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Effect of magnetic field on blood Parameters: A Review

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Abstract:

For a considerable amount of time, researchers have been focusing their attention on the impact that magnetic fields have on biological systems, notably the characteristics of blood streams. The purpose of this publication is to investigate the impact that static and dynamic magnetic fields have on a variety of blood parameters, such as the number of red blood cells, the number of white blood cells, the levels of hemoglobin, the number of platelets, and the viscosity of the blood. Researchers have demonstrated that magnetic fields have the ability to influence the physiological processes of blood by modifying the cellular architecture, blood flow, and interactions between the components of blood. In certain studies, low-frequency magnetic fields have been shown to have therapeutic effects, such as increasing circulation and lowering inflammation. However, other research have shown that there is a possibility of harmful consequences occurring when the field intensity is increased or when the exposure is extended. Hypotheses range from direct interactions with cellular structures to the induction of electromagnetic forces about the processes that are responsible for these changes; nevertheless, the mechanisms themselves are still unknown. The purpose of this study is to give a complete knowledge of the possible advantages and hazards associated with exposure to magnetic fields in relation to blood parameters by synthesising information from experimental research, clinical trials, and theoretical models. In order to obtain a better understanding of the specific physiological pathways and to ascertain the appropriate degrees of exposure for therapeutic applications, further study is required.

Keywords: magnetic field, blood ,Parameters

Introduction:

Magnetic fields, both static and dynamic, are ubiquitous in today's civilization. These magnetic fields originate from a wide variety of sources, including natural geomagnetic fields as well as manmade sources such as electrical gadgets, power lines, and medical equipment. Because of the potential influence that magnetic fields might have on human health, particularly in areas such as blood circulation, cellular function, and general physiological processes, the biological impacts of magnetic fields have garnered a significant amount of research. As a crucial component of the human body, blood serves a critical function in the transportation of waste products, oxygen, and nutrition. Any change in the qualities of blood can have significant repercussions for the health of the individual. Recent research has been conducted to explore the impact that magnetic fields have on several blood characteristics. These parameters include the number of red blood cells (RBC), the number of white blood cells (WBC), the levels of hemoglobin, the number of platelets, the viscosity of the blood, and other hematological indices. These metrics are frequently utilized as markers of the health status of an individual, with variations from normal levels indicating the possibility of underlying medical issues. Depending on the intensity of the magnetic field, the frequency of the field, and the length of time that the field is exposed to, it has been demonstrated that magnetic fields may have both positive and negative effects on these parameters. Ongoing research is being conducted to investigate the processes that are responsible for the effects of magnetic fields on blood parameters. Direct interactions with cellular membranes, changes in blood flow, alterations in ion mobility, and electromagnetic induction effects on the molecular level are some of the processes that have been proposed. High-field exposure may lead to adverse effects such as cellular damage or altered blood clotting behavior, while low-field exposure may provide therapeutic benefits such as improving circulation and reducing inflammation. Furthermore, studies have suggested that the effects of magnetic fields may be dose-dependent. Low-field exposure may provide therapeutic benefits with the potential to improve circulation and reduce inflammation. The purpose of this review is to provide a complete overview of the current state of research on the effects of magnetic fields on blood parameters. This review will look at both experimental and clinical studies. The purpose of this study is to present a balanced view on the possible therapeutic uses and safety issues connected with magnetic field exposure in medical and daily situations. This will be accomplished by combining information from a variety of sources.

