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Original Research Article

Monitoring the Electromagnetic Pollution Potential of Some Medical Apparatus and Devices

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Abstract

The large-scale assessment of the effects of ambient electromagnetic radiation on human, animal and plant health requires the coverage of large areas, which still exceed the capacity of conventional measurement methods.The aim of this study was to monitor the potential of electromagnetic pollution of some devices and systems used in medical procedures for diagnosis and veterinary therapy, in order to apply measures to protect staff and patients. The investigations consisted of the comparative monitoring of the electrosmog in six enclosures equipped with devices and veterinary medical equipment. The measurements were performed in three spectra of electromagnetic waves. The recorded values were the basis for assessing the polluting impact of the following devices: a surgical aspirator, two operating tables, an electrocautery, an automatic injector, an X-ray system, a computed tomography and a defibrillator. The analysis of the recorded values revealed the achievement of the maximum levels of the electrosmog around the telescopic tables and the automatic injectors. Roentgen and CT systems have proven to be less polluting, due to being designed and manufactured with efficient protection features. In conclusion, we propose the application of passive and active protection measures in rooms with high potential for electromagnetic pollution.

Keywords: Electrosmog, Medical equipment, Patients, Protection, Staff

INTRODUCTION

Electromagnetic waves are given by the overlap of various electric and magnetic fieldsover the natural magnetic field of the earth, with frequency values of 7.83 Hz (Lolea et al., 2013; Neamțu and Morariu, 2005). In the environment, there are many natural and artificial sources generating electromagnetic waves of different frequencies. When their frequency exceeds 50 Hz, we can expect the health of humans, animals and plants to be affected (Belyaev, 2015; Havas and Marrongelle, 2013).

Concerns about the effects and risks generated by artificial electromagnetic fields have multiplied significantly in recent decades. Thus, the term ''electrosmog'' was introduced for electromagnetic pollution, and it describes the electromagnetic waves surrounding us in our environment, becoming a phenomenon of global interest (Evans et al., 2014; Jin et al., 2020; Munteanu et al., 2009; wikipedia.org/wiki). In this regard, we consider relevant a simple message with public impact transmitted by NASA, which states: ,' While watching TV, the visible TV waves hit us in the eye, and to these could be added the radio waves transmitted by a nearby station, and also the waves generated by the microphones of the mobile phones or by the neighbor's WiFi, respectively by the

GPS units of the cars. Therefore, a chaos wave can be created, that generates a real electromagnetic field in the space in which we survive. In this context, we recall the well-known concerns about the harmful effects of medical systems and, more recently, towards smartphones and other portable devices, with wireless equipment, worn very close to the users body (Trevor et al, 2016; Walker et al., 2014). Admitting that the animal body is sensitive to extremely weak electromagnetic fields also involves generating a specific response to their action, including an information component (Munteanuet al., 2010). According to the current concept of electromagnetic biocompatibility, wave-generating sources with bearable frequencies of the body are needed to ensure the healthy development of all living things (Munteanu et al., 2010). The harmful effects of ionizing radiation (X, Y), energy generators (heat), through which they act on living organisms, are already well known.

It is currently believed that electromagnetic athermal waves can affect living matter, but these effects are not yet fully demonstrated, and their reproduction is very unlikely (Havas, 2015). It is also worth noting the considerable increase in research regarding the effects of non-ionizing radiation, or very low frequency electromagnetic fields, as it is the case of wireless communication systems (GSM, wireless) on human health (Berlana and Úbeda, 2017; Crainic et al., 2006; Munteanu et al., 2010). Biomedical concerns abound in observations and research on the multiple harmful effects of electrosmog. Thus, electromagnetic fields with frequencies above 7.5 Hz, affect the health of humans and animals to a greater or lesser degree, and can produce various harmful effects: memory difficulties, concentration disorders, nervousness, irritability, headache, insomnia, immunosuppression, growing deficiencies and development, decreased fertility, miscarriages, cancer (especially cerebral), diabetes, cardiovascular disease (Bandara and Weller, 2017; Jin et al., 2020; Kleiber, 2017; Havas, 2015; Marina, 2011; Vornicu et al., 2018).

