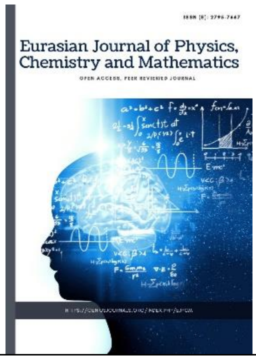


Effect Of Electromagnetic Field On Living Structures And Its Importance In Diagnostics And Therapy

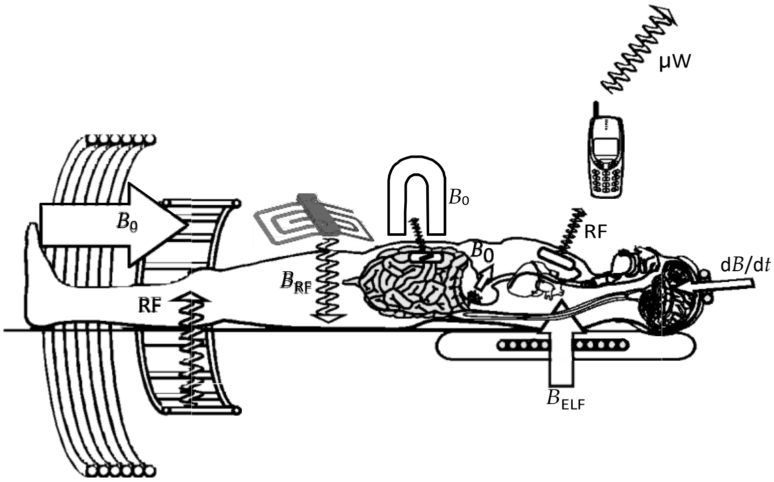
I.B. Zuparov
Toshkent tibbiyot akademiyasi Biotibbiyot muhandisligi informatika va biofizika kafedrasi assistenti

ABSTRACT

Effect of Electromagnetic Field on Living Structures: Electromagnetic fields can be generated by living structures. The influence of electric and magnetic fields can restore interactions within these structures. Electromagnetic radiation (EMR) and its effects can cause damage in the processes of living structures.
Diagnostics and Therapy: Electromagnetic fields are widely used in diagnostics and treatment areas. For example, MRI (Magnetic Resonance Imaging) devices use electromagnetic fields to correct abnormalities and identify changes in the body. Electromagnetic therapy, on the other hand, uses infrared radiation and radiowaves to treat patients.
Importance: Electromagnetic fields affect living structures and have the potential to be used in diagnostics and treatment. Through these methods, various diseases and conditions in the body can be identified and treated.

Keywords:

Main Section
Electromagnetic fields (EM) are becoming increasingly important in healthcare. Main applications are based on the direct interaction of EM or on delivering energy for therapeutic purposes, such as stimulating nerve and muscle cells or obtaining diagnostic information through techniques like MRI or Transcranial Magnetic Stimulation (TMS).
New applications are emerging for monitoring, targeting, tracking, and navigating by transmitting information through electronic implants and endoscopic capsules or delivering magnetic sources like magnetic nanoparticles to tissues. Such intracorporeal EM sources expose tissues directly, with field amplitude decreasing with distance.
Magnetic fields and EM are widely used in medicine (Figure 1), whereas the use of electric fields plays a smaller role. They are mainly limited to capacitive applicators in strong electric fields for diathermy or destruction and cutting of tissues, and by RF surgery devices for delivering spark discharges to tissue surfaces for cancer treatment.
The use of high-amplitude intracorporeal electric fields for applications such as electroporation of cell membranes to introduce drugs or nucleic acids into cells, directed with electrodes, are not discussed here. Similarly, surface electrodes for nerve and muscle cell stimulation in diagnostic and therapeutic applications or functional stimulation are excluded. Surgical devices (e.g., RF) are only discussed in relation to their stray fields, not their intentional use for cutting, coagulating, or ablating tissues.



Magnetic Resonance Imaging (MRI), diathermy, magnetic navigation and tracking, capsule endoscopy, magnetic therapy, transcranial magnetic fields (TMS), electromagnetic fields (EMF), and microwaves (MW) applications in medicine.

Electromedical Devices: It is clear that electromedical devices can intentionally expose patients to EM, like in diathermy or MRI. Electromedical devices can also inadvertently expose patients or staff to stray EM fields from surgical devices, telemetric data transmission from implants, or by the physical nature of the materials used, such as magnetic nanoparticles.