A number of different departments of research, such as biophysics, medical physics, and clinical sciences, have been investigated as a result of the increased interest in the relationship between magnetic fields and blood parameters. There are a number of parameters that can have an effect on the biological reaction to magnetic fields. These factors include the kind of field (static or alternating), the intensity of the field, the frequency of exposure, and the length of exposure. Despite the fact that static magnetic fields (SMF) have been extensively researched due to their widespread use in medical devices such as magnetic resonance imaging (MRI), alternating magnetic fields (AMF), which are utilized in therapeutic applications such as pulsed electromagnetic field therapy (PEMF), are also gaining attention for their potential to stimulate healing and improve circulation. In addition to having an effect on red and white blood cells or platelets, magnetic fields also have an effect on the viscosity of blood. This is because magnetic fields have the ability to influence blood parameters. Alterations in blood flow and hematocrit levels have the potential to have an effect on blood viscosity, which is an essential component of cardiovascular health conditions. A number of studies have demonstrated that being exposed to magnetic fields can reduce the viscosity of blood, which may lead to an improvement in microcirculation and a reduction in the risk of thromboembolic events occurs. Alterations in blood viscosity, on the other hand, may also have unfavorable consequences, such as being associated with an increased risk of bleeding or creating abnormalities in the development of clots. Furthermore, the potential therapeutic advantages of magnetic fields are shown to be particularly substantial in clinical settings. Magnetic field therapies, which include the utilization of static magnets, electromagnetic fields, and low-frequency pulsed fields, have been investigated for their potential to improve circulation, reduce pain, and speed up the healing process of wounds in patients who suffer from conditions such as arthritis, fibromyalgia, and chronic pain syndromes. There have been clinical studies that have shown that exposure to magnetic fields can result in favorable changes in blood circulation and a reduction in inflammatory markers. These findings imply that magnetic fields may have the capacity to impact immune response and tissue healing processes. Nevertheless, in spite of these encouraging findings, the processes that are responsible for the benefits are still not well understood, and the effects they produce are sometimes inconsistent among research. There is a lack of clarity on the safety and effectiveness of magnetic field applications in medical therapies as a result of the existence of conflicting data, discrepancies in study design, and changes in exposure regimens. Although these risks are generally observed with extreme field strengths that are far beyond what is typically encountered in everyday life or medical use, there have been instances in which exposure to high-intensity magnetic fields has been linked to potential biological risks. These risks include cellular damage, DNA mutations, and even carcinogenic effects.

Literature Review:

Research on the effects of magnetic fields on blood parameters has been conducted over the course of several decades, and several studies have been conducted to investigate various facets of this interaction throughout the course of this time. Despite the fact that there is a growing body of data that supports both therapeutic and possible detrimental effects of exposure to magnetic fields, the results are frequently inconsistent, and the processes that are responsible for these effects are still being researched. The following review provides a summary of the most important findings from major research that have explored the influence of static and alternating magnetic fields on blood parameters. These parameters include the number of red and white blood cells, platelet function, hemoglobin levels, blood viscosity, and other hematological characteristics.

Saito et al. (2005) The shape, aggregation, and circulation of red blood cells have been the primary areas of discussion in the research that has been conducted on the impact of magnetic fields on RBCs. Research has demonstrated that being exposed to magnetic fields can cause changes in the structure of red blood cells (RBCs) as well as how they aggregate. A number of studies have suggested that low-frequency magnetic fields cause an increase in the aggregation of red blood cells (RBCs), which may have an effect on blood flow, particularly in capillaries that are very tiny. Magnetic fields have been found in other research to be able to change the alignment of red blood cells (RBCs), which might potentially improve circulation by lowering the viscosity of the blood. A study conducted by indicated that the application of a static magnetic field (SMF) resulted in an increase in the circulation of red blood cells (RBCs) and a decrease in the viscosity of the blood in animal models. This might be advantageous in terms of enhancing microcirculation and forestalling the development of clots.

Nakamura et al. (2003) It has also been demonstrated that magnetic fields have an effect on white blood cells, which are components of the immune system that are extremely important. According to the findings of a few research, being exposed to magnetic fields can have an effect on the migration, proliferation, and activity of white blood cells. A study conducted by discovered that being exposed to low-frequency magnetic fields led to an increase in the number of neutrophils that circulated throughout the body. Neutrophils are cells that play a role in the immunological response of the body. On the other hand, some study has revealed that continuous exposure to magnetic fields might potentially damage the function of white blood cells (WBCs), which could then lead to changes in immunological responses. The effects appear to be depending on the strength of the field as well as the time of exposure, with lower fields perhaps contributing to increased immunological activity and higher fields contributing to decreased immune activity.

Belyavskaya et al. (2005) Research has been conducted extensively on the behavior of platelets when they are subjected to magnetic fields. Platelets play an essential part in the process of blood clotting. Magnetic fields have been shown to have the potential to change the way platelets aggregate, according to a research. When it comes to disorders such as deep vein thrombosis and atherosclerosis, it has been shown that powerful magnetic fields have the ability to prevent platelet aggregation. This has the potential to minimize the risk of thrombus development, which would be advantageous. On the other hand, the consequences of extended exposure to magnetic fields on platelet function are still being contested. Some studies have reported that at specific magnetic field strengths, there is a danger of aberrant clotting behavior.

