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Lymphatic effusions in cows: Diagnosis and treatment

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Abstract. The relevance of the study was determined by the insufficient study of the lymph changes in various pathological conditions of cows and the lack of effective approaches to lymphatic effusions diagnosis and treatment in veterinary practice. Thus, the aim of this scientific study was to improve the diagnosis of lymphatic effusions in cows and methods of their

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treatment. Clinical, planometric, cytological, haematological and statistical research methods were used in the study. The feasibility of using an environmentally friendly, natural remedy – a solution of Poltava bischofite – was substantiated. Clinical studies diagnosed similar lymphatic effusions in the area of the cow's withers, caused by injuries sustained due to design flaws in the farm's equipment. The development of lymphatic effusions was characterised by the formation of a weak inflammatory reaction, as evidenced by a relatively low number of leukocytes in the puncture. In smears from the lymph puncture, an increase in the number of dystrophically altered epithelial cells and leukocyte accumulation was noted. The therapy involved performing a relieving puncture, after which a 10.0% iodine solution (traditional method) was injected into the effusion cavity of some animals, and a solution of Poltava bischofite (proposed method) was injected into others. The clinical condition of the cows was monitored and the composition of the lymph effusion puncture was determined. A temporary exacerbation of the inflammatory reaction was noted after the introduction of the Poltava bischofite solution into the cavity, which was accompanied by an increase in the number of leukocytes and total protein content in the effusion puncture. During the treatment of cows with the Poltava bischofite solution, a decrease in the number of leukocytes in the blood was recorded, indicating its stimulating effect on the restoration of affected tissues. The number of erythrocytes and haemoglobin content in the blood of these cows also increased. The proposed method of therapy using Poltava bischofite solution has shown high therapeutic efficacy and can therefore be recommended as a therapeutic agent for traumatic effusions in cows. The results of the scientific study have practical value for veterinary doctors who ensure animal welfare

Keywords: cattle; animal welfare; closed mechanical injuries; lymph; Poltava bischofite

Introduction

The lymphatic system, as part of the cardiovascular system and immune defence, plays an extremely important role in the body. It provides drainage, metabolic and cleansing functions in the body, and is one of the first to respond to changes in tissues. Thus, its study is of great diagnostic importance in the work of a veterinary doctor. The lymphatic system consists of lymph, lymph nodes and lymphatic capillaries, vessels of various diameters, the lymphatic cistern and lymphatic ducts that flow into the bloodstream (cranial vena cava). Each of these links can be used to assess the condition of tissues in a specific area of the body.

Not enough attention has been paid to studying the lymphatic system in animals: more attention has been paid to lymph nodes (Febo *et al.*, 2023; Oblak *et al.*, 2024), and less to lymphatic vessels and lymph. According to H.P. Janardhan *et al.* (2023), there are still unanswered questions related to the layered arrangement of lymphatic vessels in organs and the composition of lymph. In particular, the following are considered drainage of cardiac lymph from all three layers of the heart from the subendocardium and myocardium to the subepicardium, and further to the mediastinal lymph nodes, and the heterogeneous origin of endothelial cells lining the cardiac lymphatic vessels; the integrated nature of lymphatic function or dysfunction in various diseases, including cardiac and renal diseases, and disorders of the structure and function of the intestinal lymphatic system and gastrointestinal

tract. Despite enormous progress in the structural description of lymphatic vessels, the issue requires further development.

In addition to the crucial role of lymphatic vessels in maintaining fluid balance in the body, in recent years, increasing attention has been paid to establishing the role of lymphatic vessels in organ-specific functions and immune surveillance. S. Arroz-Madeira *et al*. (2023) pointed out the importance of lymphatic vessels in maintaining tissue homeostasis and forming adaptive immune responses. In their work, B. Ponikowska *et al*. (2025) emphasised the role of the lymphatic system in the pathogenesis of internal diseases, which had previously been largely overlooked, and drew attention to the need to develop therapies, particularly for heart failure, that target the lymphatic system. Their studies tested various interventions, from mechanical removal of lymphatic stasis to pharmaceutical interactions and lymphatic microcirculation.

Y. Jian *et al*. (2025) pointed to the lack of effective methods for the prevention of lymphedema and devoted their research to finding them through the influence on the lymph nodes. Damage to the lymphatic system is an initiating factor in the development of a number of diseases, leading to the accumulation of lymph in tissue spaces, chronic inflammation with an imbalance of immunocompetent cells, fat tissue deposition and fibrosis, which further impairs the lymphatic system. The authors proposed the use of decellularised lymph nodes for effective regeneration of lymphatic vessels and their integration into the lymphatic system.

J.C. Lee & S.K. Lee (2024) observed and treated post-traumatic lymphatic effusions in the extremities. Chylous effusion in the wrist was treated with surgical incision and drainage, octreotide administration, and a low-fat diet. Two weeks after surgery, blood parameters returned to normal. S. Sotillo *et al*. (2025) presented the results of an analysis of fluids from various types of cavity effusions, including lymphatic effusions, in dogs and cats. They demonstrated that the leukocyte composition of effusions varies significantly depending on the aetiological factor and the pathogenetic mechanism of formation, in particular with a predominance of neutrophilic reactions in inflammatory processes and relative dominance of mononuclear cells in non-inflammatory conditions. This highlights the diagnostic value of cytological analysis of effusions and may be extrapolated to the assessment of lymphatic effusions in cattle with surgical pathology.

