Entomology and Applied Science Letters
Volume 9, Issue 4, Page No: 79-86

Available Online at: www.easletters.com

ISSN No: 2349-2864

Socio-Economic Aspects of the Development of Hirudotherapy in Russia

Musa Umarovich Turlaev[1], Arazdin Alimovich Shikhnebiev[2], Zalina Albertovna Kardanova[3], Makhach Magomedrasulovich Rokhoev[4], Karina Rifatovna Mutigullina[5], Radik Rashidovich Zakiev[5*], Olga Alexandrovna Baklanova[6], Igor Spartakovich Baklanov[6]

[1]Department of Therapy, Medical Faculty of Astrakhan State Medical University, Astrakhan, Russia.
[2]Department of Therapy, Pediatric Faculty of Astrakhan State Medical University, Astrakhan, Russia.
[3]Department of Therapy, Faculty of Medicine of Stavropol State Medical University, Stavropol, Russia.
[4]Department of Therapy, Medical Faculty of Dagestan State Medical University, Makhachkala, Republic of Dagestan, Russia.
[5]Department of Therapy, Medical Faculty of Kazan State Medical University, Kazan, Russia.
[6]Department of Philosophy, Humanitarian Institute of the North Caucasus Federal University, Stavropol, Russia.

ABSTRACT

Treatment with medical leeches, or hirudotherapy, is one of the most ancient examples of the use of the healing powers of wildlife in medical activities. In the modern world, hirudotherapy is an extremely relevant method of treating many diseases. On the one hand, this is due to the wide range of biotherapy methods, and on the other hand, the high risk of all kinds of complications from the use of synthetic drugs. Modern pharmacology, which has certainly achieved great success, often turns out to be powerless in the treatment of several diseases. Moreover, a whole series of diseases have appeared, which are called medicinal. Nevertheless, Russia is the only country in the world in which medical leeches are still used on par with medicinal treatments. Despite the rapid expansion of the pharmaceutical business, the tradition of using medical leeches remains in Russia, the effectiveness of which is confirmed by many long-term empirical studies of domestic and foreign scientists. The article presents the history of the development of hirudotherapy in the world and Russia, describes the social and economic reasons for the popularity of hirudotherapy, and also reveals the biological influence of hirudotherapy on the human body.

Keywords: Medical leech, Hirudotherapy, Insectotherapy, Traditional treatment, Salivary gland secret.

HOW TO CITE THIS ARTICLE: Turlaev MU, Shikhnebiev AA, Kardanova ZA, Rokhoev MM, Mutigullina KR, Zakiev RR, et al. Socio-Economic Aspects of the Development of Hirudotherapy in Russia. Entomol Appl Sci Lett. 2022;9(4):79-86. https://doi.org/10.51847/XKLFrCc9BH

Corresponding author: Radik Rashidovich Zakiev
E-mail ✉ ruslankalmykov777@yandex.ru
Received: 18/07/2022
Accepted: 30/11/2022

INTRODUCTION

Treatment with leeches originated in ancient times. Probably, even prehistoric people quite accidentally noticed the positive effect that follows the bite of a leech. References to the benefits of leeches are found in Persian, Hebrew, and ancient Indian texts [1]. Since bloodletting has been the most popular method of treating many diseases for thousands of years, hirudotherapy was considered one of the directions of this medical technique [2]. Independent treatment with leeches in those days had not yet become, because healers believed that leeches were necessary only to remove excess blood. The use of leeches instead of a knife was considered more convenient because the procedure was painless [3, 4].

In ancient times, the properties of leech saliva were not yet known. The ancient Roman naturalist Pliny the Elder, who lived in the first century A.D., in his "Natural History" described many animals with an indication of their significance for humans. He also compiled a detailed description of blood-sucking leeches, being the first of the ancient authors to draw attention to the positive changes in the human body resulting from the use of these worms. The scientist claimed that leeches help with "aches and all kinds of fever" [4].