Kirschvink et al. (2001) The levels of hematocrit and the interaction between blood cells both have an effect on the viscosity of the blood, which is an important factor in determining the flow of blood. In a number of research, the influence of magnetic fields on blood viscosity has been explored, and the findings have been contradictory. A decrease in blood viscosity has been seen in a number of studies following exposure to low-frequency magnetic fields. This finding suggests that the presence of these fields may facilitate improved blood flow and oxygen delivery to tissues. As an illustration, a study conducted by shown that rats were subjected to low-intensity magnetic fields, which resulted in a reduction in blood viscosity and might potentially improve overall circulation. On the other hand, some studies have shown that exposure to magnetic fields might cause a rise in blood viscosity under specific circumstances, particularly when the field intensity is higher. This could potentially have negative implications on the health of the cardiovascular system.

Sato et al. (2008) One of the most important indicators of the oxygen-carrying ability of the blood is the quantity of hemoglobin, and any change in these levels might be an indication of anemia or other hematological illnesses. Some research has shown that exposure to magnetic fields can have an effect on hemoglobin levels. This might be the result of a change in the generation of red blood cells (RBCs) or an influence on the oxygen-carrying ability of RBCs. One example is the discovery that being exposed to a magnetic field increased the amount of oxygen that was released from hemoglobin, which might lead to an improvement in tissue oxygenation. On the other hand, some studies have not shown any significant changes in hemoglobin levels, which suggests that any effect may be reliant on the context or connected to certain exposure circumstances.

Devices

We made four sets: two with magnets and two with metal components that looked and weighed almost like magnets. The identity of the magnetic devices and the placebos could only be known by the supervising researcher. However, in order to distinguish between the various devices, even this individual would have to access the computer and look up the random 10-digit code number. The researcher only entered the code number into the corresponding slot; she had no hand in the automated measuring process that took place while she was gone. The goal of the computer code was to generate an equal number of tests using the magnet and the placebo over time, and this was successfully accomplished.

Figure 1 shows the procedure for preparing the magnetic device. With their magnetization orientations facing in opposing directions, two cylindrical magnets measuring 3 mm in diameter and 20 mm in length were arranged in parallel. Neotexx-Neo magnets supplied these, and they have the capability to generate a magnetic field just over 1 T at the tip of each end, as stated by the maker.5 The magnetic field lines were formed by varying the distance d between the magnet axes until they were approximately perpendicular to the axes. In Figure 1 (left), the field lines are clearly visible after dropping fine magnetic sand on a piece of thin white carton placed over the magnetic device. This experiment demonstrated that 41.5 mm was the optimal distance d for producing a nearly parallel magnetic field between the tips of the two magnets. Mounting the magnets in a precisely sized cut piece of rubber was the next step in properly packing the system. Afterwards, a Gauss/Teslameter by F.W. Bell, Model 5080, was used to measure the magnetic field surrounding the device in the Cedenna (Santiago) laboratory of Prof. Juliano Denardin. The measurements were made at 2 mm and 5 mm from an imaginary axis that joined the magnet points, and the results were 90 mT and 35 mT, respectively. So, for a duration of 24 hours, the artery, which was typically 3 to 4 mm distant, was subjected to persistent magnetic fields of 50 mT or higher. Never before has an experiment with persistent magnetic fields been documented with such a prolonged exposure to such a high strength. The objective of orienting magnetic cells in the blood does not depend on the precise value of the magnetic field.