MATERIALS AND METHODS

The investigations consisted of monitoring the electrosmog in six enclosures of the Faculty of Veterinary Medicine Cluj-Napoca, using an HF59B device type with UBB27 antenna for high frequency (Figure 1). This professional device allows omni-directional measurements in the 700 MHz-3.3 GHz spectrum, being equipped with an audio analysis signal and a sensor (an optimized logarithmic periodic antenna), designed to identify pulsed radiation sources-mobile radio (GSM, UMTS/G3) , or generated by cordless phones (DECT), WLAN (Bluetooth), air traffic control radar. The main advantage of using UBB27 antennas lies in their isotropic characteristic, resulting in an easier positioning respective to the radiation sources and the measuring point, thus improving the spatial character of the measurement.

The working protocol included two uniaxial measurements in the six enclosures, at intervals of three weeks, in three spectra of electromagnetic waves: All 3D; frequency 50/60 Hz; frequency 150/180 Hz. La baza efectuării testărilor au stat metodoele și instrucțiunile prevăzute în Users guide – RF Analyzer (https://slt.co/Products/RFMeters/ HF59BRFMeter.aspx), în coloborate cu cele utilizate de alți cercetători în domeniu (Fedorowski and Steciwko, 1997; Guidance on measurement and numerical prediction of electromagnetic fields). In the case of each enclosure, an evaluation plan was elaborated, taking into account the dimensions and the equipment from their endowment. Therefore, measurements were performed during the operation of medical devices and systems, respectively during the rest period, when they were disconnected from the power grid. The evaluations were carried out gradually, at different distances from the main polluting sources, represented by: a surgical vacuum cleaner, two operating tables (telescopic and with its own heating system), an electrocautery, an automatic injector, a Roentgen system, a computed tomography scan and a defibrillator.

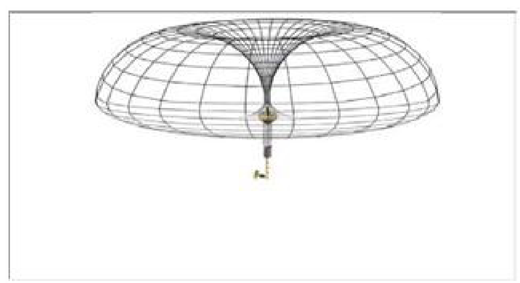

Figure 1. Directionality and reception components of the UBB27 antenna (Users Guide – RF Analyzer; https://slt.co/Products/RFMeters/HF59B RFMeter.aspx)

The working procedure included measuring at long distances (at intervals of 0.25 m), from the polluting source, gradually covering the entire surface of each investigated enclosure. Following the measurements, we obtained diagrams, such as the one in Figure 2, which provided differentiated data on the two measurements, respectively on the three electromagnetic wave monitoring spectra. The result was a set of diagrams, from which the valuesrecorded and centralized in the initial tables were taken (Table 1). Finally, the values from the obtained tables were statistically processed and represented graphically, using the Windows operating system, with GraphPad, InStat and Microsoft Excel programs, which allowed the calculation of basic

