Volume 3, Issue 5, May 2025 ISSN (E): 2938-3765

INFLUENCE OF MAGNETIC STORMS ON THE CONDITION OF PATIENTS WITH ARTERIAL HYPERTENSION

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Abstract
Magnetic storms caused by solar activity are a significant environmental factor that can affect human health, especially in patients with arterial hypertension. This review examines current understanding of the pathophysiological mechanisms of geomagnetic activity impact on the cardiovascular system. It summarizes the results of large epidemiological and clinical studies confirming the relationship between magnetic storms and deterioration of hypertensive patients' health, including increased blood pressure, more frequent complaints, and increased hospitalizations. Particular attention is paid to meteosensitivity as a predisposing factor. Practical recommendations for prevention and adaptation of therapy during periods of geomagnetic instability are also provided. The data obtained emphasize the importance of taking into account the geophysical environment in clinical practice and the need for further scientific research in this area.

Keywords: Magnetic storms, arterial hypertension, meteosensitivity, geomagnetic activity, cardiovascular diseases, prevention, pressure.

Introduction

Arterial hypertension (AH) is one of the most common chronic non-communicable diseases of our time, affecting millions of people worldwide. According to the World Health Organization (WHO), high blood pressure is a leading risk factor for the development of cardiovascular events, including stroke, myocardial infarction, and chronic heart failure. Particularly alarming is the fact that hypertension is increasingly being detected in people of working age, as well as in combination with other metabolic disorders.

In recent decades, the scientific community has been paying increasing attention to the influence of environmental factors on the course of chronic diseases. Of particular interest is the impact of geomagnetic activity, in particular magnetic storms, on the health of people suffering from cardiovascular pathologies. Magnetic storms are the result of solar activity, during which there is a sharp disturbance of the Earth's magnetic field. These changes, although imperceptible to the senses, can cause a biological response in weather-sensitive people.

A number of observations show that during periods of increased geomagnetic activity, many patients with arterial hypertension report a deterioration in their health, increased headaches, blood pressure surges, irritability, and worsening sleep. However, despite the growing interest in this

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problem, the impact of magnetic storms on the clinical course of hypertension remains unstudied and requires further generalization and analysis of scientific data.

The aim of this review article is to systematize modern concepts about the impact of magnetic storms on blood pressure, identify possible pathophysiological mechanisms and analyze available clinical studies devoted to this topic.

Magnetic storms as a natural factor

Magnetic storms are sharp disturbances of the Earth's geomagnetic field caused by solar flares and coronal mass ejections. These phenomena occur as a result of complex processes in the outer atmosphere of the Sun, when giant streams of charged particles (protons and electrons) rush toward the Earth and interact with its magnetosphere. As a result, geomagnetic disturbances are formed that can last from several hours to several days.

The magnitude and intensity of magnetic storms are assessed using a special scale reflecting the level of geomagnetic activity. The most commonly used indices are:

- **Kp index** - characterizes global geomagnetic activity (from 0 to 9);
- **Ap index** is the average amplitude of magnetic field oscillations;
- **The NOAA G-scale** ranges from G1 (mild storm) to G5 (extreme storm).

According to NOAA classification :

- **G1 (Kp = 5)** - weak storms that can cause minor fluctuations in biorhythms;
- **G2-G3 (Kp = 6-7)** - moderate and strong storms that already affect the health of weather-sensitive people;
- **G4-G5 (Kp ≥ 8)** — powerful magnetic storms accompanied by massive disruptions in radio communications, navigation, and an increase in the number of cardiovascular complications.

It is important to emphasize that magnetic storms are not directly felt by humans - neither visually nor tactilely. However, at the cellular and neurohumoral level, certain reactions are activated, especially in people with increased sensitivity to external physical stimuli.

Scientific observations have shown that periods of intense solar activity, as a rule, coincide with an increase in the number of visits to doctors regarding deterioration of health, especially in the cardiovascular and nervous systems. This makes the study of magnetic storms relevant not only from the point of view of geophysics, but also as an important medical and biological factor.

Arterial hypertension and weather sensitivity

Arterial hypertension (AH) is a chronic disease characterized by a persistent increase in blood pressure above 140/90 mm Hg. Despite a wide range of medications and prevention programs, hypertension control remains a difficult task. The reason for this is not only internal (endogenous), but also external (exogenous) factors, including changes in weather conditions and geophysical conditions.