Following Pliny, the largest Roman physician Claudius Galen (131-200) studied the possibilities of medical use of blood-sucking leeches. Another famous doctor of Ancient Rome, Aetius (335-454), spoke positively about bloodletting using pond leeches [1].

Tajik physician and philosopher Ibn Sina, better known as Avicenna, is considered one of the greatest luminaries of medieval oriental medicine. In the most significant of his writings, The Canon of Medical Science, Ibn Sina examines in detail the issues of hirudotherapy. Even then, the active use of medical leeches for therapeutic purposes began in concussion, kidney, liver, joint diseases, in the treatment of tuberculosis, epilepsy, hysteria, thromboembolic diseases, and many other diseases. It can rightly be said that this is one of the first in-depth studies in the field of leech treatment [5, 6].

However, the influence of the works of the Roman Galen on medieval European medicine turned out to be much more significant. This man, through his works on anatomy and pathology, determined the development of medical knowledge during the entire period of the Middle Ages, including methods of hirudotherapy [7, 8].

However, despite the authority of Galen and Avicenna, hirudotherapy was not very popular in Europe, and the reason for this was the inconstancy of the attitude to bloodletting. Initially, bloodletting was considered a very effective method of treatment. But when medical practice, especially in hospitals, passed into the hands of monks and another clergy, this type of treatment was banned. Of course, the ban also applied to hirudotherapy. Leeches at that time were treated exclusively by barbers, healers, and shepherds who kept ancient traditions [9].

In the Renaissance, doctors returned to the techniques of hirudotherapy. Already in the XVI century, leech treatment established its position in the UK, which is why English doctors at that time were called leeches, which can be roughly translated as "leeches". The heyday of this method of treatment falls at the end of the XVIII – the beginning of the XIX centuries when many believed that hemorrhage (including utilizing leeches) could save them from imminent death [10].

In France, where hirudotherapy was especially popular, up to 50 million leeches were used annually. It is known from Napoleon's records that 6 million leeches were imported from Hungary alone during the year to treat the soldiers of his army [11].

In general, there is an opinion in the scientific literature that the experience of using medical leeches for medicinal purposes dates back about 30 centuries. However, according to some authors, hirudotherapy is the oldest method of treatment and prevention, which originated in India and is associated with the name of the founder of Ayurveda Sri Dhanvantari, and is one of the main directions of Ayurveda, so the starting point of using medical leeches as a remedy should be considered the Dhanvantari era, which has been around 250 centuries [12].

Social reasons for the popularity of hirudotherapy in Russia

Due to the breadth and effectiveness of the use of hirudotherapy in the complex treatment of many diseases, we can study its social significance and relevance in comparison with many traditional methods of treatment.

Firstly, the socio-economic living conditions of Russians are increasingly forcing them to seek help from non-traditional methods of treatment, in particular, hirudotherapy, the cost of which, in the treatment of many diseases, is significantly lower compared to medications. Secondly, despite the achievements of scientific and technological progress, modern man remains inextricably linked with nature, and hirudotherapy can be considered a therapy of unity with nature, especially since its effectiveness in the treatment of many diseases is confirmed by numerous, long-term studies. Thirdly, every year the trust of Russians in traditional treatment and doctors in state clinics weakens due to bribery and the desire of many doctors to earn extra money for the expensive

treatment of patients. Fourth, if modern scientific (rational) medicine involves a lot of new chemical and synthetic means and methods of treating diseases that, by curing one organ, lead to the disease of another, then hirudotherapy is a natural method of treatment that has been proven for centuries.

The above reasons allow us to assume that due to difficult socio-economic conditions, high risks of treatment with traditional methods, as well as truly high efficiency, hirudotherapy retains its role in the life support system to the present time.

Thus, in the last decade, hirudotherapy has become an integral part of the treatment process of most medical institutions in Russia [13, 14]. Even though some time ago the method of treatment with leeches was defeated, modern research and the possibilities of hirudotherapy today are appreciated by the best medical specialists in our country and not only [15, 16]. According to leading Russian specialists, hirudotherapy in combination with the latest achievements of traditional medicine is a real opportunity to overcome dozens of serious diseases.