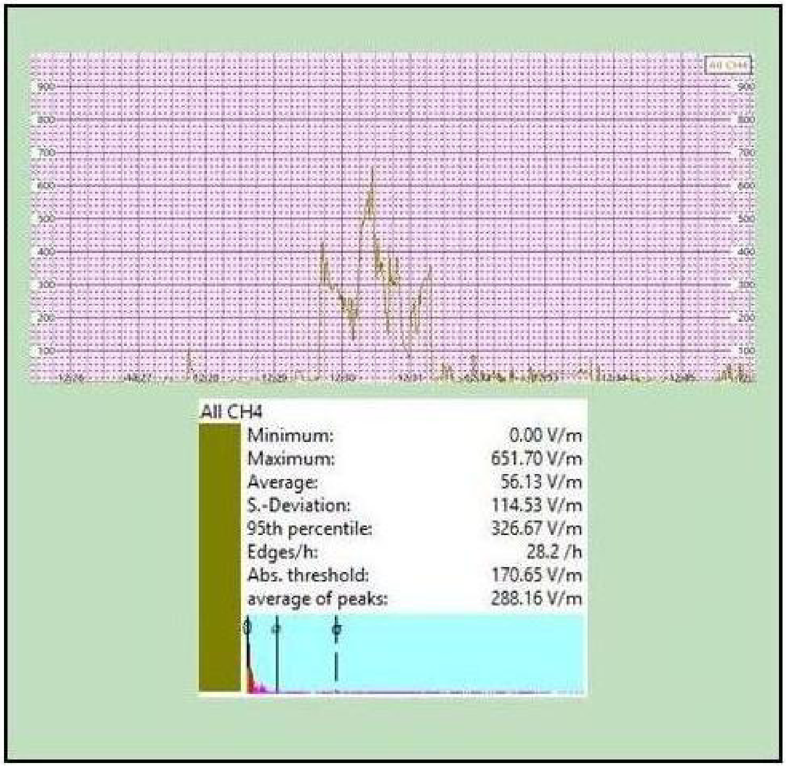

Figure 2. The representation of 3D magnetic field values in the histogram provided by the HF59B device

Table 1. Centralization of values taken from the measurement with the HF59B device charts

Statistical parameter	Average electric field values (nT) (3D measurements)		
	3D	**50 Hz**	**150/180 Hz**
Min	71.50	57.90	38.40
Max	16884.80	15732.40	6364.70
Average	2161.52	2036.69	667.84
S-Deviation	3072.69	2947.59	909.54
95th percentile	9889.79	9741.52	2416.71
Edges/h	56.3	50.7	73.2
Abs.threshold	5233.75	4983.84	1577.25
Average of peaks	9222.60	7936.42	2499.64

statistical parameters and the interpretation of study sketches. While we used the measuring data from the instrument „per se" the instrument itself uses in the DAQ and primary conversion and display process a mean value statistical aproach based on a limited (eg.100) samples for each measured and displayed value.

RESULTS

The values obtained at the two sets of measurements carried out in the 6 enclosures are presented in the graphs in figures 3-5, which were performed differently for the three spectra in which the electrosmog was monitored, starting from the initial centralizing tables (Table 1). Thus organized, the recorded data could be analyzed compared to some of the multiple and controversial standards currently accepted in the evaluation of electromagnetic wave emission sources (Figure 3-B).

From all the interpretations that lend themselves to the values illustrated in the charts obtained after processing the diagrams, we only present some of the aspects that we considered relevant for the proposed objectives. In this regard, we recall that the analysis of average values indicated the achievement of maximum levels of electrosmog in operating rooms, with the predominant distribution of polluting electromagnetic waves around

