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THE MICROCLIMATIC FACTORS – SOME NEW TOPICS IN TEACHING MEDICAL PHYSICS AT MEDICAL UNIVERSITY – SOFIA

V. Hadjimitova*

Department of Medical Physics and Biophysics, Medical University of Sofia, Bulgaria

ABSTRACT

Microclimatic factors determine the physiological comfort. They are studied in the syllabus in different aspects: as a condition for a healthy work and life environment and conservation of drugs as well as a method for the treatment of chronic diseases in regions with a specific microclimate and other.

EMFs were always part of the curriculum in Medical Physics. Because of their various biological effects they find a diverse application in medical practice. They are studied mainly for their use in diagnostics and therapy.

Cell phones are widely used in our everyday lives. The potential effects of electromagnetic fields on human health vary widely depending on the frequency and intensity of the fields. Their antennas assure the coverage of almost the whole country. This makes EMFs an inevitable component of the climate.

Along with physical factors such as temperature, pressure, humidity, illumination, etc. in the syllabus are included low frequency EMF. The main points taken in consideration in lectures are quantities that characterize them, biological effects, that they may cause, and the standards determined by WHO. The potential health effects of the very low frequency EMFs are represented by classic and modern theories in lecture. This information is important for students studying 'Health inspector'.

Key words: EMFs, medical physics, microclimatic factors

EMFs are a part of the medical physics syllabus. Because of the many common points with the medical practice they are included in different lessons. In all themes are included the main quantities, their relations, the possible effects on living systems on a molecular, cellular and organism level. The methods for diagnostics and treatment using EMF are examined separately from EMF as an environment factor. We start with the bioelectromagnetic field.

Bioelectromagnetics is the study of how electromagnetic fields interact with and influence biological processes, as a radiobiology of non-ionizing radiation, which respects biological effects of mainly weak, static and low-frequency magnetic fields, which do not cause heating of tissues. Most of the molecules that make up the human body interact only weakly with electromagnetic fields that are in the radiofrequency or extremely low frequency bands. One basic interaction is the absorption of energy from the electromagnetic fields, which can cause tissue to heat up; more intense field exposures will produce greater heating. This heat deposition can lead to biological effects ranging from discomfort to protein denaturation and to burns. Many nations and regulatory bodies have established safety guidelines to limit the electromagnetic fields exposure to a non-thermal level, which can either be defined as heating only to the point where the excess heat can be dissipated/radiated away, or as some small temperature increase(<0.1°C) that is difficult detectable with standard instruments.

In the second part low frequency EMFs are considered as an element of the environment. The sources of these fields are natural or technological. Permeability of the atmosphere for outside sources is discussed **(Figure 1).**

***Correspondence to:** *Vera Hadjimitova, Department of Medical Physics and Biophysics, Medical University of Sofia, Sofia-1431, 2 Zdrave str Bulgaria tel. 02-9172-721 e-mail: verah@mail.bg*