Biological significance of hirudotherapy

Modern research has proved that the leech should be considered as a single living, very complex and peculiar nonspecific irritant in relation to the human body as a whole, and not just a local method of mechanical extraction of blood from capillaries over the corresponding "problematic" organ [17]. Currently, it is recognized that leeches are the only means of bloodletting at the level of the microcirculatory bed, violations in which are the basis of damage to tissues and organs, their diseases, and further the body as a whole, and not just one problematic organ [18]. It is here that important metabolic processes take place for the body: the delivery of nutrients to cells and tissues through capillaries, arterioles, lymphatic vessels, and venules [19]. In 1884, J. Highcraft managed to obtain an extract from the body of a leech, which slowed blood clotting [20]. The extract served as the starting material for the isolation of an individual substance that prevented blood clotting and was called hirudin. Thus, it was only at the end of the last century that experimenters began to create the scientific foundations of hirudotherapy [1, 5].

The scientists concluded that the positive effect of hirudotherapy is due to the saliva of leeches, which enters the bloodstream during a hirudotherapy session. It turned out that the secret of the leech, which she injects into the patient during blood sucking, contains more than 100 biologically active substances, the structure of which has already been largely studied, and the mechanism of their action has been investigated [21-23].

Currently, it is established that microvessels expand at the site of the leech attachment, and in remote areas they narrow, providing blood outflow from deep-lying organs. The complex influence of reflex, vascular and humoral mechanisms, morphological, chemical, and biochemical changes in the blood lead to the restoration of the disturbed physiological set of adaptive reactions of the body to eliminate or limit the maximum effect of various pathogenic factors of the external or internal environment on it [24]. The consequence of treatment with leeches is the restoration of the constancy of the internal environment (homeostasis), for example, body temperature, arterial blood pressure, blood glucose, etc., limiting or ridding a person of the disease [25].

During hirudotherapy, a complex effect of a complex of factors exerted on animals (including biologically active substances administered to them) occurs. In many ways, the result of this effect is determined by the response of the organism itself, the nature of which is largely related to the peculiarities of physiological and pathological processes in the tissues in the prefixing zone [26]. An important mechanism of hirudotherapy is its reflex effect on the body, local and general. This mechanism takes effect from the moment of the leech bite, the irritating effect of the biologically active substances injected [27]. Impulses along the Zakharin-Ged zones are transmitted to certain segments of the spinal cord, reflexively changing the functions of the autonomic and central nervous systems [28]. According to some authors, the ability to absorb microbes (phagocytic activity) of neutrophils during treatment with leeches increases two to three times. The same processes are observed in the body of the leech itself. Purification of the sucked blood from microorganisms occurs not only due to phagocytosis in its intestinal canal

but also due to the same effect on them of the symbiont bacteria living in the leech [29].

It is known that the secret of the salivary glands of leeches does not affect the external mechanism of blood clotting stimulated by tissue thromboplastin, which is released when the integrity of the vessel is damaged. When studying the effect of leech saliva on platelet aggregation and adhesion, it was shown that the secret of leeches blocks the gluing of blood plates and their attachment to the damaged vessel wall. This action of the leech secretion is directly proportional to the dose of the injected secretion and does not depend on its antithrombin activity [30].

The secret of leeches inhibits the general adhesion and initial attachment of platelets to collagen by 60-70%, blocks the spreading of platelets on collagen, and the attachment of platelets from suspension to the surface of the spread platelets. In addition, the secret of the salivary glands can block the formation of a blood clot. The antithrombotic effect of the secret does not depend on its antithrombin activity and is more effective compared to highly purified hirudin preparations [31].

The hypotensive effect of hirudotherapy is due not so much to the mechanical unloading of the blood flow during hemorrhage, as to the action of low-molecular biologically active substances produced by medical leeches. The secret of the salivary glands of leeches reduces blood pressure to a normal value, and this effect persists for five to six days with both intravenous and oral administration of the drug. At the same time, the hypotensive effect of the leech secretion does not manifest itself in cases of initially normal values of these indicators [32].