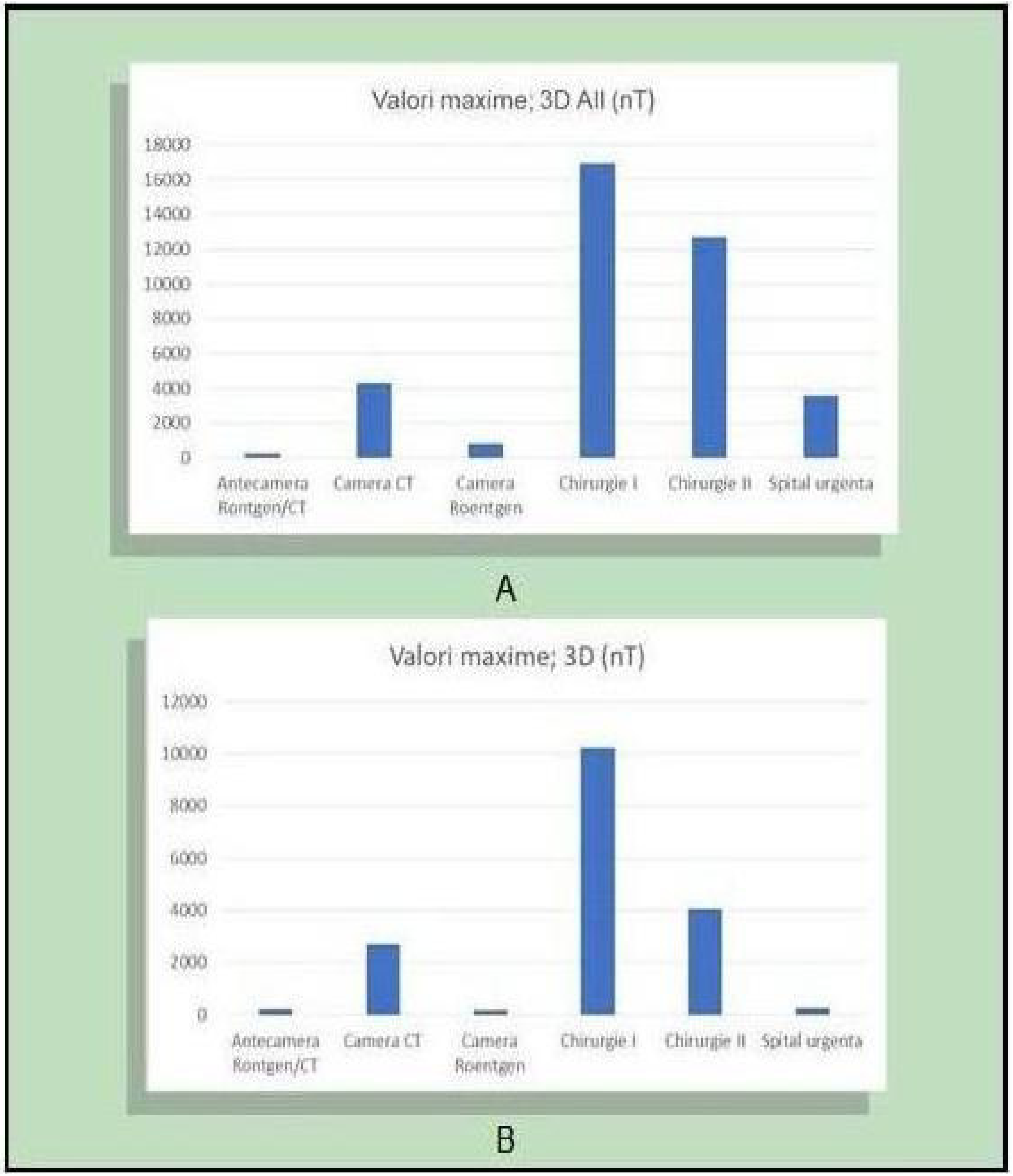

Figure 3. Maximum pollution values with electromagnetic waves reached in the 3D. All spectrums in the six enclosures, at first (A) and second measurement (B)

telescopic tables, respectively automatic injectors (Figure 3-5). Regarding the distribution in space, we found that at a distance of 0.25 m from these devices the intensity of electromagnetic waves was at the maximum level reached (4900-16884 nT), while maintaining the high values within a radius of 1.5 m around them, following that at short distances, of 3-4 m, to dissipate quickly. Contrary to expectations, the values found in the enclosures equipped with CT scan (1133-4230 nT) and Roentgen system (372-849 nT), were lower than those recorded in the two operating rooms. A similar evolution was found in the emergency hospital premises (234-2163.9 nT), in which we recorded lower values than those found in the operating rooms. The analysis of the presented charts also shows that the values recorded in the second measurement were lower, correlating with the frequency of use of polluting systems in therapeutic procedures. However, the evolution of the values recorded the next dayproved to be more relevant in this respect, when the measurements were performed during