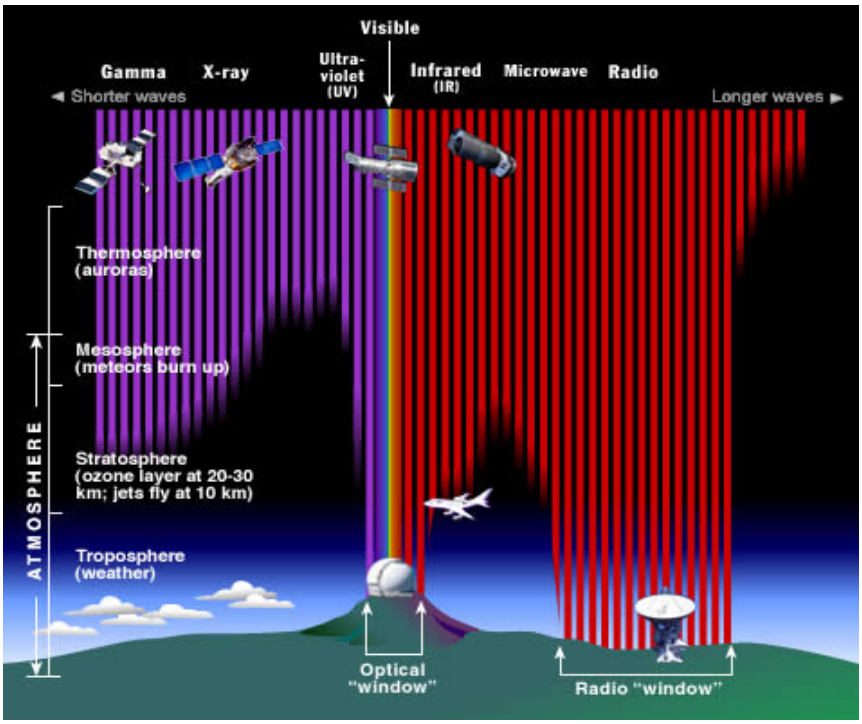

Figure 1. Permeability of the atmosphere for electromagnetic spectrum. (5)

Technological sources with non-ionizing radiation are for example microwave ovens and mobile phones.

Mobile phones take central place because of the large quantity of mobile cells and their widespread usage. The problem is current and is needed close examination of the risks that they might pose and the cause of their effects.

The structure of the subject begins with a short description of the problem. Health concerns about the use of mobile (cellular or cell) phone radiation and other wireless transmitting systems have been raised, because such apparatus use electromagnetic waves in the microwave range. These concerns have induced many studies (both epidemiological and experimental, in animals as well as in humans).

The WHO has concluded that serious health effects (e.g. cancer) are very unlikely to be caused by mobile phones or their base stations. However, some nations' radiation advisory authorities recommend their citizens to minimize radiation. Examples of recommendations are hands-free use, keeping the mobile phone away from the body and do not telephone in a car without an external antenna **(Figure 2)**.

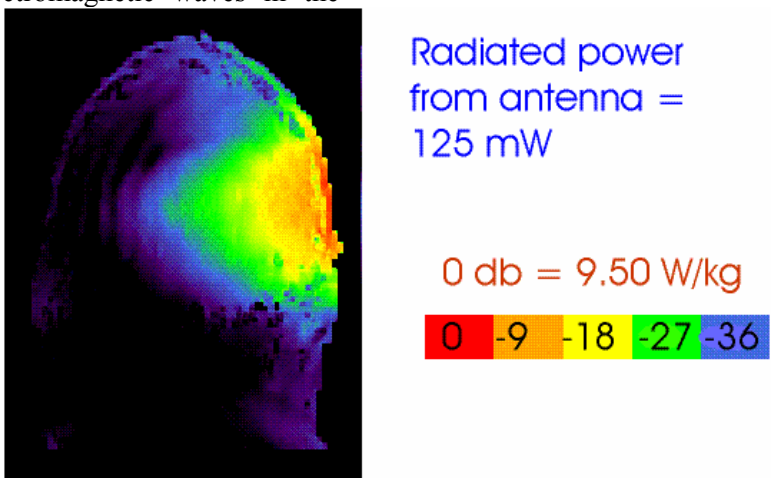

Figure 2. Transmitted power from a typical mobile phone.Calculated specific absorbed radiation (SAR) distribution in an anatomical model of the head next to a 125 mW dipole antenna. Peak SAR is 9.5 W/kg over 1 mg, whole head average is 0.008 W/kg. (3)

Part of the radio waves emitted by a mobile phone (digitally peak power of 2 W, analogue phone 3.6 W) are absorbed by the human head. In most systems the mobile phone and base station (large antenna tower or small consumer device) check reception quality and signal strength and the power level is increased or decreased automatically, within a certain span, to accommodate for different situations such as inside or outside of buildings and vehicles.

The rate at which radiation is absorbed by the human body is measured by the so called Specific Absorption Rate (SAR), and its maximum levels are governmental regulated (e.g. in USA 1.6 W/kg, averaged over a volume of 1 ml of head tissue).

