Journal of Environment and Bio Research

Short Communication Volume: 1.1 Open Access

The Problem of Electrosmog Pollution: Is it Advisable to Review the ICNIRP Guidelines?

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The development of modern technology is based on the use of various energy forms whose the most widely used is surely electricity. Low frequency electric power is produced in power stations at frequencies of 50 or 60 Hz, which is transmitted to urban centers by high voltage transmission lines. Nevertheless, these transmission lines are often located too near to buildings where humans live or work, so that they are continuously exposed to extremely low frequency electromagnetic field (ELF-EMF) generated by the same transmission system.

Static magnetic fields (SMFs) are instead produced by direct current (DC) transport systems such as trams and electric trains, magnetic resonance imaging, industrial processes such as aluminum production or even in commonly used devices such as audio speaker components. Furthermore, strong magnetic fields of around 1 T are required in magnetically levitated trains, and flux density of up to 1.33 mT inside passenger cabins has been measured in magnetic levitation systems [1].

Finally, in the last thirty years, the advent of radio stations and wireless home devices (the prototype of which is mobile phone) has considerably increased, generating high frequency electromagnetic fields (HF-EMFs), in the radiofrequency (RF) and microwave (MW) regions.

ELF-EMFs and HF-EMFs represent non-ionizing radiations, which give rise to the so-called "electrosmog" (i.e. electromagnetic wave pollution), whose harmfulness to human health has so far been contrasting. In fact, there is a great scientific production regarding the harmful effects of exposure to EMFs.

Regarding the ELF-EMF, three publications are mainly to be mentioned by the World Health Organization (WHO), which highlighted the potential health effects of low-frequency and magneto static fields [2-3]. In particular, the International Agency for Research on Cancer [4] concluded in its study that ELF-EMF can be carcinogenic to humans. In this regard, the correlation between lymphocytic leukemia infantile and proximity to high voltage transmission lines [5] is also to be remembered.

The amount of these results has induced the International Commission on Non-Ionizing Radiation Protection (ICNIRP) to publish international guidelines to identify field strength limits not to be exceeded. In particular, ICNIRP recommends exposure limit to ELF-EMF of 1 mT [6] and exposure limit to SMFof400 mT [7] for occupational exposure and for general public exposure, respectively.

Furthermore, the achievement of wireless technology has induced livings to be continuously exposed to HF-EMFs. In this regard, a correlation between increased cancer risk and exposure to RFs and MWs was evidenced [8]. In particular, an assessment published in 2007 by the European Commission Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) regarding mobile phone radiation effects on human health highlighted that despite no significant health effect having been demonstrated, more studies concerning health effects on children are needed [9]. Several studies have shown that exposure to RF-MWs produces a neuronal response and oxidative damage to brain tissue [10,11] and may alter the DNA structure [12,13]. It has also been shown that exposure to RF-MWs result in a significant increase in reactive oxygen species and heat-shock proteins (HSP), characteristics of cellular anomalies [14]. These and other similar results induced ICNIRP to publish guidelines also for exposure to HF-EMF [15]. In particular, the reference level of power density for general public exposure to HF-EMF in the range from 400 to 2000 MHz can be obtained by the expression $P = f / 200$ (W/m^2) [15]. Considering the frequencies of 900 and 1800 MHz generally used by GSM system for mobile phones, we obtain the exposure limits of 4.5 W/m^2 and 9 W/m^2, respectively.

However, in recent literature, significant effects were observed in simple organic systems, using Fourier Transform Infrared (FTIR) Spectroscopy techniques, even below the EMFs limits recommended by ICNIRP. FTIR spectroscopy can provide accurate information on the secondary structure of proteins in H_2O-based structure or in deuterated form, in cells or in organic tissues, as largely demonstrated up to now [16-18].

In particular, significant transitions from proteins α-helix component to β-sheet features and a shift to lower frequencies of the Amide I vibration occurred in neuronal-like cells after 10 h exposure to a SMF around 2 mT [19]. These findings can be responsible for aggregation mechanisms. In addition, orientation towards an applied SMF at 200 mT was observed in Hemoglobin in aqueous solution after 3-6 h exposure [20,21].

Transitions from α-helix component to β-sheet features were also observed in Hemoglobin, in Bovine serum albumin and in neuronal-like cells after 3 h exposure to ELF-EMF around 1 mT [22-24], confirming that unfolding and aggregation occurs at EMFs intensities below the limits recommended by ICNIRP for exposure to SMF and ELF-EMF [6,7].

Finally, exposure to HF-EMF induced proteins unfolding and aggregation together with alignment towards the applied field, at the intensity around 1 W/m^2 that is, below thelimits recommended by ICNIRP for exposure to HF-EMF [15]. In particular, this resultwas observed in typical proteins in aqueous solution, exposed for 3-6 h to mobile phone MWs at 900 or 1800 MHz [25-31].

Received date: 11 Aug 2017; **Accepted date:** 28 Sep 2017; **Published date:** 4 Oct 2017.

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Citation: Calabrò E (2017) The Problem of Electrosmog Pollution: Is it Advisable to Review the ICNIRP Guidelines?. J Environ Biores. 1(1)

The amount of these recent results leads us to hypothesize the possibility that EMFs can be a cofactor for some diseases. Indeed, the phenomenon of protein aggregation can be the precursor of various neurological disorders and diseases such as Alzheirmer, Parkinson and Huntington, because it was shown that protein aggregation in the fibrillar form (named 'amyloid') can be associated with signs of neurodegeneration [32-37]. In addition, aggregated can be found in some forms of anemia [38-41] and in cancer diseases, particularly in childhood cancer, whose cause is still unknown [42].

In view of these facts, we would think about the opportunity to review the ICNIRP Guidelines.

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