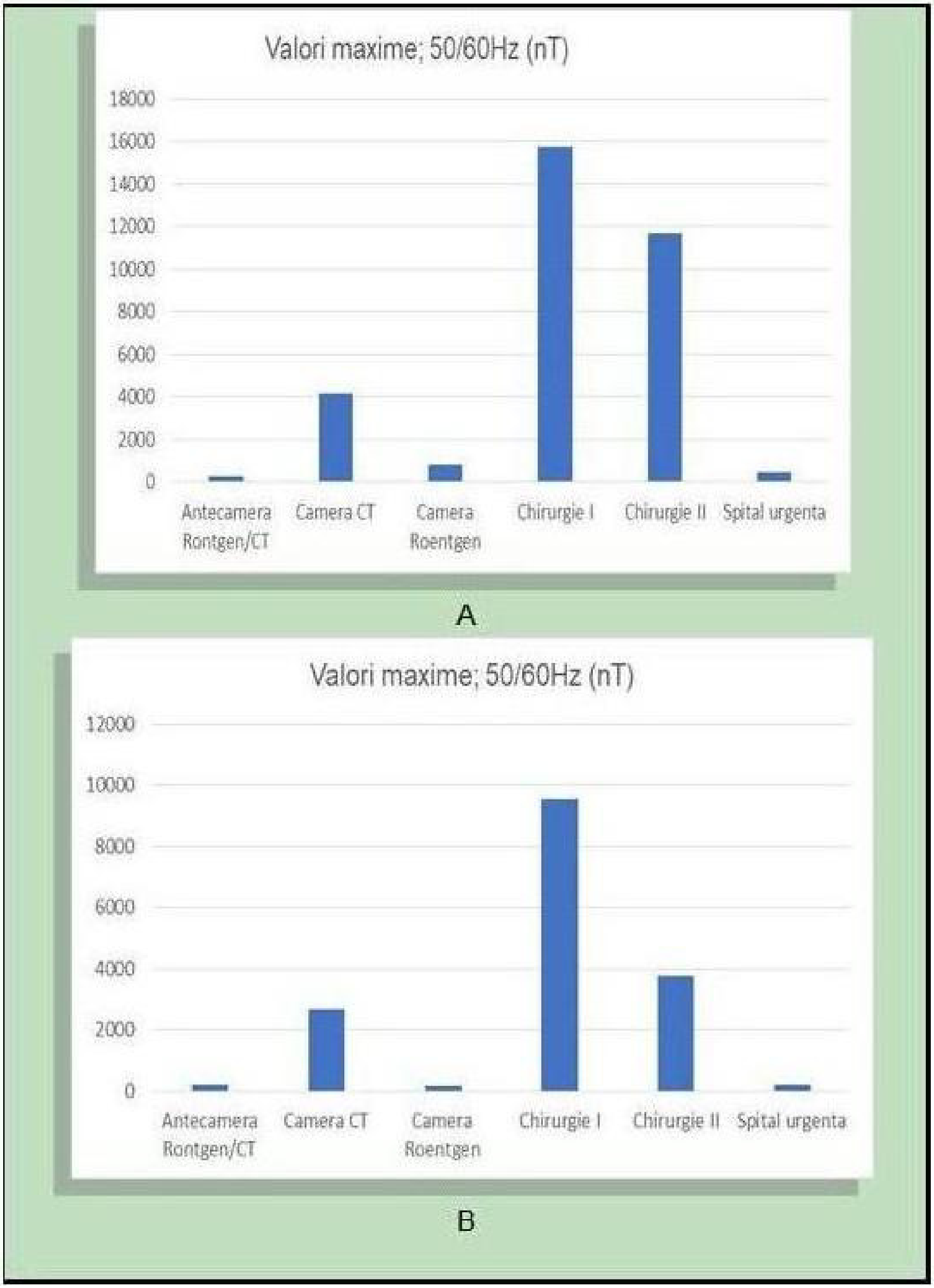

Figure 4. Maximum pollution values with electromagnetic waves reached In the 50/60 Hz spectrum, in the six enclosures at first (A) and second measurement (B)

