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The Role of Society and Economy in Advancing Hirudotherapy in Russia

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ABSTRACT

Hirudotherapy, or medical treatment with leeches, is the oldest known method of utilizing nature's healing potential in medicine. Today, this practice remains highly relevant for addressing a variety of health conditions. Its continued use can be attributed both to the diverse applications of biotherapy and the increasing concerns about the side effects associated with synthetic pharmaceuticals. Despite significant advancements in pharmacology, there are still numerous diseases that remain challenging to treat, and a growing number of ailments have emerged as a direct result of medication use. Uniquely, Russia is the only country where medical leeches continue to be integrated into mainstream treatment alongside conventional pharmaceuticals. Even as the pharmaceutical industry is rapidly expanding, the tradition of hirudotherapy continues, supported by extensive empirical research conducted by both Russian and international scientists. This article reviews the historical evolution of hirudotherapy globally and within Russia, analyzes the socio-economic factors contributing to its sustained popularity, and examines its biological effects on the body.

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

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Introduction

The practice of using leeches for medical purposes dates back to ancient times. It is likely that early humans, by chance, observed the beneficial effects of leech bites. Historical references to the therapeutic value of leeches can be found in Hebrew, Persian, and ancient Indian writings [1]. For a long time, bloodletting was widely regarded as an effective treatment for numerous ailments, and hirudotherapy was considered a branch of this medical practice [2]. However, in its early days, leech therapy was not recognized as a standalone treatment—healers primarily used leeches to extract excess blood. Compared to the use of surgical blades, leeches offered a more convenient and painless alternative [3, 4].

The medicinal properties of leech saliva were unknown in very old times. The first-century Roman naturalist, Pliny the Elder, documented various animals and their significance to humans in his work *Natural History*. Among his observations, he described blood-sucking leeches in full detail and was the first known author to highlight their positive impact on the human body. He suggested that leeches could alleviate “aches and all kinds of fever” [4].

After Pliny’s work, Claudius Galen (131–200), one of Rome’s most influential physicians, explored the medical applications of leeches. Another notable Roman doctor, Aetius (335–454), also praised the effectiveness of pond leeches for bloodletting [1].

The renowned Iranian philosopher Ibn Sina, widely known as Avicenna, is considered the most influential figure in medieval oriental medicine. In his seminal work, *The Canon of Medical Science*, he provided a comprehensive analysis of hirudotherapy. Even at that time, medical leeches were actively employed for treating a wide range of conditions, including concussions, kidney and liver disorders, hysteria, joint diseases, epilepsy, tuberculosis, thromboembolic diseases, and several other ailments. His research stands among the earliest in-depth studies dedicated to the therapeutic use of leeches [5, 6].

Despite Avicenna’s contributions, the effect of the Roman physician Galen had a much greater impact on medieval European medicine. His extensive writings on anatomy and pathology shaped medical knowledge throughout the Middle Ages, including the application of hirudotherapy [7, 8].

Despite the authority of both Galen and Avicenna, hirudotherapy did not gain widespread acceptance in Europe due to shifting perspectives on bloodletting. Initially regarded as a highly effective treatment, bloodletting was later prohibited when medical practices in hospitals came under the control of monks and clergy, who opposed the procedure. As a result, hirudotherapy was relegated to non-medical practitioners such as barbers, shepherds, and folk healers who preserved ancient traditions [9].

With the arrival of the Renaissance, medical professionals revisited the practice of hirudotherapy. By the 16th century, leech therapy had gained a strong foothold in the United Kingdom, where physicians were even referred to as “leeches,” a term historically associated with their use of the creatures in treatment. The method reached its peak in the late 18th and early 19th centuries when a lot of people believed that controlled blood loss, including the use of leeches, could be lifesaving [10].

France emerged as one of the leading countries in the use of hirudotherapy, with an annual demand of up to 50 million leeches. Records from Napoleon’s era indicate that over six million leeches were imported from Hungary in a single year to treat wounded soldiers in his army [11].

In general, there is an opinion in the scientific literature that the experience of medical leeches use for medicinal purposes dates back about thirty 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 the main direction of Ayurveda, so the starting point of using leeches as a remedy should be considered the Dhanvantari era, which has been around 250 centuries [12].