Heat Therapy

Heat therapy, also known as thermotherapy, involves applying heat to the body from various sources, including electric heating pads, blankets, and mattresses or low-temperature infrared cabins for medical use.

Heating Blankets: Due to the proximity of patients to the wires in electric heating blankets, local magnetic field exposure is significant but decreases rapidly with distance and varies with the arrangement of heating wires. The lowest magnetic fields are produced by bifilar wound filaments, while conventionally meander-like wires produce higher fields. Measured magnetic induction values remain low due to the large sensing area of about 100 cm^2, even under current regulations. Electronic power control of devices results in complex frequency spectra, including harmonics beyond the network frequency. The combined frequency spectrum resulted in an equivalent induction of 0.6 μT at 50 Hz. Consequently, the induced current density in the central nervous system remains low, making up about 8% of the ICNIRP basic restriction.

Distribution of induced intracorporeal current density by a heating blanket. (Data from Leitgeb, N. 2010. Safety of Electromedical Devices. Law-Risks-Opportunities. Vienna, Austria: Springer. With permission).

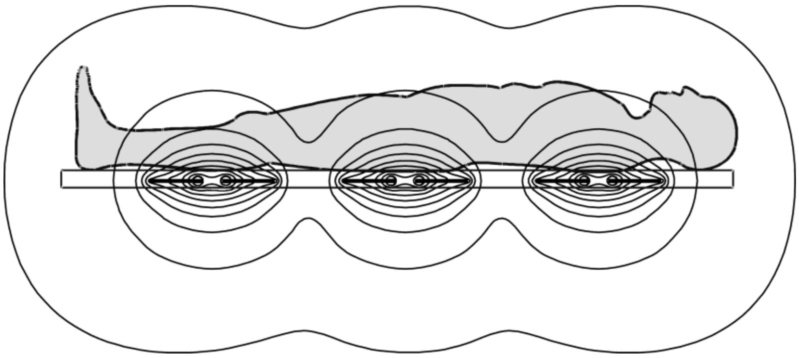
Sinus Fields

Devices are equipped with Helmholtz coils producing uniform magnetic fields or integrated flat coil cushions and mattresses producing very inhomogeneous alternating current (AC) magnetic fields. The applied frequency range is 1 Hz–1 kHz, and the amplitudes usually fall below the exposure guidelines limits (ICNIRP 1998) from a few nT to approximately 100 μT.

An exception is devices for treating wounds and bone fractures, where magnetic induction can reach several milliteslas. Due to the rapid decline of magnetic fields with distance, determining the exposure parameter for integrated flat coil cushions and mattresses is challenging. Different parts of the body are affected entirely differently. Therefore, if a dose-dependent therapeutic effect occurs, it is unclear whether the necessary therapeutic conditions can be achieved in the targeted area and maintained long enough during the expected treatment duration, given the patient's movements (each session lasting about 30 minutes).

Pulsed Fields

Scientific studies have proven the validity of treatment with electric stimulation. Clinically, three types of technologies produce intracorporeal electric signals: (1) contact currents, (2) capacitive coupling, and (3) inductive coupling (Gan and Glazer 2006). Inductive coupling through pulsed magnetic therapy (PMT), also called pulsed electromagnetic therapy (PEM), is often used in orthopedics to treat non-union fractures or failed fusions (pseudarthrosis).



Distribution of inhomogeneous AC magnetic field created by three flat coils integrated into a magnetic mattress. A series of magnetic pulses produce electric fields that stimulate bone healing (e.g., 72 mT, 50 Hz). Several FDA-approved PEM stimulators are widely available for patient use. These devices are believed to aid bone growth and healing (Grana, Marcos, and Kokubu 2008). The effectiveness of PEM in treating osteoarthritis has been studied with varying results. A meta-analysis concluded that pulsed EM improves clinical outcomes and function in patients with knee osteoarthritis and should be considered adjunctive therapy in managing osteoarthritis (Vavken et al. 2009).

Study Example

In a study involving 57 cases of tibial pseudarthrosis, 22 were treated surgically combined with PEM. Of the PEM-treated group (22), 20 fractures (91%) healed, and two (9%) did not. Of the non-PEM treated group (35), 29 (83%) healed, and six (17%) did not. PMT was considered clinically significant in terms of healing and union time (Cebrián et al. 2010).