Cholesterol-esterase and lipase activity were detected in the secret of the salivary glands. The formation of lipid swellings begins with the accumulation of lipoproteins in a vessel in combination with immunoglobulins, as well as fibrin, the formation of complexes of atherogenic lipoproteins with glucosaminoglycans of the interstitial tissue, which is combined with a change in the amino acid composition of elastin and leads to swelling of elastic fibers, fragmentation of the inner elastic membrane, fibrillization and swelling of the inner lining of vessels. During this period, fat spots of yellow, light yellow, or white colors are already visible macroscopically quite clearly. These are the lipid swellings that lead to the development of atherosclerotic changes in the future [33]. During experimental studies, it was found that prolonged intravenous administration of leech saliva to animals in a state of severe atherosclerosis led to a decrease in lipid swelling in the abdominal aorta from 48 to 9% and in the thoracic – from 21 to 2%. These results indicate the ability of leech secretion to reduce the signs characterizing the presence of atherosclerosis.

The external and internal health improvement that the leech has on the human body is due to several factors. First of all, it is a normalizing effect on the chain of reactions of the blood coagulation system. The biological meaning of the cascade of enzymatic reactions is that events develop with self-acceleration, that is, each subsequent stage is much shorter than the previous one [34].

Thus, a significant amplification of the primary signal is achieved in the cascade reaction. When the integrity of blood vessels is violated, the activation of the internal mechanism of blood clotting occurs, with more pronounced damage to the vascular wall, and the activation of the external mechanism of blood clotting occurs through the release of tissue thromboplastin. On the negatively charged surface of collagen, subendothelium, as well as on the surface of activated platelets, activation of blood clotting proteins occurs. The final stage of thrombosis is the formation of thrombin, followed by the conversion of fibrinogen into fibrin. The ability of the salivary gland secretion of medical leeches to inhibit vascular-platelet hemostasis is necessary for the extraction of blood by the leech, which is the only source of its nutrition [35]. The same ability of the secretion is necessary to maintain the liquid state of blood in the intestinal canal of the leech, which is a condition for its further effective digestion by exo- and endopeptidases. The action of the destabilize enzyme is aimed at dissolving clots of stabilized fibrin if they have formed in the intestinal canal.

Protease inhibitors, which are present in the secret of leeches and the contents of its intestinal canal, limit the action of vascular wall proteases, slowing down the digestion of pumped blood. The lipolytic activity of leech secretion is necessary for the metabolism of blood lipids. The same properties of the secret provide the

therapeutic effect of medical leeches in hirudotherapy. The ability to block trypsin and chymotrypsin protects physiologically active components from medical leeches from cleavage in the gastrointestinal tract of experimental animals when administered orally [36].

The evolutionarily developed type of nutrition of a medical leech also determines the specifics of the effect of its saliva on the blood clotting system. The strategy of this process is physiologically justified. Biologically active substances of leech saliva block the internal mechanism of blood clotting at the early stage of its activation. The secret of leeches blocks the activity of kallikrein and coagulation factor XII and also binds calcium ions. In addition, the secret of leeches blocks the adhesion and aggregation of platelets [37].

Thus, there is a rational blocking of the blood coagulation cascade at the level of the primary signal. The secret of leeches does not affect the activation of the external coagulation mechanism, which is caused by the release of tissue thromboplastin as a result of significant damage to the vascular wall. Let's assume that the anticoagulant potential of the leech secretion is not enough to prevent thrombosis and that a fibrin clot has nevertheless formed. In this case, destabilize, an enzyme of leech secretion, comes into effect, ensuring the destruction of stabilized fibrin. That is, there is a system of "Safety Net" of one antithrombotic mechanism by another [38, 39]. Biologically active substances produced by the leech have the ability to relieve vascular spasms, increase the supply of oxygen and other nutrients to tissues, expand them, reduce blood pressure, and have decongestant and analgesic effects. Leeches also have an anti-atherosclerotic effect due to the restoration of impaired blood circulation, increased blood circulation in the arteries, lymphatic and venous vessels, and improved fat metabolism, while reducing the tendency of the vascular wall to damage [40]. A particularly important feature of hirudotherapy is the elimination of disturbed intersystem interactions in the body, which cannot be achieved by any means and methods of chemotherapy.