This article explores the historical evolution of hirudotherapy globally and within Russia, analyzes the socio-economic factors contributing to its sustained popularity, and examines its biological effects on the body.

Results and Discussion

Social factors behind the popularity of hirudotherapy in Russia

The widespread use and effectiveness of hirudotherapy in treating various medical conditions highlight its social significance, especially when compared to conventional treatment methods.

Firstly, the socio-economic realities in Russia increasingly drive people toward alternative treatments, including hirudotherapy. For many ailments, this method proves to be a far more affordable option compared to costly pharmaceutical treatments. Secondly, despite advancements in science and technology, people remain deeply connected to nature. Hirudotherapy aligns with this connection, offering a natural healing approach backed by extensive long-term research confirming its effectiveness.

Another key factor influencing its popularity is the growing distrust in state healthcare institutions. Corruption, bribery, and the financial motivations of some doctors—who push patients toward expensive treatments—have led many Russians to seek alternative therapies. Additionally, while modern medicine relies heavily on synthetic drugs and chemical-based treatments, which often cure one ailment while causing side effects in another part of the body, hirudotherapy provides a time-tested, natural alternative with minimal risks.

Given these challenges—economic difficulties, risks associated with conventional medicine, and the demonstrated effectiveness of hirudotherapy—it continues to play an important role in healthcare today. Over the past decade, this practice has been increasingly integrated into mainstream medical institutions across Russia [13, 14]. While leech therapy was once considered outdated, modern research has restored its credibility. Today, top medical experts in Russia and beyond recognize its potential. Leading specialists believe that when combined with advancements in traditional medicine, hirudotherapy offers a viable solution for combating numerous serious illnesses [15, 16].

Biological significance of hirudotherapy

Recent studies have demonstrated that a leech should be viewed as a complex, living biological agent that affects the whole body rather than merely a tool for mechanically drawing blood from capillaries near a problematic organ [17]. Today, it is widely accepted that leeches are the only natural method capable of bloodletting at the microcirculatory level, where disruptions often lead to tissue and organ damage, disease progression, and ultimately systemic health issues rather than just localized problems [18]. This microcirculatory system plays a crucial role in metabolism, as it facilitates the delivery of essential nutrients to cells and tissues through lymphatic vessels, capillaries, arterioles, and venules [19].

A significant breakthrough occurred in 1884 when J. Highcraft successfully extracted a substance from leech tissue that was found to slow blood clotting [20]. This discovery led to the isolation of hirudin, a compound that prevents coagulation, laying the foundation for the scientific study of hirudotherapy by the 19th century [1, 5]. Researchers later confirmed that the therapeutic benefits of leech therapy stem primarily from the biologically active components in leech saliva, which are introduced into the bloodstream during treatment. It has been determined that leech secretions contain over one hundred biologically active substances, many of which have already been identified and extensively studied for their mechanisms of action [21-23].

Further research has shown that when a leech attaches to the skin, microvessels in the immediate area dilate while those in distant regions constrict, facilitating the drainage of blood from deeper organs. This interaction triggers a complex response involving vascular, reflex, and humoral mechanisms, along with various morphological, chemical, and biochemical changes in the blood. These processes help restore the body's natural physiological adaptations, allowing it to counteract or minimize the effects of harmful external and internal factors [24]. Ultimately, hirudotherapy contributes to the stabilization of the body's internal environment (homeostasis), regulating parameters such as arterial blood pressure, body temperature, and blood glucose levels, and in many cases, alleviating or eliminating disease symptoms [25].

Hirudotherapy exerts a multifaceted influence on the body, primarily through the interaction of various biological factors, including the bioactive substances introduced during treatment. The effectiveness of this therapy largely depends on the body's response, which is influenced by both pathological and physiological processes occurring in the treated area [26].

One of the key mechanisms of hirudotherapy is its reflexive impact, both localized and systemic. This response begins the moment a leech attaches to the skin, triggering a reaction due to the biologically active compounds it injects [27]. Neural impulses travel through the Zakharin-Ged zones to specific segments of the spinal cord, leading to reflexive modifications in the central and autonomic nervous systems [28].