In general, lymph can be of particular diagnostic importance. It is a biological fluid formed by the combination of interstitial fluid with tissue metabolism products, apoptotic cells, cellular fluid, and circulating immune complexes. It plays a key role in every immunological process, including the maintenance of immunological tolerance, immunity to pathogens, autoimmunity, inflammation, and cancer. A review of the literature reveals the basis of the structural and functional organisation of the lymphatic system in normal and pathological conditions, but a number of questions remain unanswered. Currently, there was a lack of scientific information in the literature devoted to the study of lymph in cattle and its changes in various pathological conditions, as well as methods of treating these animals for lymphatic effusions. Although subcutaneous lymphatic effusions in cows are quite common on farms. Most of them are post-traumatic in nature. Closed injuries cause tissue separation and displacement and damage to blood vessels. Thanks to the coagulation system, blood vessels clot and bleeding stops, but lymph from damaged lymphatic vessels enters the space between tissues, where it accumulates and forms swelling. Considering the above, it remains relevant to study the composition

of lymph in cattle and methods of treatment for lymphatic effusions, which will affect the restoration of health and productivity in cows, ensuring their well-being. Thus, the aim of this work was to study lymphatic effusions in cattle and to search for new methods of treating sick animals using an environmentally friendly, natural remedy – a solution of Poltava bischofite.

Literature Review

For a long time, the composition of lymphatic fluid was virtually unknown. It was believed that the composition of lymph and blood was the same. L. Santambrogio (2018) noted that this lack of knowledge was largely due to technical difficulties in cannulating lymphatic vessels and the small amount of fluid collected, which hindered the study of lymph. Since 2010, progress has been made in understanding the mechanisms that regulate the formation, circulation, and composition of lymph. L. Weaver & B. Weaver (2025) emphasised that the lymphatic system of cattle is an integral part of the mechanisms that maintain homeostasis in the body, as well as immune responses and inflammatory reactions. Structurally, it originates from branched networks of lymphatic capillaries responsible for collecting interstitial fluid and transporting it through regional lymph nodes to central lymphatic vessels. K.C. Hansen *et al*. (2015) noted that interstitial fluid is a precursor to pre-nodal lymph, which is formed as an ultrafiltrate in the process of capillary microcirculation. Thus, most of the proteins contained in the blood are also present in the lymph. According to their data, the osmotic composition of lymph depends on the characteristics of plasma protein ultrafiltration. In addition, the process is influenced by proteins and molecules formed in tissues as a result of the metabolic and catabolic activity of each parenchymal organ from which lymph flows. The data obtained and new insights have led to a new understanding of the importance of the lymphatic system in the physiology and pathology of the body.

In their studies on mathematical models and cattle, C.M. Quick *et al.* (2014) noted that lymph flow is the main mechanism for returning interstitial fluid to the bloodstream and determined the functional responses of post-nodal mesenteric lymphatic vessels, which adapt to venous hypertension by reducing internal contractile activity. Lymphatic vessels have relatively thin walls and can collapse. They contain muscles that exhibit phasic and tonic contractions modulated by a number of vasoactive mediators. Increasing attention is being paid to the observation that lymphangions, segments of lymphatic vessels connected by valves, form units that function similarly to cardiac ventricles. Lymphangions can act as cyclically contracting chambers and are capable of actively pumping lymph against the axial pressure gradient. This property allows lymph to move from the low-pressure interstitial space to the higher-pressure venous system, as well as to respond to increases in interstitial fluid pressure by pumping more fluid out of the interstitium.

Pathological processes are considered to be accumulations of lymph, which are classified as pathological effusions. As noted by K. du Preez (2023), effusions are abnormal accumulations of fluid in the pleural, peritoneal, or pericardial cavities of the body, and they come in all shapes and sizes. Effusions fall into two broad categories: exudates and transudates. S.J. Quantrill & L. Dabal (2002), M. Tahara *et al*. (2011) emphasised the importance of establishing the aetiology of effusions and examining the cytology, protein, and lactate dehydrogenase in effusions to differentiate them. Microscopic examination is critical for determining the type of fluid and identifying specific cells or microorganisms that may cause

pathological changes. F.H. Alonso *et al*. (2022) found that excess fluid can accumulate in body cavities for many reasons, which vary in terms of the cytological properties of the effusion. For diagnosis, along with clinical examination methods, the number of cells and protein content must be determined. Microscopic examination is a critical aspect of the diagnostic procedure. It allows not only to fully classify the fluid, but also to identify specific types of cells or microorganisms that may be responsible for fluid accumulation. Thus, these data should always be interpreted together.

It is noteworthy that, according to research, fluid accumulation in organs is characteristic mainly of large animals. In particular, D. Funk & R. Neiger (2014) reported that in dogs and cats, the volume of fluid in the abdominal, pleural and pericardial cavities is quite small (usually less than 10 mL), and the fluid cannot be aspirated from them. Conversely, it accumulated in clinically healthy horses, cattle and camels. In addition, E. Monnet (2004) noted that chylothorax is rare in domestic animals and, as an exception, can be observed in cows.

The study of lymph, both in cases of excess accumulation and in normal conditions, is of great diagnostic importance, since lymph is an intercellular fluid and clearly reflects the state of processes occurring in cells, tissues and organs as a whole. It requires in-depth comprehensive analysis. In order to use lymph for diagnostic purposes, it was necessary to determine the characteristics of its composition in normal and pathological conditions, which became the task of further research. Thus, W.R. Hein *et al.* (1988) studied lymph from the ovaries or uterus at different stages of pregnancy in cows. They determined the lymph flow rate, cell composition, and levels of protein, progesterone, testosterone, estrone, etc. It was found that at all stages of pregnancy, the concentration of progesterone and androgens, in particular androstenedione, was higher in ovarian lymph than in uterine lymph or blood plasma. Lymph more accurately reflects the tissue cell environment than efferent blood, and further analysis of differences in the concentration of substances in lymph relative to their productivity in arterial and venous blood of the ovaries and uterus may lead to the identification of factors important for local regulatory mechanisms of the reproductive tract.