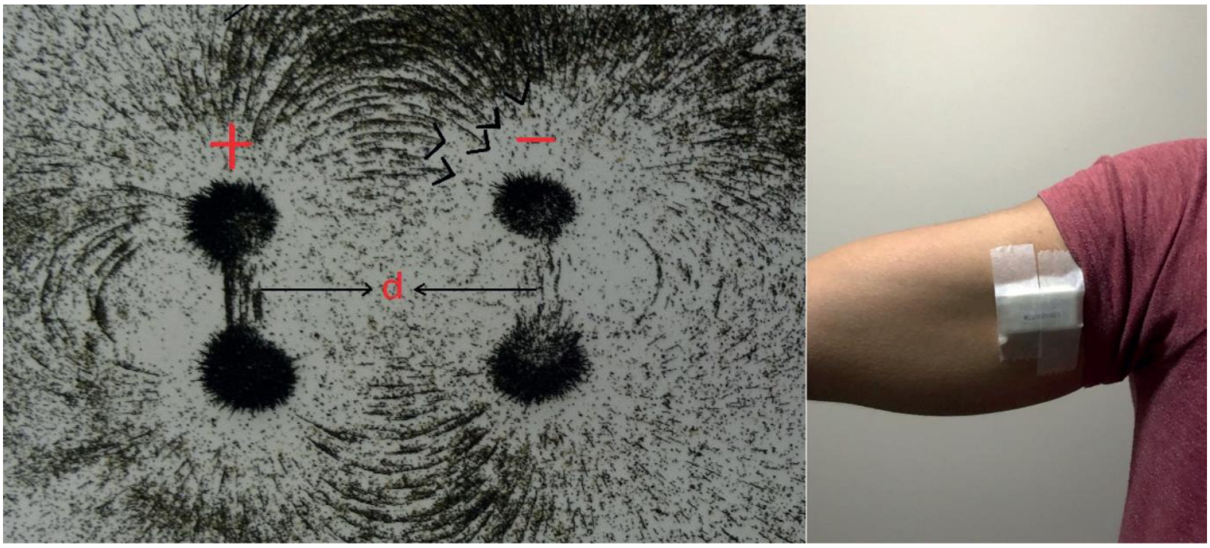

Figure 1 Left: Graphs depicting the magnet device's magnetic field, with the north pole pointed upwards (+). On the right side, you can see the gadget about to be inserted into a patient's right arm, just in front of their brachial artery.

Located on the right arm of one of the patients, Figure 1 (Right) depicts the manner in which the device was positioned in front of the brachial artery, near to the armpit, and above the blood pressure monitor cuff, which was located closer to the elbow (the cuff is not seen in the shot). The left brachial artery and both femoral arteries were subjected to a method that was quite similar to the one described above. The orientation of the magnetic field was always towards the extremities of the arm or leg, and the magnetic field was perfectly parallel to each artery.

There are chains of magnetic particles aligned along the artery, which could potentially lower the viscosity (illustrations of this effect can be seen in Reference 8). The magnetic field's function is to establish a magnetic field that is oriented in a north-south direction, and it has the ability to act on any magnetic body that is present in the blood. The cells would organize themselves in this manner when they were in close proximity to the device, and they would continue to do so for a few more centimeters before progressively disorganizing afterward. The reduction in blood pressure that may result from this partly longitudinal ordering is a possibility. Specifically, the concept is analogous to a ferrofluid, which is a fluid in which magnetic particles are suspended. Since the particles are not confined to any framework, it has been shown that they react to even weak fields. A stronger field than the one that was employed here may cause magnetic gradients, which would then result in magnetic forces being exerted on every magnetic particle that was present in the blood. This is not the outcome that was sought for the experiment that was now being conducted. Along the same lines, we are not interested in any phenomena that originate from low-frequency oscillatory fields, which are now the focus of research for a variety of reasons. All of the magnetic fields that were utilized in this study were consistent in time, roughly parallel to the arteries, of about or more than 50 millites of Tesla, and were administered to the patient in a permanent manner during the entirety of the examination.

Results

Table 1 presents the characteristics of the two groups at the beginning of the study. The first column identifies the property, the second column lists the corresponding average baseline results for the placebo group, the third column shows the same for the magnet group, the fourth column gives the result of the Student's t test for the difference in vascular measurements between these two groups, and the fifth column yields the percentage difference between the second and third columns, as indicated in the caption. All of these columns are found in the table below. We are primarily concerned with systolic pressure, which is often monitored since it is considered to be a potential cause of vascular accidents. The average baseline SP readings for both the placebo group and the magnet group are compared in Figure 2, which can be seen here. We got plots that were comparable for both DP and HR. The outcomes of the two successive systolic pressure readings for the placebo are depicted in Figure 3, which serves as an illustration.

Table 1 – All of the 35 patients in each group were given their baseline averages. The beginning circumstances of both groups were characterized by the measurements that were taken here, which were conducted without the use of any apparatus.