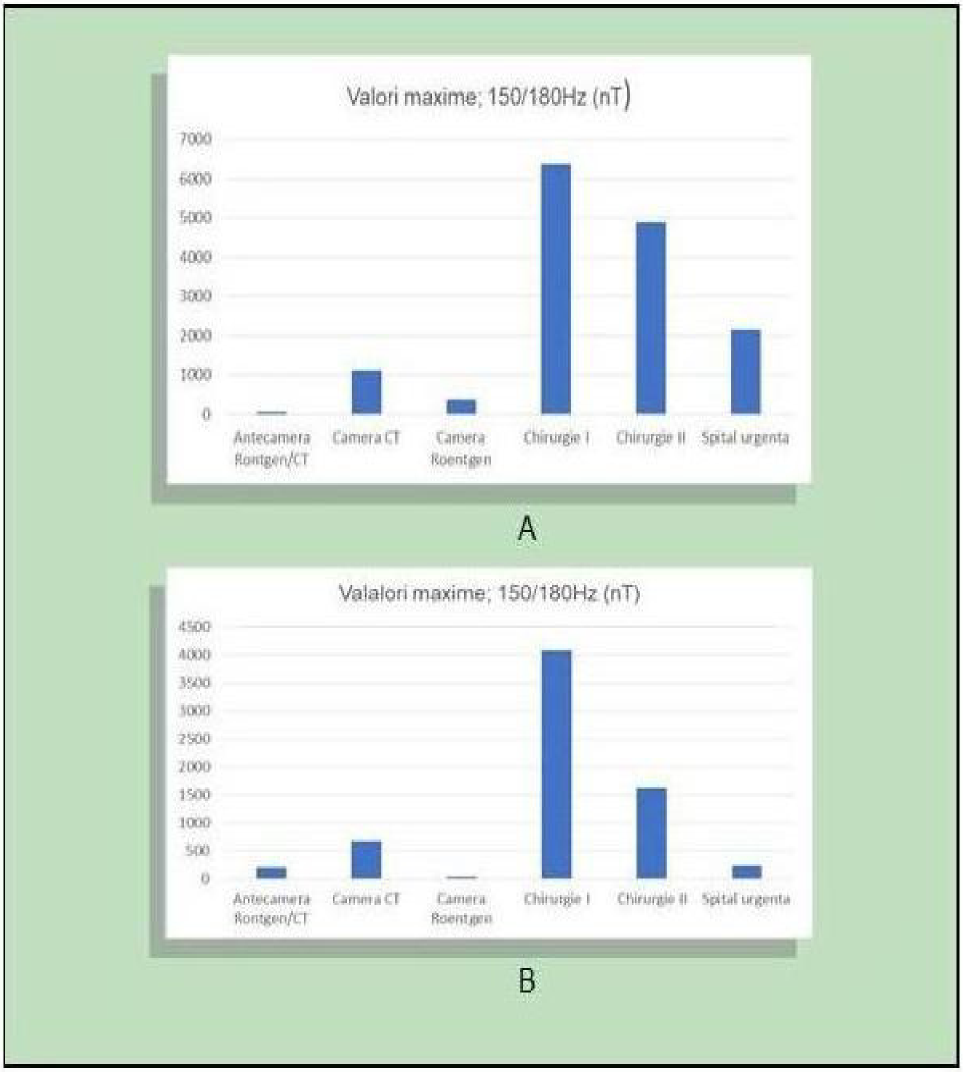

Figure 5. Maximum values of pollution with electromagnetic waves reached In the 150/180 Hz spectrum, in the six enclosures at the first (A) and second measurement (B)

the morning, with the medical equipment turned off and the electromagnetic field levels were below 200 nT in all the analyzed enclosures.

DISCUSSIONS

In explaining the lower pollutant level found in rooms equipped with Roentgen and CT equipment, known as sources of ionizing radiation, compared to the values recorded in the operating rooms, equipped with usual medical equipment (injectors, heated telescopic tables), we consider useful the following results from the documentation performed. Thus, we must remember that Roentgen and CT systems benefit from a higher protection and security level achieved by the manufacturer, which is always a well-known and recognized company, including by complying with relevant legislation and technological standards, as well as staff and the environment safety.

In contrast to the previous equipment, the telescopic tables and automatic injectors, identified as major sources of pollution, were made by lesser-known companies, in almost artisanal conditions, without being verified in terms of electromagnetic pollution potential. On the other hand, it should be mentioned that the ionizing radiation emitted by the Roentgen and CT equipment, having a much higher frequency, spread over shorter distances in space than the non-ionizing radiation generated by the rest of the investigated medical devices. Regarding the evaluation of the harmful effects generated by the action of the electrosmog, we mention that the recorded diagrams facilitate a quick and relevant interpretation, due to a different staining scheme on the graphic sets, which is identical to that used for biological measurements of buildings, having the following meanings: green- " lack of concern"; yellow - "slight concern"; red- "severe concern"; purple- "extreme concern". As we have already mentioned, in the analysis of the polluting potential of electromagnetic fields, it is admitted that any electromagnetic disturbance, located above 7.5 Hz, can affect human and animal health. The observations reported by many researchers in the field are based on this reality, appreciating that even non-ionizing radiation and very low frequency electromagnetic fields can adversely affect the human, animal and plant health.