Studies also examined PEM's effectiveness in treating soft tissue wounds, suppressing inflammatory reactions at the cellular membrane level to relieve pain, and increasing the range of motion. Pieber, Herceg, and Paternostro-Sluga (2010) reported on two small and three large studies describing the analgesic benefits of PEM treatment, although no beneficial effects were found in the large study. Kroeling et al. (2009) indicated that PEM methods might be more effective than placebo in treating neck pain but are not compared to other interventions.

References used:

1. Zuparov I.B., Elmurotova D.B. Automation of Data Processing for Assessing the Acid-Base State of the Organism.: Medicine, 2024. - 140 pages.
2. Elmurotova D.B., Zuparov I.B., EJHEA.: A MODERN APPROACH TO HAND

HYGIENE IN MEDICINE. -M.: Medicine, 2024. - 53 pages.

3. Komarov F.I., Korovkin B.F. Biochemical Indicators in the Clinic of Internal Diseases: Handbook. -M.: MEDpress, 2000. - 232 pages.
4. Raxmatov, A., Boʻriboyev, B., Boʻriboyev, A., Otabekov, A., & Egamov, S. (2020). On the Problems of Mathematical Modeling of Children's Sports Development in Regions. Archive of Scientific Publications of JSPI.
5. Akbar, K., & Sulton, E. (2021). Cloud Technology. Galaxy International Interdisciplinary Research Journal, 9(12), 458-460.
6. Malikovich, E. S. (2024). Improving the Methodology of Teaching the Basics of Programming in a Visualized Environment. IMRAS, 7(1), 168-173.
7. Egamov, S. (2020). EPRA International Journal of Research and Development (IJRD). Archive of Scientific Publications of JSPI.
8. Malikovich, S. E. (2022, December). Creation and Teaching Methodology of 3D Models. In Proceedings of International Educators Conference (Vol. 1, No. 3, pp. 46-50).
9. Khalikov, A., Egamov, S., & Normatov, J. (2022). The Concept of Graphic Information and Its Essence.
10. Khalikov, A., Egamov, S., & Normatov, J. (2022). Virtual Education Technologies in Informatics. Society and Innovations, 3(4/S), 109-113.
11. Turapov, U. U., Isroilov, U. B., Raxmatov, A., Egamov, S. M., & Isabekov, B. I. (2024). Splay-Method of Model Acquisition Assessment. International Journal of Trend in Scientific Research and Development, 5(1), 934-936.
12. Elmurotova, D. B., Mamashova, N. T., & Bozorov, E. H. X-ray Therapy and Its Applications. Journal of Academic Research and Trends in Educational Sciences (JARTES) V, 1, 358-363.
13. Elmurotova, D. B. (2021). Nanomaterials for High-Efficiency X-ray Sources. Internauka, (17-4), 68-71.
14. Elmurotova, D., Bozorov, E., Isroilova, S., & Uzoqova, G. (2023). Lecture on "Faults in Scanning X-ray Machines" Using "Feedback" Method.
15. Él'murotova, D. B., & Ibragimova, É. M. (2007). Intensification of Electroluminescence of ZnSe:(Te, O) Crystals as a Result of Irradiation with γ-ray Photons. Semiconductors, 41, 1135-1139.
16. Elmurotova, D. B., Ibragimova, É. M., Kalanov, M. U., & Tursunov, N. A. (2009). Radiation-Induced Formation of ZnO Nanoparticles on ZnSe Single Crystal Surfaces. Physics of the Solid State, 51(3), 429-436.
17. Abdullaev, A. K. (2023). The Influence of Transformations in Uzbekistan's Economy on Personnel Issues During the Great Patriotic War. Bulletin of Volgograd State University. Series 4: History. Regional Studies. International Relations, 28(3), 42-53.
18. Abdullaev, A. K. (2023). The Role of Transport Diplomacy in Developing Foreign Trade Routes of the Republic of Uzbekistan. Post-Soviet Studies, 6(3), 315-323.
19. Abdullaev, A. (2021). Some Aspects of the Development of the Transport Sector in the Central Asian Region. In Innovative Technologies in Management: Managerial and Social Aspects (pp. 296-299).
20. Abdullaev, A. K. (2021). The Improvement of the Transport System Leads to Economic Growth: A Myth or Reality . International Relations: Politics, Economics, Law, 2020(1), 39-47.