One of such exogenous factors is meteosensitivity - increased susceptibility of the body to changes in climatic and geophysical parameters. Meteosensitivity can manifest itself both in completely healthy people and in patients with chronic diseases, especially with cardiovascular pathology.

In people with hypertension, meteosensitivity is most pronounced. Changes in atmospheric pressure, temperature, humidity and geomagnetic activity can lead to:

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- fluctuations in blood pressure,
- increased heart rate,
- headaches and dizziness,
- sleep disturbance,
- increased irritability.

According to clinical observations, about 60-70% of hypertensive patients consider themselves weather-sensitive. The greatest vulnerability is demonstrated by elderly patients, postmenopausal women, people with autonomic dysfunction and anxiety-depressive disorders. In these categories of patients, even weak geomagnetic fluctuations can provoke a hypertensive crisis requiring medical intervention.

It is believed that the main mechanisms of meteosensitivity are:

- instability of the autonomic nervous system,
- impaired regulation of vascular tone,
- altered baroreceptor reactivity ,
- increased production of catecholamines and cortisol during a stress response to external stimuli.

Thus, arterial hypertension in combination with meteosensitivity is a clinically significant problem that requires an individualized approach to treatment and monitoring of the patient depending on the geophysical situation.

The impact of magnetic storms on the cardiovascular system

The cardiovascular system is considered one of the most vulnerable physiological systems of the body to external physical and geomagnetic influences. During magnetic storms, the delicate balance between the sympathetic and parasympathetic activity of the autonomic nervous system is disrupted, which provokes a whole cascade of reactions from the heart and blood vessels, especially in patients with existing pathologies, such as arterial hypertension.

1. Violation of neurovegetative regulation

Magnetic storms activate the sympathetic-adrenal system, contributing to an increase in the concentration of catecholamines (adrenaline and noradrenaline) in the blood. This causes vascular spasm, increased heart rate and increased blood pressure. In people with hypertension, this leads to an aggravation of the underlying disease, increasing the risk of developing a hypertensive crisis.

2. Deterioration of rheological properties of blood

Some studies indicate that blood thickens and becomes more viscous during periods of intense geomagnetic activity, increasing the risk of thrombus formation . This is especially dangerous for patients with arrhythmia, atherosclerosis, and previous cardiovascular events.

3. Increased incidence of vascular complications

Epidemiological data from Russia, Japan and Germany show a statistically significant increase in the number of hospitalizations for strokes, heart attacks and hypertensive crises on days with high

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geomagnetic activity. For example, in Moscow, on days of severe storms, the number of ambulance calls for cardiac reasons increases by 10–15% (Kireev et al., 2020).

4. Heart rhythm disturbances

Frequent complaints of extrasystole, tachycardia and irregular heartbeats are observed. People with implanted pacemakers or defibrillators have reported malfunctions of the devices on days of increased geomagnetic load.

5. Exacerbation of concomitant conditions

Magnetic storms also contribute to poor sleep, increased anxiety, irritability and chronic fatigue. These psycho-emotional factors additionally overload the cardiovascular system, reducing the body's adaptive reserves.

Thus, magnetic storms are an important environmental factor capable of exerting a pronounced effect on the cardiovascular system, especially in weather-sensitive individuals and patients with arterial hypertension. Understanding these mechanisms is necessary for developing preventive and therapeutic strategies during unfavorable geophysical periods.

Evidence from literature and research

In recent years, numerous studies have been conducted confirming the influence of geomagnetic activity on the cardiovascular system, in particular on blood pressure. The most significant of them cover large samples of patients and demonstrate a stable correlation between magnetic storms and deterioration of the condition of people with arterial hypertension.

1. Multicenter study in China (2015–2020)

A large study conducted in the Chinese cities of Qingdao and Weihai analyzed more than **554,319** blood pressure measurements over five years. The results showed a clear positive correlation between the geomagnetic activity index Ap and systolic and diastolic pressure levels, especially in women. The most pronounced changes in blood pressure were observed 1–2 months after solar activity peaks (Nature Portfolio , 2025).

2. Research by Harvard School of Public Health (USA, 2021)

A study of **675 older men compared** geomagnetic activity (Ap index) with changes in blood pressure. Increases in geomagnetic activity were found to be associated with increases in both systolic and diastolic pressure. The effect persisted for several weeks (JAHA, 2021).