Some studies suggest that leech therapy significantly enhances the phagocytic activity of neutrophils, increasing their ability to absorb microbes by two to 3 times. Interestingly, a similar process occurs within the leech itself. The blood it ingests undergoes microbial purification not only through phagocytosis in its digestive tract but also because of the antibacterial properties of the symbiotic bacteria residing in the leech's body [29].

Research has demonstrated that the secretion from leech salivary glands does not interfere with the external pathway of blood coagulation, which is typically triggered by tissue thromboplastin when a blood vessel is damaged. However, studies on its influence on adhesion and platelet aggregation have revealed that leech saliva effectively prevents blood platelets from clumping together and attaching to the injured vessel walls. The extent of this inhibition is proportional to the amount of secretion introduced and remains independent of its antithrombin properties [30].

Furthermore, leech saliva significantly reduces platelet adhesion and their initial attachment to collagen by 60–70%. It also hinders the spreading of platelets on collagen surfaces and their binding from suspension to already attached platelets. Additionally, the secretion plays a crucial role in preventing the formation of blood clots. Unlike

purified hirudin-based treatments, the anticoagulant effect of leech saliva is more potent and operates through mechanisms unrelated to direct antithrombin activity [31].

The blood pressure-lowering effects of hirudotherapy are primarily attributed to biologically active low-molecular-weight compounds secreted by leeches rather than simply to blood loss. These compounds help normalize blood pressure levels, with their effects lasting for approximately 5-6 days after administration, whether through intravenous or oral routes. Notably, this hypotensive action is observed only in cases of elevated blood pressure and does not affect individuals with already normal levels [32].

Additionally, leech saliva contains enzymes such as cholesterol-esterase and lipase, which play a role in lipid metabolism. The formation of fatty deposits within blood vessels begins when lipoproteins accumulate and interact with immunoglobulins, fibrin, and glycosaminoglycans in the interstitial tissue. This interaction alters the amino acid structure of elastin, leading to swelling, fragmentation of elastic fibers, and eventual thickening of the blood vessel lining. These early lipid deposits, visible as yellow or white fat spots, serve as precursors to atherosclerosis [33].

Experimental studies have shown that prolonged intravenous administration of leech saliva in animals with advanced atherosclerosis resulted in a significant reduction in lipid deposits within blood vessels. In the abdominal aorta, lipid swelling decreased from 48% to 9%, while in the thoracic aorta, it dropped from 21% to just 2%. These findings suggest that leech secretion has a remarkable ability to mitigate the progression of atherosclerosis, offering a potential avenue for therapeutic intervention.

The beneficial effects of leech therapy on human health, both externally and internally, are attributed to several key mechanisms. One of the most significant is its regulatory influence on the complex sequence of reactions within the blood coagulation system. The enzymatic cascade involved in clotting operates with increasing speed at each stage, meaning that every subsequent step in the process occurs more rapidly than the last one, leading to an amplified response [34].

In the event of vascular injury, the body's coagulation system is activated. Minor damage primarily triggers the internal clotting pathway, while more severe vascular wall disruptions initiate the external pathway through the release of tissue thromboplastin. Coagulation proteins become active on negatively charged surfaces such as collagen, subendothelium, and activated platelets. The final phase of this process results in thrombin formation, which subsequently converts fibrinogen into fibrin, leading to the development of a clot. The secretion from medical leeches effectively inhibits vascular-platelet hemostasis, a function essential for their ability to extract blood, which serves as their primary source of sustenance [35].

Additionally, this anticoagulant property plays a crucial role in maintaining the liquid state of ingested blood within the leech's intestinal canal. This fluidity is essential for the efficient breakdown of blood by digestive enzymes, including exo- and endopeptidases. Moreover, the destabilized enzyme within leech saliva dissolves any stabilized fibrin clots that may form in the intestinal tract, ensuring the continuous digestion and utilization of the absorbed blood.