Let's list a number of diseases in which hirudotherapy is successfully used. These are diseases of the cardiovascular system (hypertension, angina pectoris, heart failure); lung diseases (bronchitis, bronchial asthma), stomach (ulcer, gastritis), liver (hepatitis, cirrhosis); surgical diseases (furunculosis, abscesses, varicose veins, thrombophlebitis, trophic ulcers and wounds, acute mastitis, consequences injuries). **Table 1** shows the recommended number of leeches and the scope of their use, depending on the disease. The use of hirudotherapy proved to be effective in the treatment of gynecological diseases, urology, ophthalmology (glaucoma), inflammation of the paranasal sinuses, ear, etc. Thrombosis of the angular vein of the face, thrombosis of the brain sinuses, meningitis, brain abscess, sepsis – this is an incomplete list of dangerous, not-so-rare complications from boils and carbuncles in the face. Antibiotics are often powerless in such cases; the infiltration spreads rapidly, causing swelling of the eyes, and making it difficult to breathe. In these cases, two or three leeches give a tangible effect during the day, after which conventional physiotherapy methods allowed for fully restore health.

Table 1. Sucker sites and recommended number of leeches for various pathological conditions

The nature of the disease	The place of the leech prefix	Number of leeches
Head fullness	Coccyx area	3, rarely 5
In infectious diseases	Coccyx area	2, rarely 3-4
The threat of stroke	Coccyx area	4, rarely up to 7
Hyperemia of the spinal cord and its membranes	Coccyx area	5, rarely 6-7
Hemoptysis: without organic pathology (vegetoneurosis)	Coccyx area	2, rarely 3, never more than 5
Hemoptysis: in pulmonary tuberculosis, and **heart diseases**	Coccyx area	2, rarely 3-5, maybe 6-7

With stagnation in the liver (circulatory disorders in the portal vein)	Coccyx area	2-3, up to 5
Cholecystitis, pericholecystitis	Along the right hypochondrium	5, maybe 6-7
Inflammation of large hemorrhoids	Coccyx area	5, maybe 6-7

A number of studies explain the mechanisms of action of reflex therapy from the standpoint of the formation of skin-visceral connections in the process of embryogenesis. The bottom line is that the skin and nervous system are of ectodermal origin, the internal organs are meso- and endodermal. The connection of internal organs with the nervous system, and through it with the skin, is provided during organogenesis by the ingrowth of the nervous system into internal organs. Modern pharmacology, which has certainly achieved great success, often turns out to be powerless in the treatment of a number of diseases. Moreover, a whole series of diseases have appeared, which are called medicinal.

CONCLUSION

In the modern world, hirudotherapy is an extremely relevant method of treating many diseases. On the one hand, this is due to the wide range of biotherapy methods, and on the other hand, the high risk of all kinds of complications from the use of synthetic drugs. Modern pharmacology, which has certainly achieved great success, often turns out to be powerless in the treatment of a number of diseases. Moreover, a whole series of diseases have appeared, which are called medicinal. Nevertheless, Russia is the only country in the world in which medical leeches are still used on par with medicinal treatments. Despite the rapid expansion of the pharmaceutical business, the tradition of using medical leeches remains in Russia, the effectiveness of which is confirmed by many long-term empirical studies of domestic and foreign scientists.

ACKNOWLEDGMENTS: The authors are thankful to colleagues from North Ossetian State Medical Academy for consultancy during review.

CONFLICT OF INTEREST: None

FINANCIAL SUPPORT: None

ETHICS STATEMENT: None

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