3. Review work by Meyerowitz (2023)

Meyerowitz conducted a meta-analysis of available data, which found that increased geomagnetic activity can cause an increase in systolic pressure by **3–8 mmHg** , especially in women and patients with hypertension. The study highlights the importance of individual sensitivity to magnetic storms (ResearchGate , 2023).

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4. Relationship between atmospheric pressure and geomagnetic storms with AD (2017)

Work published in International Journal of Biometeorology , examines the simultaneous impact of geomagnetic activity and atmospheric pressure on blood pressure readings. It has been established that during periods of strong magnetic storms, average arterial pressure increases significantly (ADS Harvard , 2017).

Table 1. Review of key studies on the influence of geomagnetic activity on blood pressure

Source	Number of participants	Key findings
Nature (China, 2025)	554 319	Increase in Ap -indicator correlates with increase in blood pressure in women
JAHA (USA, 2021)	675	Blood pressure increases with increasing geomagnetic activity, the effect persists
Meyerowitz (2023)	Review	Increase in SBP by 3–8 mmHg, highest risk in women
IJBm (Germany, 2017)	-	Geomagnetic storms + atmospheric pressure cause blood pressure to rise

Thus, observational data from different regions of the world confirm the clinically significant impact of magnetic storms on arterial pressure, especially in meteosensitive patients with hypertension. These results require the implementation of adaptive strategies for managing such patients, taking into account the geophysical situation.

Prevention and recommendations

Given the growing body of data on the adverse effects of magnetic storms on blood pressure and the general well-being of patients with hypertension, it is especially important to develop and implement preventive measures and corrective therapy during periods of geomagnetic instability.

1. Individual monitoring of geomagnetic conditions

Patients with arterial hypertension are advised to monitor geomagnetic activity forecasts using specialized applications (for example, Magnetic Storm, Space Weather Live ") or through official meteorological sites. In case of expected storm of level G2 and higher it is necessary to take preventive measures.

2. Blood pressure control

On unfavorable days, patients should measure their blood pressure more often - at least 2-3 times a day. This will allow timely detection of deviations and, if necessary, adjust the dosage of medications.

3. Correction of drug therapy

Based on individual sensitivity and on the doctor's recommendation, a temporary increase in the dose of antihypertensive drugs during periods of severe storms is possible. However, this should be done strictly under the supervision of a specialist.

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4. Avoidance of provoking factors

On geomagnetically active days, patients are recommended to:

- avoid physical and emotional overload,
- reduce salt and caffeine intake,
- give up smoking and drinking alcohol,
- ensure adequate sleep and rest.

5. Support of the nervous system

Since magnetic storms can provoke anxiety, insomnia and headaches, it is appropriate to use mild herbal sedatives (motherwort, valerian) or magnesium preparations, but only as prescribed by a doctor.

6. Information and training

Healthcare workers are advised to conduct explanatory work among patients at risk, especially the elderly, postmenopausal women and people with concomitant neurosis-like symptoms. Awareness reduces anxiety and increases readiness to adapt on adverse weather days.

Conclusion

In the course of this review, the current scientific literature devoted to the influence of magnetic storms on the condition of patients with arterial hypertension was analyzed. The presented data allow us to make an unambiguous conclusion: geomagnetic disturbances have a reliable effect on the cardiovascular system, especially in weather-sensitive individuals and patients with hypertension.

The main mechanisms of such effects include activation of the sympathetic-adrenal system, disruption of the autonomic balance, changes in vascular tone and increased anxiety. These physiological changes contribute to increased blood pressure, deterioration of well-being and increased risk of hypertensive crises and vascular complications.

Numerous epidemiological and clinical studies conducted in different countries confirm the existence of a statistically significant relationship between geomagnetic activity indices and arterial pressure fluctuations. Particularly pronounced reactions are observed in women, the elderly, and patients with a predisposition to autonomic disorders.

Taking into account the above, it is advisable to introduce into practice individualized preventive and therapeutic measures during periods of magnetic storms. This includes regular pressure monitoring, adaptation of the dosage of antihypertensive drugs, psycho-emotional support and informing patients about possible risks.

Thus, magnetic storms should be considered not only as a physical and geophysical phenomenon, but also as a significant medical factor capable of influencing the course of chronic diseases, including arterial hypertension. The relevance of further research in this area remains in order to deepen knowledge and develop clinical recommendations aimed at improving the safety and quality of life of patients.

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