In their studies, C.M. Smuts *et al.* (2016) found that measuring lactate dehydrogenase activity may be useful for differentiating transudates and exudates in cats and dogs. Lactate dehydrogenase activity was significantly higher in exudates than in transudates and varied significantly depending on the measurement method. Studies of lymph composition are also aimed at assessing metabolic processes. In particular, J.L. Khol *et al.* (2012) evaluated the feasibility of collecting and examining lymph from the udder of cows to determine its diagnostic value. The results demonstrated the potential of such testing for the early detection of paratuberculosis in cows. Studies by a number of authors: K. Alitalo (2011), E. Weber *et al*. (2022) and K. Koltowska *et al.* (2023) pointed to the relevance of determining the composition of lymph and the clinical manifestations of its accumulation, as well as the condition of lymphatic vessels in diseases. Defects in lymphatic function can lead to lymph accumulation in tissues, weakened immune responses, accumulation of connective tissue and fat, and tissue oedema. The article highlighted how the lymphatic system contributes to the pathogenesis of various diseases, including immune and inflammatory reactions, and its role in the spread of tumour cells. Thus, based on studies of the lymphatic system, its key role in the pathogenesis of various diseases has been identified. Thus, the composition of lymph is an important diagnostic indicator that is significant for

determining the aetiology of pathological effusions and selecting treatment approaches.

Materials and Methods

The study was conducted over eight years (from 2018 to March 2025) at the "Trostyanets" dairy farm (Poltava region, Poltava district, Velykyi Trostyanets village). At the farm, a dispensary examination of approximately 300 cows of different ages and breeds was carried out in order to study the prevalence of lymphatic effusions. During this process, cases of diseases requiring surgical intervention were recorded, namely closed mechanical injuries of soft tissues.

During clinical examinations of cows with lymphatic effusions, attention was paid to the size of the swelling, the presence of signs of fluctuation, and the nature of the punctate. To determine the dimensions of the lymphatic effusions, a type 1 vernier calliper with a scale division of 1 mm was used. The volume of the effusions was calculated using the formula for a rectangular parallelepiped.

At the next stage, the contents of the swellings were examined. The morphological composition of blood was also determined using generally accepted methods in a Goryaev counting chamber (Ukraine). Comparisons were made between the values of haematological parameters in animals of the experimental groups diagnosed with lymphatic effusions and healthy cows of the control group. To determine the nature of the inflammatory process in affected cows, lymph samples were collected and smears were prepared. These were stained using the Romanowsky–Giemsa method. The smears were examined under a MICROmed XS-5520 microscope (Ukraine) and photographed using a Canon Power Shot III attachment (Japan).

The number of leukocytes in the lymph was counted in a Goryaev chamber (Ukraine) according to the following method: 0.4 mL of a 3% acetic acid solution with gentian violet (Turk's solution) was added to a test tube. The lymph in the tube was thoroughly mixed. Using a capillary pipette, 0.02 mL of lymph was drawn up, its tip was carefully wiped with a moistened and then dry cotton swab, transferred into the test tube and gently expelled. The pipette was rinsed several times with the diluting fluid, drawing it up to the level of the taken blood. The test tube was closed with a rubber stopper and left for 4 minutes, periodically mixing the contents. The lymph was then introduced under the ground glass of the Goryaev chamber. Leukocyte counting was started 1 minute after filling the chamber, when the lymph cells had settled. The number of leukocytes was counted at low magnification of the microscope in 100 large squares and multiplied by 50 to obtain the final result. The total protein content in the lymph was determined by the refractometric method (Refractometer RHC-300, China). Based on the refractive index value, the percentage of total protein was established using the Reiss table. Native blood from the animals was also examined; it was collected from the jugular vein and stabilised by the addition of heparin. In the blood of diseased and healthy cows, the number of leukocytes, erythrocytes and the haemoglobin content were determined using generally accepted classical methods.

After identifying the affected cows, treatment was carried out. For this purpose, 13 diseased cows were divided into two experimental groups with an even distribution according to the severity of lymphatic effusions. Animals of the first experimental group (n = 5) underwent a relieving puncture, after which a 10.0% iodine solution was introduced into the cavity (traditional therapy). If the lymph outflow did not stop, the procedure was repeated after 3 days. Treatment of cows in the second experimental group (n = 8) also involved a relieving puncture, after which a gauze drain impregnated with a solution of Poltava bischofite (Mineral LLC,

Ukraine) was inserted into the wound and left in place for 3 days. If the lymph outflow did not stop, the procedure was repeated. The control group consisted of clinically healthy animals (n = 5). Regular clinical examinations of the affected animals and monitoring of the effectiveness of the therapeutic agents were carried out over a period of 18 days.

The Poltava bischofite solution was selected as a treatment agent due to its properties. Bischofite is a natural mineral containing a large amount of magnesium chloride and other beneficial elements such as calcium, potassium, sulphates and others. Poltava bischofite is extracted from a great depth of up to 2.5 km, which ensures its environmental purity. The Poltava bischofite solution is used for therapeutic purposes in human and veterinary medicine, but in this work it was applied for the first time in cases of subcutaneous lymphatic effusions in cows.

Scientific studies involving animals complied with the requirements of the European Convention (1986) and the Law of Ukraine No. 3447-IV (2006). All necessary interventions on animals were carried out in accordance with the ARRIVE (n.d.) recommendations, without violating the guiding principles of Directive 2010/63/EU (2010). Statistical processing of planimetric, cytological and haematological data was performed using a personal computer with MS Office software, specifically Microsoft Excel. To determine the statistical significance of the obtained results, Student's t-test was used with significance levels of $P < 0.05$, $P < 0.01$ and $P < 0.001$. The results are presented as the mean value and the standard error of the mean ($M \pm m$).

Results and Discussion

The results of monitoring studies made it possible to assess the structure of surgical pathology in cows on the farm and determine the place of lymphatic effusions among other diseases requiring surgical intervention. It was found that the most common pathology remains hoof pathology – purulent pododermatitis and ulcers of the interdigital tissue, which accounted for about half of all other pathologies (Table 1). Less common were lymphatic effusions (lymph extravasations) in the withers area of cows and haematomas, and the least diagnosed were accidental purulent wounds.