The salivary secretions and intestinal contents of leeches contain protease inhibitors that effectively limit the action of vascular wall proteases, thereby slowing the digestion of the ingested blood. The lipolytic activity within leech secretion is also crucial for metabolizing blood lipids, contributing to the therapeutic effects observed in hirudotherapy. Furthermore, these properties play a vital role in the protective function of leech components when administered orally, particularly by blocking enzymes like trypsin and chymotrypsin, which prevents the breakdown of these active substances in the gastrointestinal tract of test animals [36].

The medical leech's evolved feeding strategy is closely linked to the unique influence its saliva has on the blood clotting process. This biologically adaptive mechanism is physiologically sound. Active compounds in the leech's saliva block the internal clotting pathway early on by inhibiting key factors such as kallikrein and coagulation factor XII, as well as binding to calcium ions. Additionally, leech saliva prevents the adhesion and aggregation of platelets [37].

This sophisticated mechanism effectively halts the blood coagulation cascade at the early stages of activation. While the secretion does not interfere with the external coagulation pathway triggered by significant vascular damage and the release of tissue thromboplastin, it serves a critical purpose when a fibrin clot forms. In this case, the destabilized enzyme from the leech secretion is activated to break down the stabilized fibrin clot, providing a "safety net" effect, where one antithrombotic mechanism complements and supports another [38, 39].

The biologically active compounds found in leech saliva offer a range of therapeutic effects on the human body. These substances help alleviate vascular spasms, improve the delivery of oxygen and nutrients to tissues, and

promote the dilation of blood vessels. Additionally, they contribute to lowering blood pressure, reduce swelling, and provide pain relief. Leeches are also beneficial in combating atherosclerosis by improving blood flow in the arteries, veins, and lymphatic vessels, enhancing fat metabolism, and reducing the risk of vascular wall damage [40]. A key advantage of hirudotherapy is its ability to restore disrupted intersystem interactions within the body, a benefit that cannot be achieved through chemotherapy or other conventional treatments.

Hirudotherapy has been successfully applied to treat a variety of conditions, including cardiovascular diseases (such as hypertension, angina, and heart failure), respiratory issues (such as bronchitis and asthma), digestive disorders (like ulcers and gastritis), liver diseases (such as hepatitis and cirrhosis), and a range of surgical conditions. **Table 1** outlines the number of leeches suggested and their application for various diseases. Moreover, leech therapy has proven effective in treating gynecological conditions, urological issues, eye diseases like glaucoma, and sinus and ear inflammations.

Leeches are also a valuable treatment for serious complications such as thrombosis of the angular vein of the face, brain sinus thrombosis, meningitis, brain abscesses, and sepsis, which can arise from facial boils or carbuncles. In cases like these, where antibiotics are often ineffective, leeches can provide significant relief. Just a few leeches can have a marked impact within a day, enabling subsequent conventional treatments to 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
Hemoptysis: in pulmonary tuberculosis, and heart diseases	Coccyx area	2, rarely 3-5, maybe 6-7
Hemoptysis: without organic pathology (vegetoneurosis)	Coccyx area	2, rarely 3, never more than 5
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
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
Head fullness	Coccyx area	3, rarely 5
In infectious diseases	Coccyx area	2, rarely 3-4

Several studies have explored the mechanisms behind reflex therapy, focusing on the forming the skin-visceral connections during embryonic development. Essentially, both the skin and nervous system originate from the ectoderm, while the internal organs arise from the mesoderm and endoderm. The link between the internal organs and the nervous system, and consequently with the skin, is established during organogenesis through the integration of the nervous system into the internal organs. Despite the significant advancements in modern pharmacology, there are still numerous conditions that remain resistant to treatment, and a range of so-called “medicinal” diseases has emerged as a result.

Conclusion

In today’s world, hirudotherapy remains a highly relevant approach for treating a variety of ailments. This is partly because of the diverse range of biotherapy options available and partly due to the growing risks associated with synthetic drugs. While modern pharmacology has made significant strides, it often fails to effectively treat certain conditions, and many new diseases, referred to as “medicinal,” have emerged as a result. Notably, Russia stands out as the only country where medical leeches are still widely used alongside conventional medical treatments. Despite the rapid growth of the pharmaceutical industry, the practice of hirudotherapy continues in Russia, with its efficacy supported by numerous long-term empirical studies conducted by both domestic and international researchers.

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