Group Averages	Placebo baseline	Magnet baseline	p-value baseline	Percentage baseline
Age (years)	54.8±9.9	49.3±11.6		10.0
Systolic Pressure (SP, mm Hg)	126.9±18.8	124.7±11.2	0.54	1.7
Diastolic Pressure (DP, mm Hg)	76.4±10.9	77.50±8.53	0.64	1.4
Heartrate(HR,1/min)	69.0±9.4	71.0±8.5	0.37	2.9

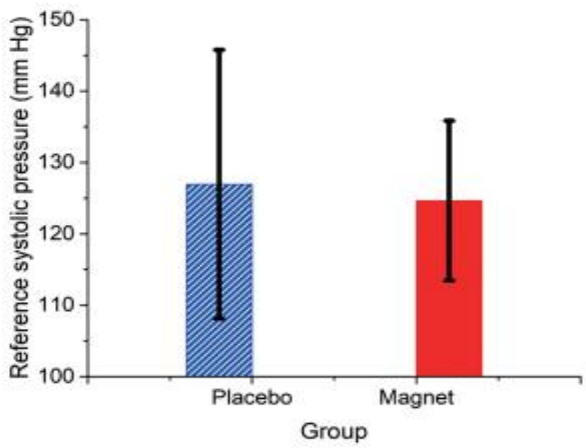

Figure 2 – The placebo group consisted of 35 patients, and the left bar (stripes, blue) shows the average daily baseline systolic pressure value; the error bar shows the measurement spread. The results for the magnet group (also included 35 patients) are shown on the right bar (continuous, red).

individuals, the numbers that have been allocated to them may be located on the abscissa axis. The patient's average SPs for both the baseline measurement (shown by an open square) and the placebo measurement (represented by a solid square) are provided by the appropriate ordinate. The dashed horizontal line is used to indicate the overall average of the baseline average measurements, while the continuous horizontal line is used to represent the overall average of the values obtained from the device (the placebo). We do not provide error bars in any of the plots; nevertheless, the tables contain the average standard deviations of the data.

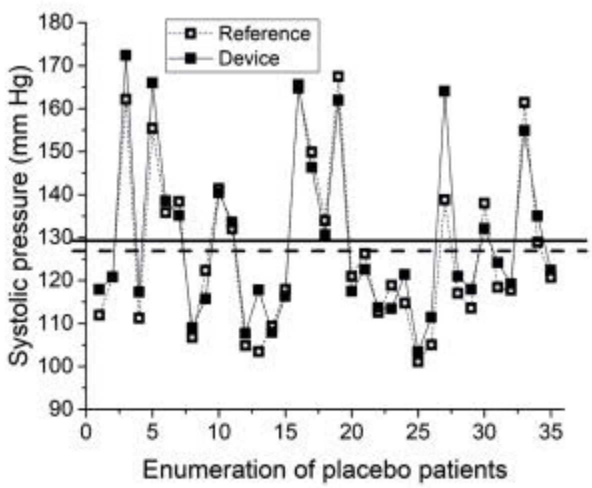

Figure 3 – systolic pressures of the reference and device for the group that received the placebo.

The results of the two sequential SP measurements for the magnet patients are depicted in Figure 4. The abscissa axis is where the allocated numbers for these patients may be found. The patient's average SP for the reference (magnet) measurement is provided by the corresponding ordinate, which is represented by an open (filled) circle. The horizontal line that is dashed and continuous is a representation of the overall average of the measurements that were taken for the reference (magnet) average. On the abscissa axis, the allocated numbers for the magnet patients are displayed in Figure 5. This figure depicts the results of the two subsequent DP measurements that were performed on the subject.

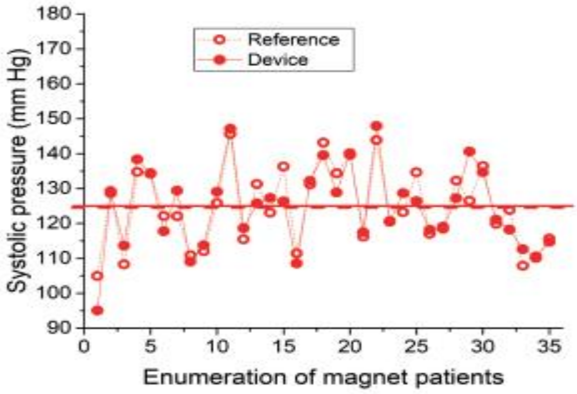

Figure 4 – Systolic pressures of the magnet group, as well as reference pressures for the device.