Table 1. List of surgical pathologies in cows based on the results of a clinical examination

Pathology	Absolute number of cows, head	Relative number of cows, %
Inflammatory processes in the distal parts of the limbs	24	47.1
Lymphatic effusions	15	29.4
Haematomas	7	13.7
Wounds	5	9.8
Total:	51	100.0

***Source**: developed by the authors*

A clinical examination of the existing cow population helped to establish the prevalence of lymphatic effusions among animals kept on the farm. According to the results obtained, lymphatic effusions were found in 15 cows, of which 13 animals were diagnosed with the same type of lymphatic effusions in the withers area, accounting for 4.3% of the total herd. In the structure of surgical diseases, the number of cows with lymphatic effusions was 29.4%, which was second in prevalence after pathology in the distal part of the limbs.

During the course of the study, no seasonal pattern was observed in the occurrence of this disease. However, J. Jerlström *et al*. (2025) observed a seasonal increase in soft tissue injuries in cows. The researchers noted that traumatic injuries in cattle due to incidents on farms, animal transport, etc. indicated a decline in animal welfare. The study aimed to determine the prevalence and seasonal variations of traumatic injuries in cows and heifers raised on organic and conventional farms in Sweden. The results showed a higher prevalence in animals from conventional farms (9.8%) compared to organic farms (6.9%; $P < 0.001$).

The current study found that the appearance of lymphatic effusions in cows was caused by trauma and had the same location – in the area of the withers. Pathological changes varied in size. In some cases, the diameter was 8 cm, and in others, 15 cm. Based on the collected medical history, it was found that lymphatic effusions in the experimental cows occurred when the soft tissues in the withers area came into contact with a metal barrier pipe located along the entire length of the cowshed (Fig. 1).

Constant contact between the skin of the withers and the iron pipe caused chronic trauma in cows. As a result, the skin and subcutaneous loose tissue became detached. At the same time, small lymphatic vessels contained in the loose subcutaneous tissue were ruptured. As a result, lymph effusions under the skin were recorded, which was the main cause of local effusion formation.

A B

Figure 1. Chronic trauma as a cause of lymphatic effusions in cows
***Note**: A – position of the cow in the stall; B – cow's withers; arrows indicate swelling of lymphatic effusion in the cow's withers and a restrictive metal pipe*
***Source**: photo taken by the authors*

F.C. Furnaris & T.N. Constantin (2024) emphasised the need to optimise between two opposing elements: cow comfort and stall hygiene. The authors described two specific elements in the stall, namely: a chest locator (strap/tube) and a neck rail (strap/tube) – located above the stall partition, which minimise stall contamination. Only through structural optimisation can the welfare of cows on farms be ensured. S.F. Peek & T.J. Divers (2018) demonstrated that the neck area of cattle is at risk of lymphatic effusions due to the presence of numerous superficial and deep lymph nodes and, accordingly, a dense network of lymphatic vessels. Pathological conditions affecting these lymphatic structures often manifest clinically as non-inflammatory ("cold") or acute inflammatory ("hot") swellings, which varies significantly depending on the nature and duration of the underlying lesion.

The study found that lymphatic effusions in injured cows were characterised by typical

symptoms in the vast majority of cases. Thus, the animals developed undulating swelling in the area of the withers, which was clearly demarcated from the surrounding tissues. It was painless and the temperature in the damaged area remained unchanged. Upon examination of the pathological focus in five animals out of eight in the second experimental group, which accounted for 62.5% of cases, significantly pronounced local alopecia was established compared to the surrounding areas. The skin in these animals in the area of the withers had practically no hair cover and was thickened. When performing a test puncture of the swelling in the withers area in 6 animals (75.0%), lymphatic exudate (clear lymph was secreted) was noted, and in two patients (25.0%) – haemolymphatic exudate (lymph mixed with blood) (Fig. 2).

A B C

Figure 2. Lymphatic effusions
***Note**: A – local alopecia in the area of swelling; B – palpation examination of the pathological area; C – haemolymph*
***Source**: photo taken by the authors*

In 100% of cases, these were superficial lymphatic effusions. However, the size of the swellings in the affected animals varied. The symptoms of lymphatic effusions in animals in experimental group 1 did not differ significantly from those in experimental group 2, namely: a gradual slow increase in the size of the affected area of the body was observed. The exfoliated skin directly in the area of the pathological process thickened and had reduced elasticity. When attempting to palpate the affected area, the animal felt discomfort and tried to free itself from fixation, which indicated the presence of local pain. In chronic cases, in isolated cases, the formation of ulcers and the discharge of cloudy lymph were observed on the surface of the lymphoextravasate. The results of planimetric studies of lymphatic effusions in individual cows included in the 1st and 2nd experimental groups are presented in Table 2.

Table 2. Planimetric studies of lymphatic effusions in cows

Age, inventory number	Size of swellings, cm			V, cm³
	l	***b***	***h***	
5 years, 8751	10.5	9.5	8.5	847.8
6 years, 8719	15.0	11.0	12.0	1,980.0
5 years, 4952	13.0	8.0	9.0	936.0
6 years, 4953	8.5	11.0	9.5	888.2
7 years, 8568	11.0	22.5	6.5	1,608.0
6 years, 4230	12.5	10.7	7.5	1,003.0
5 years, 4361	10.5	10.0	9.0	945.0

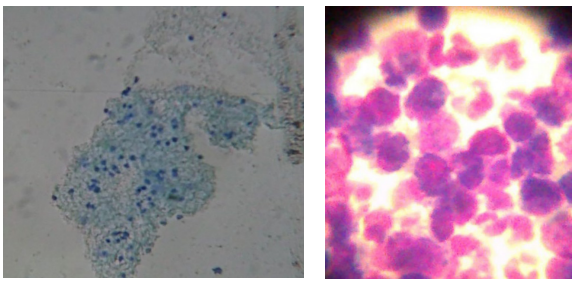
Table 2. Continued

Age, inventory number	Size of swellings, cm			V, cm^3
	l	*b*	*h*	
5 years, 4381	14.0	15.0	7.0	1,470.0
M ± m	118 ± 0.8	12.2 ± 0.9	8.6 ± 0.7	1,209.0 ± 150.5

***Note**: l – length, b – width, h – height, V – volume of swelling*
***Source**: developed by the authors*

Analysis of the data obtained showed that the volume of swellings in sick cows varied. Thus, the largest swelling size was 38.9% higher than the average value, and the smallest differed by 29.9%. The number of leukocytes was determined in the lymphatic effusions of sick animals from both experimental groups. It was found that the development of lymphatic effusions was characterised by the formation of a weak inflammatory reaction, as evidenced by the relatively low number of leukocytes in the puncture (5.5 ± 1.4 × 10^9/L).