Than we take a closer look at the possible effects of the interaction with living systems. – thermal and non-thermal effects. Thermal effects - one well-understood effect of microwave radiation is dielectric heating, in which any dielectric material (i.e. particles at molecular level comprising positive and negative charges, as holds in body tissues) is heated by rotations of the polar molecules induced by the electromagnetic field. Using a mobile phone, most of the heating effect will occur at the surface of the head, causing an irrelevant temperature increase by a fraction of a degree since the circulatory system is well capable of disposing of excess heat by increasing local blood flow. However, the cornea of the eye does not have this temperature regulation mechanism. Premature cataracts are known as an occupational disease of engineers who work on much high power radio transmitters at similar frequencies. Mobile phones do not have this hazard (1).

Microwave radiation may cause a leakage of albumin into the (rat) brain via a permeated blood-brain barrier. When this is a temperature effect, it will not occur in humans with their thicker skin and scull. Non-thermal effects include several hypothesis and some of the demonstrations.

Genotoxic effects - There is some compelling evidence of DNA damage and indications of other cell changes of cells in in-vitro cultures, when exposed between 0.3 to 2 watts/kg, whole-sample average.

Mobile phones and cancer. Whether mobile phones do increase the risk of glioma or meningioma with long-term and frequent use is highly controversial (for possible explanation) (2-3).

Free radical processes – We have our own results about the influence of low frequency EMFs on free radicals production *in vivo.* Free radicals production increased in many case of disorder (4).

Electromagnetic hypersensitivity?!- The report of users of mobile handsets of several unspecific symptoms during and after its use has never been confirmed scientifically. Probably this all is based on imagination; hypersensitivity of all these persons is very unlikely.

Health hazards of base stations - Another area of worry about effects on the population's health have been the radiation emitted by base stations (the antennas on the surface which communicate with the phones), because it is emitted continuously and is more powerful. On the other hand, due to the attenuation of power with the square of distance, field intensities drop rapidly with distance away from the base of the antenna. The results of the various studies were diverging, if not conflicting.

Studies of occupational health hazards of telecommunication workers show that the risk is totally negligible. Such workers spend time at a short distance from the active equipment, for the purposes of testing, maintenance, installation, etc. may be at risk of much greater exposure than the general population. Many times base stations are not turned off during maintenance, because that would affect the network.

A variety of studies over the past 50 years have been done on workers exposed to high radio frequent radiation levels. Studies including radar laboratory workers, military radar workers, electrical workers, amateur radio operators. Most of these studies found no increase in cancer rates over the general population or a control group. Many positive results could have been attributed to other work environment conditions, and many negative results of reduced cancer rates also occurred. Evidently we reach the Safety standards and licensing Precautionary principle.

In order to protect the population living around base stations and users of mobile handsets, governments and regulatory bodies adopt safety standards (often including licensing), which translate to limits on exposure levels below a certain value. The International Committee for Non-Ionizing Radiation Protection (ICNIRP), adopted so far by more than 80 countries, proposes two safety limits for radio stations: one for occupational exposure, another one for the general population. Often, the authorities use the "precautionary principle". This means that as long as the ultimate conclusions of scientific research can not be drawn, recommendations are made such as the minimization of cellular phone usage, the limitation of use by at-risk population (such as children), the adoption of mobile phones with maximal levels of radiation, the wider use of hands-off and earphone technologies such as Bluetooth headsets, the adoption of maximal standards of exposure, RF field intensity and distance of base stations antennas. Bluetooth is a very low power wireless personal area network system to exchange information between devices such as mobile phones, laptops, PCs, printers and digital cameras.

The subject about mobile phones is in the form of discussion for student studying to be health inspectors. As well as the known facts, some of the theories about the influence of the low frequency EMFs are shown. The students are instigated to ask questions and to express an opinion. The inclusion of this theme in the syllabus is helpful for the complete understanding of EMFs' effects.

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