 lactations in year 2012.

In the dynamics of the level of milk productivity and the timing of economic use of animals living under different conditions, there are significant differences. Thus, in farms with tie-up housing, in years 2004 and 2012, there was a decrease in the level of dairy productivity of cows. In agricultural enterprises with yard housing, an increase in the dairy productivity of cows was observed in all years by 2.50% - 9.03%.

Intensive growth in the productivity of cows in agricultural enterprises with tie-up housing was accompanied by lower indicators of the duration of productive use of animals, which in the nine-year period was, on average, 0.3 lactation less than in the case of yard housing.

Reduction in the duration of productive longevity of cows on average in the flock is mainly due to the culling of animals due to various diseases (Table 3).

**Table 3** – Causes of cow culling living under different conditions

Causes of culling	Type of housing	
	Tie-up	Yard
Gynecological diseases, %	27,06	16,18
Low productivity, %	18,37	12,09
Udder diseases, %	19,27	11,98
Limb diseases, %	18,69	9,51
Injuries, %	8,17	4,03
Other causes, %	30,44	25,21

### 3. CONCLUSIONS

1. In agricultural enterprises with tie-up housing, the main causes of culling are gynecological diseases (27.06%), udder diseases (19.27%), and low animal productivity.

2. With the increase in herd productivity, with tie-up housing, the share of discharged animals, caused by infectious diseases, technological symptoms (diseases of the limbs and udder) and impaired reproductive function, increases.

### 4. CONCLUSION

Thus, in the case of yard housing, the increase in the dairy productivity of animals over the nine years was 632.5 kg or 2.06 times higher than with tie-up housing.

## 5. CONFLICT OF INTERESTS

The authors confirm that the presented data do not contain a conflict of interest.

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