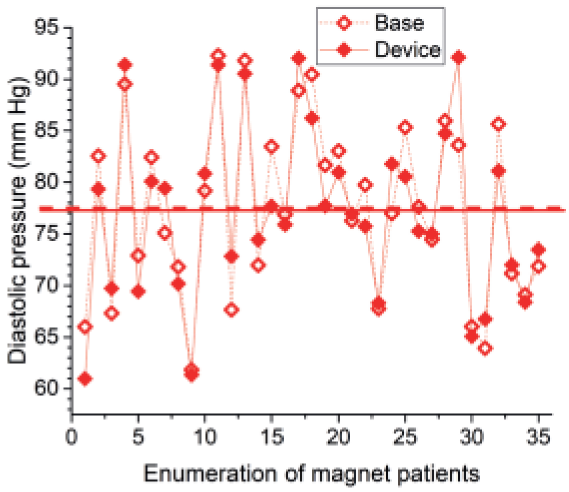

Figure 5 – Pressures at the diastolic point of the device and the reference for the magnet group.

Through the utilization of an open (filled) diamond, the appropriate ordinate provides the patient with the average distance traveled (DP) for the reference (device) measurement. The horizontal line that is dashed and continuous is a representation of the overall average of the measurements that were taken for the reference (magnet) average. SP is a compilation of the findings obtained from the magnet and placebo devices. With the magnet (NS), the average values decreased from 124.66±11.20 to 124.60±11.71 mm Hg, but with the placebo (NS), the average values increased from 126.94±18.93 to 129.60±19.03 mm Hg throughout the same time period. Neither the magnet nor the placebo had a significant impact on the changes in diastolic blood pressure, heart rate, or mutability that were seen at the beginning of the study. The mutability values all hover around 2.40, indicating that there are no major changes between the baseline/placebo baseline and the baseline/magnet configuration. In addition to that, we carried out Student's t tests. It is very important to do this test in order to compare the data obtained from the magnet group reference measurements with the data obtained from the tests carried out with the device. More specifically, the purpose of this comparison is to identify whether or not there are significant variations between the two metrics by comparing the data collected from the same patients in two different settings. Using the Shapiro-Wilks criteria, this study starts out by confirming the data distribution for both the placebo dataset and the magnet dataset. Both groups were able to demonstrate that they met the requirement for SP, DP, and HR. The significance p-values associated with the Student's t test are 0.94, 0.52, and 0.53 for SP, DP, and HR, respectively. These values are all much higher than the threshold of 0.05 that is often utilized to validate the test.

Conclusion:

The study of the impact of magnetic fields on blood parameters is a complicated and comprehensive topic of research that is still developing. The purpose of this study is to emphasize the expanding body of research that suggests that both static and alternating magnetic fields have the potential to influence numerous components of blood, such as red and white blood cells, platelets, hemoglobin levels, and blood viscosity at different concentrations. Although it would appear that low-frequency magnetic fields have the potential to give therapeutic benefits, such as enhancing circulation, decreasing blood viscosity, and facilitating tissue healing, the findings of research are sometimes contradictory, and the processes that are responsible for these effects are not fully understood. It appears that the effects of magnetic fields on blood parameters are dependent on factors such as the intensity of the field, the frequency of exposure, and the length of time spent in the field. It has been demonstrated that low-intensity magnetic fields have the potential to improve microcirculation and immunological response, but high-intensity magnetic fields may have unfavorable consequences, such as cellular damage and reduced blood coagulation. In clinical settings, the therapeutic uses of magnetic field exposure have been investigated, with promising results. These applications have been notably investigated in the context of wound healing, pain management, and inflammatory disorders. On the other hand, it is impossible to ignore the potential dangers that are connected to prolonged or intense exposure to magnetic fields, and further research is required in order to get a deeper comprehension of the interactions that this phenomenon occurs. In spite of the fact that several studies have shown positive findings, there is still a great deal of work to be done in order to understand the precise processes by which magnetic fields influence blood parameters. It will be essential to have a solid understanding of these mechanisms in order to design magnetic field-based treatments that are both safe and effective. The present information gaps should be addressed by future research, which should include the standardization of exposure protocols, the execution of large-scale clinical studies, and the evaluation of the long-term consequences of magnetic field exposure on blood health. Although exposure to magnetic fields has the potential to be therapeutically beneficial, particularly in terms of enhancing circulation and bolstering immunological systems, it is important to exercise caution when undergoing such exposure. Continued study will be necessary in order to determine the ideal exposure levels, decipher the biological processes that are involved, and guarantee the safety and effectiveness of magnetic field treatments for clinical and daily uses.

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