When determining the total protein content in the lymph effusions, it was found that its average values did not differ significantly from the normative values in blood serum (72.0-86.0 g/L). Cytological studies of smears from lymph punctures of cows in both experimental groups revealed a significant number of epithelial cells. The latter were in a state of dystrophy and necrosis. A large number of different forms of lymphocytes were also found in smears from lymph puncture (Fig. 3).



A B

Figure 3. Cytological examination of lymph punctures from sick cows
***Note**: A – accumulation of epithelial cells with embedded lymphocytes; B – accumulation of lymphocytes*
***Source**: photo taken by the authors*

Thus, in cases of lymphatic effusions in cows, smears prepared from lymph punctates showed an increase in the number of epithelial cells, their dystrophic changes, as well as the appearance of foci with accumulations of leukocytes. In this context, the cellular composition in five microscopic fields of view was as follows: the number of lymphocytes was 144.3 ± 4.5, and epithelial cells 12.5 ± 1.1. N.V. Barbosa *et al.* (2024) reported similar data on the cytological composition of lymph in lymphatic effusions in small animals and emphasised the informativeness and necessity of conducting cytological examinations of lymphatic effusion punctates.

In accordance with the objectives set, studies of the morphological composition of blood were carried out. This included counting the total number of leukocytes and erythrocytes and determining the haemoglobin level (Table 3). In the blood of cows with lymphatic effusions,

compared with clinically healthy animals, a tendency towards an increase in the number of leukocytes by 35.6% was noted. A tendency towards a decrease in the number of erythrocytes in affected animals by 16.7% compared with the control was also established. At the same time, the haemoglobin content showed a tendency towards a slight decrease of 2.8% in the blood of cows in the first experimental group and by 8.0% in cows of the second experimental group.

Table 3. Morphological blood parameters of clinically healthy cows and cows with lymphatic effusions of the withers (M ± m, n = 5)

Indicator	Group of cows		
	"Control", clinically healthy animals	1st experimental, traditional therapy	2nd experimental, therapy with Poltava bischofite solution
Leukocytes, 10^9/L	10.1 ± 1.3	13.7 ± 0.1	13.8 ± 0.1
Erythrocytes, 10^{12}/L	6.0 ± 0.7	5.0 ± 0.1	5.0 ± 0.1
Haemoglobin, g/L	100.0 ± 0.8	97.2 ± 2.6	92.0 ± 3.6

***Note**: no significant difference was found between the values of the studied indicators in clinically healthy animals and those of the sick animals*
***Source**: photo taken by the authors*

The next stage of the work involved the treatment of the affected animals. Therapy of diseased cows included performing a relieving puncture of the injured withers area. After this, animals of the first experimental group received a 10.0% iodine solution into the cavity of the lymphatic effusion, whereas animals of the second experimental group were administered a Poltava bischofite solution in a volume of 40-60 mL. If lymph leakage did not cease, the procedure was repeated several times. It should be noted that on the third day of treatment in cows of the second experimental group, following the introduction of the Poltava bischofite solution into the cavity, a sharp change in the clinical picture was observed: the swelling became hot, painful and of a doughy consistency. At the same time, with the development of an inflammatory reaction provoked by the introduction of the Poltava bischofite solution into the pathological cavity, the number of leukocytes in the lymph increased by 42.1% and amounted to $9.5 \pm 1.2 \times 10^9$/L (Fig. 4).

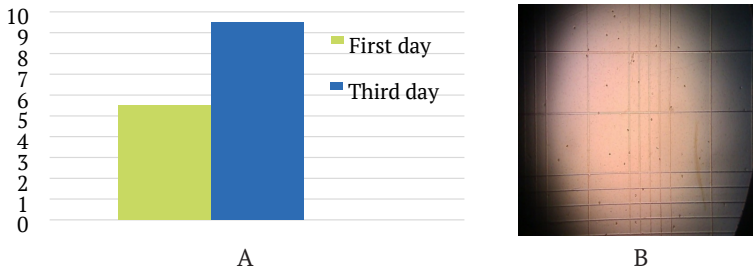


Figure 4. Determination of the number of leukocytes in lymphatic effusions obtained from cows in the second experimental group
***Note**: A – dynamics of leukocyte content in lymphatic effusions before and after the application of Poltava bischofite solution; B – microscope field of view for leukocyte counting*
***Source**: developed by the authors*

The increase in the number of leukocytes in the lymph of animals in the second experimental group during the development of an inflammatory reaction was combined with an 11.7-fold increase in the number of segmented neutrophils ($P < 0.001$) (Table 4). In addition, the appearance of band neutrophils and eosinophils was noted. At the same time, these processes occurred against the background of a decrease of more than 2.1 times ($P < 0.001$) in the number of lymphocytes compared to the first day of treatment of cows in the second experimental group.

Table 4. Leukogram of lymphatic effusions from sick cows in the second experimental group, % (M ± m, n = 3)

Study period	Indicator				
	E	N		M	L
		B	S		
First day	0	0	4 ± 0.9	1 ± 0.6	95 ± 1.2
Third day	1 ± 0.5	5 ± 0.3	47 ± 1.2***	1 ± 0.4	46 ± 1.6***

***Note**: *** – P < 0.001 compared to the baseline on the first day of treatment; E – eosinophils, N – neutrophils, B – band neutrophils, S – segmented neutrophils, M – monocytes, L – lymphocytes*
***Source**: developed by the authors*

An increase in the number of segmented and band forms of neutrophils in the punctates of lymphatic effusions of diseased cows in the second experimental group indicates the development of an inflammatory response. Activation of non-specific factors of the animals' resistance occurred, namely microphagocytic reactions. This is a consequence of the activating action of Poltava bischofite and confirms its effectiveness in stimulating cleansing and reparative processes in the area of the lymphatic effusion. The influence of the Poltava bischofite solution on the formation of immunological processes has been reported in previous studies by O.B. Kyrychko *et al*. (2021a; 2021b).

Determination of the total protein content in the punctates of lymphatic effusions was carried out in order to assess the nature of the effusion and the intensity of the local inflammatory response, since an increase in protein concentration in lymph indicates increased permeability of the vascular wall, activation of exudative processes, and the course of resorptive and reparative changes in the affected area under the influence of treatment. As shown by the results, indicative changes were already observed on the third day of treatment in animals of the second group when the Poltava bischofite solution was used. The dynamics of total protein content in lymph punctates of effusions in cows of the second experimental group are presented in Table 5.

Table 5. Dynamics of total protein content in lymph punctates of effusions in cows of the second experimental group, g/L (M ± m, n = 3)

Age and inventory number of the cow	Study period, days	
	first	third
6 years, 4953	81.0	162.0
7 years, 8568	76.0	154.0
6 years, 4230	85.0	145.0
M ± m	80.6 ± 3.8	153.0 ± 7.1***

***Note**: *** – P < 0.001, compared to the punctate on the first day of treatment*
***Source**: developed by the authors*

After the introduction of the Poltava bischofite solution, an increase in protein content by 89.8% ($P < 0.001$) was observed compared with the first day of treatment. This process indicates the development of an acute inflammatory response in the lymph of diseased cows in the second experimental group. Thus, the data demonstrate the effectiveness of using this agent at the initial stage of treatment. During puncture of the injured area, the lymph acquired a blood-tinged colour. The walls of the pathological cavity filled with lymphoextravasate became tense, and the volume of the contents decreased. After evacuation of the lymph from the cavities, given the high intensity of the inflammatory response, repeated administration of the Poltava bischofite solution was not performed. Continuous clinical monitoring of the affected animals was carried out for 18 days. Analysis of the observation results was performed to evaluate the effectiveness of the therapeutic agents (Table 6).

Table 6. Dynamics of clinical parameters in cows with lymphatic effusions after therapy (n = 13)

Indicator	Group of animals	Day of observation					
		3	6	9	12	15	18
Presence of lymphatic effusion	2 ex	±	±	±	-	-	-
	1 ex	±	±	-	-	-	-
Total affected, head	2 ex	8	8	6	4	1	1
	1 ex	5	5	4	2	1	-
Recovered, head	2 ex	-	-	2	4	7	7
	1 ex	-	-	1	3	4	5
Local inflammation	2 ex	+	+	±	±	-	-
	1 ex	+	+	+	+	±	±
Recovered, %	2 ex	-	-	25.0	50.0	75.0	75.0
	1 ex	-	-	20.0	40.0	80.0	100.0
Affected, %	2 ex	100.0	100.0	75.0	50.0	25.0	25.0
	1 ex	100.0	100.0	80.0	60.0	20.0	-

***Note**: 1 ex – first experimental group; 2 ex – second experimental group; + – symptoms strongly expressed; ± – symptoms weakly expressed; - – symptoms not expressed*
***Source**: developed by the authors*

During clinical examination on the sixth day, no increase in effusion size was observed in two animals of the experimental group. Palpation of these cows revealed thickening of the skin and deeper tissues. The tissues in the pathological area were hot and painful to the touch. Upon further examination of the pathological area, it was found that on the ninth day there was a decrease in the area of inflammatory oedema and the degree of tissue pain on palpation. However, the local body temperature in the pathologically altered area was higher compared to other areas.

Upon examination of the pathological focus on the 12th day of observation of the sick cows in the experimental group, no pain on palpation was recorded, the inflammatory reaction was not pronounced, and local thickening of the soft tissues was noted. A similar picture was observed in two other animals in the same group, in which lymph secretion and the intensity of the inflammatory reaction decreased starting on the ninth day. By the 12th day, the inflammatory process and lymph secretion had ceased. Thus, by the 12th day of observation, the proposed method was 50% effective.

With practically similar dynamics of clinical symptoms on the 15th and 18th days of observation, the proposed method ensured the

recovery of 75% of cows in the experimental group. At the same time, one animal was recognised as having an improvement in the course of the pathological process, which was manifested by a decrease in the intensity of the detected clinical signs. However, its complete recovery was not recorded. This was characterised by the fact that during a clinical examination, a decrease in lymph secretion was noted in the animal, the pathological area became denser, and a formation the size of an average fist was formed, similar to a mucous bursa. In addition, the connection with the skin was not observed on the entire surface of the pathological process; it was mobile on some areas of lymphatic effusion. That is, a separate pathological formation similar to a mucous bursa was created.

Analysis of the data obtained showed that in cows of the first experimental group, the traditional method of treatment provided 100% effectiveness within 18 days, namely: lymph secretion in most animals stopped on the 15th day. During the treatment process, after two administrations on the 9th day, one animal (20%) recovered. Accordingly, after three manipulations, two animals (40%) recovered on the 12th day, and after four treatments, four animals (80%) recovered on the 15th day. At the end of the observation period on the 18th day, no sick animals were found among the total number of cows under study. Treatment of such pathologies with iodine solution is a classic method, but it has a number of disadvantages. Iodine has anti-inflammatory and antiseptic properties. At the same time, it can cause local irritation and burns, and with excessive absorption, it can cause thyroid dysfunction. Thus, this study proposes an alternative treatment method using bischofite solution, which has proven to be highly effective.

The results of clinical observations were confirmed by haematological studies of cows in the first and second experimental groups, which showed significant differences and revealed the peculiarities of the proposed and traditional treatment methods. By studying the morphological indicators of blood in dynamics (Table 7), it was found that on the fifth day of treatment in the native blood of cows in the second experimental group, the number of leukocytes decreased by 21.0% ($P < 0.001$), on the 15th day – by 23.2% ($P < 0.001$) compared to the first day of treatment, and by 18.0% ($P < 0.01$) and 19.1% ($P < 0.01$), respectively, compared to the animals in the first experimental group. This indicates a milder effect of the Poltava bischofite solution, which exhibits anti-inflammatory properties and stimulates the regeneration of affected tissues.

Table 7. Dynamics of haematological parameters in cows during treatment (M ± m, n = 10)

Indicator	Treatment period					
	1		5		15	
	Group of animals		Group of animals		Group of animals	
	1 ex	2ex	1 ex	2 ex	1 ex	2 ex
Leukocytes, 10^9/L	13.7 ± 0.1	13.8 ± 0.1	13.3 ± 0.2	10.9 ± 0.4***/**	13.1 ± 0.1	10.6 ± 0.3***/**
Erythrocytes, 10^{12}/L	5.0 ± 0.1	5.0 ± 0.1	5.3 ± 0.2	6.2 ± 0.3*/	5.1 ± 0.1	6.7 ± 0.3**/**
Haemoglobin, g/L	97.2 ± 2.6	92.0 ± 3.6	97.4±1.9	112.0 ± 4.5*/*	95.2 ± 1.5	115.8 ± 4.5**/**

***Note**: 1 ex – first experimental group (traditional treatment); 2 ex – second experimental group (therapy with bischofite solution); ***/ – P < 0.001, **/ – P < 0.01, */ – P < 0.05 compared to the corresponding results on day 1 of treatment; /** – P < 0.01, /* – P < 0.05 compared to the results of similar indicators in cows of the first experimental group*

***Source**: developed by the authors*

Thus, on the 5th day of treatment, a significant increase in the number of erythrocytes in native blood was observed only in cows of the experimental group 2 – by 24.0% ($P < 0.05$) compared to the results of this indicator on the 1st day of treatment. On the 15th day of treatment, the number of erythrocytes in the native blood of animals in the second experimental group increased significantly by 34.0% ($P < 0.01$) compared to the results of this indicator on the 1st day of treatment and by 23.9% ($P < 0.01$) compared to the values of the corresponding indicator in cows of the first experimental group, indicating positive changes in the processes of erythropoiesis.

The method of treatment of cows in the second experimental group also contributed to an increase in the haemoglobin content in native blood, which already on the 5th day significantly increased by 21.7% ($P < 0.05$) compared to the values of this indicator on the 1st day of treatment and increased by 15.0% ($P < 0.05$) compared to the corresponding results in cows of the experimental group 1 under traditional therapy. On the 15th day of treatment, the haemoglobin content in the native blood of cows in the second experimental group increased by 25.9% ($P < 0.01$) compared to its values on the first day of treatment and by 21.6% ($P < 0.01$) compared to its level in animals in the first experimental group. In previous studies using Poltava bischofite solution for other pathologies, a significant increase in the number of erythrocytes and haemoglobin content in the blood of animals was also recorded. This effect on the organism may be due to the presence of iron and other minerals in the Poltava bischofite preparation, which belong to the haematopoietic group and are directly or indirectly involved in haematopoiesis.

The results obtained confirm the modern view of the lymphatic system as an active component of local regulatory, immune and reparative processes, rather than a passive pathway for the outflow of interstitial fluid. As noted by L. Santambrogio (2018) and K.C. Hansen *et al.* (2015), the composition of lymph largely reflects the metabolic and inflammatory state of the tissues from which it drains. In the study, this was manifested by characteristic changes in the cellular composition and protein content in lymphatic effusions in cows, confirming the diagnostic value of lymph analysis in traumatic soft tissue injuries. S. Sotillo *et al*. (2025) in their study of lymphatic and other cavity effusions in dogs and cats found that fluid characteristics and cytological composition are important for determining the aetiology of effusions. Variations in leukocyte composition, particularly neutrophils, may be associated with inflammatory processes, confirming the importance of cytological analysis for the diagnosis and identification of the causes of pathology, which may also apply to lymphatic effusions in cattle.

The weak inflammatory reaction found in most sick cows, characterised by a low white blood cell count in punctures and a predominance of lymphocytes and epithelial cells with signs of dystrophy, is consistent with the data of S.A. Center (2012), who described similar cytological features for chronic non-inflammatory or low-inflammatory processes. At the same time, the introduction of Poltava bischofite solution caused a controlled exacerbation of the local inflammatory reaction, which manifested itself in a significant increase in the number of leukocytes in the lymph, primarily due to segmented and stab neutrophils. Such changes in the leukogram correspond to the mechanisms described in the literature for the transition from inert effusion to the active phase of cleansing the pathological cavity (Barbosa *et al.*, 2024). This indicates the activation of microphagocytic reactions and the involvement of non-specific immune defence, which is a necessary condition for further reparative processes.

The positive dynamics of haematological parameters in cows treated with Poltava bischofite solution, in particular, a decrease in the number of leukocytes in native blood at later stages of treatment and an increase in the number of erythrocytes and haemoglobin content, is consistent with the data of O.B. Kyrychko *et al*. (2021a; 2021b) on the systemic action of bischofite components. Analysing the data of the study of clinical changes in the damaged area of the body due to lymphatic effusions in cows and the results of the study of their haematological parameters under different therapeutic approaches, it was proven that the proposed method of treatment using a bischofite solution, unlike the traditional method of therapy, ensured faster recovery of the affected tissues after the exacerbation of the inflammatory reaction. In addition, the number of erythrocytes and haemoglobin content in the native blood of these cows increased significantly, indicating a positive effect of the components of the bischofite solution on the erythroid activity of the red bone marrow. This allows to consider the proposed treatment method as milder and more physiological compared to traditional iodine therapy, since it provides short-term local activation of inflammation with subsequent accelerated tissue recovery and normalisation of the overall condition of the cows.

Conclusions

The study conducted comprehensive clinical, cytological, biochemical and haematological studies of lymphatic effusions in cows, and experimentally substantiated the effectiveness of using Poltava bischofite solution as a local treatment for this pathology. The studies were aimed at improving the diagnosis of lymphatic effusions in cows and a comparative assessment of traditional therapy and treatment using Poltava bischofite. The study found that the number of cows with traumatic lymphatic effusions accounted for 4.3% of the total number of cows on the dairy farm where the experiment was conducted. In the structure of surgical diseases, the incidence of animals with this pathology was 29.4%, which in terms of prevalence among other pathologies was second only to diseases of the distal limbs. It was found that in cows with lymphatic effusions, the number of epithelial cells with signs of dystrophy significantly increased in smear-imprints from lymph puncture, and foci with leukocyte accumulation appeared. At the same time, lymphocytes and epithelial cells predominated in the cellular composition. The development of lymphatic effusions was characterised by the formation of a weak inflammatory reaction, which was characterised by a small number of leukocytes in the punctures of lymphatic effusions. At the same time, in the case of an exacerbation of the inflammatory reaction provoked by the introduction of a solution of Poltava bischofite into the pathological cavity, their number in the lymph puncture increased by 42.1%, and the total protein content by 89.8%. In the native blood of cows with lymphatic effusions, different treatment methods showed a tendency to increase the number of leukocytes by 35.6%, decrease the number of erythrocytes by 16.7% and slightly decrease the haemoglobin level compared to clinically healthy cows. In addition, it was found that the number of leukocytes in the native blood of cows treated with bischofite solution decreased by 23.2% compared to their value on the first day of treatment and by 23.2% compared to the values of this indicator in animals undergoing traditional therapy. The milder effect of Poltava bischofite solution with anti-inflammatory properties on the pathologically altered area of the body was also confirmed, which led to faster recovery of the affected tissues. In the native blood of such cows, an increase in the number of erythrocytes by 34.0% and an increase in haemoglobin content by 25.9% were noted

compared to the values of these indicators on the first day of treatment, and an increase of 23.9% and 21.6%, respectively, compared to the results of traditional treatment. It has been proven that the proposed local therapy using a solution of Poltava bischofite in animals with lymphatic effusions in the withers area provided 25% effectiveness by day 9, 50% by day 12, and up to 75.0% effectiveness by day 15, which indicates its high therapeutic efficacy alongside traditional therapy.

Thus, the proposed treatment method using Poltava bischofite solution can be recommended for use in applied veterinary medicine for traumatic lymph effusions in cows. Taking into account the data obtained on the therapeutic properties of Poltava bischofite solution, further research into the use of Poltava bischofite solution in veterinary medicine and animal husbandry is promising. In particular, studying the mechanisms of its effect on the course of inflammatory and reparative processes in soft tissues, optimising the dosage and duration of use for various clinical forms of lymphatic effusions, as well as evaluating the effectiveness of bischofite use in other types of traumatic and postoperative complications in cattle and other animals.

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Conflict of Interest

None.

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Лімфатичні випоти в корів: діагностика та лікування

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Анотація. Актуальність дослідження обумовлена недостатнім вивченням змін лімфи корів за різних патологічних станів та відсутністю ефективних підходів до діагностики та лікування лімфатичних випотів у ветеринарній практиці. Тому мета цього наукового дослідження була спрямована на вдосконалення діагностики лімфатичних випотів у корів та методів їх лікування. У роботі використовувалися клінічні, планометричні, цитологічні, гематологічні та статистичні методи дослідження. Обґрунтовано доцільність застосування екологічно чистого, природного засобу – розчину полтавського бішофіту. Клінічними дослідженнями діагностовано однотипні лімфатичні випоти у ділянці схилу холки корів, спричинені травмами, отриманими через конструктивні недоліки обладнання ферми. Розвиток лімфатичних випотів характеризувався формуванням слабкої запальної реакції, свідченням чого була відносно низька кількість лейкоцитів у пунктаті. У мазках-відбитках із пунктату лімфи відмічалося збільшення кількості дистрофічно змінених епітеліальних клітин та скупчення лейкоцитів. Терапія передбачала проведення звільняючої пункції, після чого в порожнину випоту одним тваринам вводили 10,0 % розчин йоду (традиційний спосіб), а іншим – розчин полтавського бішофіту (запропонований спосіб). Спостерігали за клінічним станом корів та визначали склад пунктату з випоту лімфи.

Відмічали тимчасове загострення запальної реакції за введення в порожнину розчину полтавського бішофіту, яка супроводжувалась зростанням у пунктаті випоту кількості лейкоцитів та вмісту загального білка. У процесі лікування корів із застосуванням розчину полтавського бішофіту фіксували зменшення в крові кількості лейкоцитів, що свідчить про його стимулюючий вплив на відновлення уражених тканин. У крові цих корів також зростала кількість еритроцитів та вміст гемоглобіну. Запропонований спосіб терапії з використанням розчину полтавського бішофіту виявив високу лікувальну ефективність, а тому може бути рекомендований як терапевтичний засіб за травматичних випотів у корів. Результати наукового дослідження мають практичну цінність для лікарів ветеринарної медицини, які забезпечують добробут тварин

Ключові слова: велика рогата худоба; добробут тварин; закриті механічні ушкодження; лімфа; полтавський бішофіт