It is also worth noting the studies that show that the widespread use of mobile phones has led to a tripling of brain cancer incidence, fatal especially in younger people, and wireless utilities and mobile phone pillars cover us with an increasingly dangerous layer of radiation (Jin et al., 2020). Halgamuge (2017) collected important data regarding the effects of radiation produced by mobile phones on plants, in an extensive bibliographic study. The basic conclusion from this study reveals that weak, athermic waves, RF-EMF type, have significant effects on plants. Although their effects cannot yet be extrapolated to human or animal health, the possibility of affecting them cannot be ruled out. Following an experiment, focused on the exposure to weak radiation of cultures of *Phaseolus vulgaris L.*, Surducan et al. (2020) noted an interesting morphophysiological response, consisting in the exaggerated growth of irradiated plants. In this context, we also mention the particular concern about the damage to cellular DNA by radiation emitted by telecommunication systems, which is often correlated with the increased incidence of cancer (Marina, 2011). What is serious is that all these realities are ignored by the commissions that set safety standards and analyze the negative impact of electrosmog on human health and the environment. We will probably have more protection only after the full disclosure of possible conflicts of interest between regulators and industry. Exposure to high levels of electromagnetic radiation is a global problem, which is becoming increasingly worrying for future generations (Bandara and Weller, 2017). Artificial electromagnetic fields differ from natural ones by a higher degree of coherence and well-defined frequencies, which can, however, have severe negative influences on living organisms. It is also considered that certain endogenous activities of the animal body can cause resonances or interferences, due to other characteristics of the external fields than their intensity (Yetisen et al., 2014).

The dificulty of solving the complex problems of electromagnetic field by numerical methods, require the use of calculation techniques, which have developed enormously in recent years, facilitating rapid obtaining of conclusive results. A wide range of computer programs have been developed worldwide thatdeal with numerical modeling and electromagnetic field simulation. Their number is difficult to know, there are probably several thousand software products designed for this purpose. However, some of them have predominated in academia or research, offering a number of advantages and a high degree of flexibility. Computer-assisted analysis of electromagnetic field problems in correlation with electrical devices and equipment, involves the following steps: physical modeling (identification of essential physical phenomena and establishing the electro-magnetic field regime); mathematical modeling (elaboration of equations that describe the essential phenomena, identifying the mathematical structures through which the physical quantities are represented); numerical modeling (discretization of the computational field in order to solve the electromagnetic field problem) (Havasand Marrongelle, 2013).

From all the data obtained, it appears that, at least in the two operating rooms, the electrosmog has reached a worrying level, which can have harmful effects on staff and patients. In this context, we propose the application of passive and active protection measures, which could be summarized in the installation of protective shirts for electromechanical parts, or special foils for table protection, respectively the use of electrostatic equipment for staff (foot strap equipotentialization straps , antistatic robe, electrostatic slippers).

Globally, there are currently important concerns about limiting the effects of electromagnetic fields on living organisms, some of which are worth mentioning. Thus, in the case of electrical devices, it has been shown that they continue to emit radiation even when they are turned off, so it is not enough to disconnect them from the mains to ensure that we are not affected by electrosmog. We can reduce the "leakage" of polluted electricity using certain filters (Graham Stetzer), or devices for adjusting the temperature of electrical cables, respectively devices such as Pulsing Meter to minimize polluting electricity. There is also the possibility of using sockets and extension cords with built-in filters, or elements external to the installations for attenuating the electric and magnetic field, such as shielding. It is also recommended to change the geometric position of the conductors or to increase the distance between the active elements of the networks and the neighboring objects that can be electromagnetically disturbed. Effective solutions for the protection of the human body can be based on increasing the distance from the electromagnetic field sources, reducing stationary time in areas with high intensities of it. For the same purpose the introduction of warning sensors or tracking cameras of the equipment in areas with high values of electric or magnetic fields can be made. One of the most applied solutions for removing the electric charges generating electrostatic field and electric discharges, consists in the use of antistatic clothing. In developed countries, a number of measures have already been implemented to reduce the potential adverse effects of electrosmog. Thus, a major impact is the regulation of the allowable intensities of electromagnetic fields, for industrial activities and for housing, in urban or rural centers. This differentiation is necessary because the exposure time of a person differs between an industrial activity and a habitual one.

CONCLUSIONS AND RECOMMENDATIONS

The measurement of the electrosmog generated by the medical imaging equipment and systems revealed high values in the CT (1133-4230 nT) and Roentgen enclosures (372-849 nT). Contrary to the expectations, however, they were lower than those recorded in operating rooms (6364-16884 nT), equipped with heated telescopic tables and automatic injectors. We consider that this less polluting effect of the Roentgen and CT systems is due to their higher level of security, provided by the manufacturing company. In contrast, telescopic tables and automatic injectors proved to be more intensely polluting sources, as they were made by hand and without complying with the rules of electromagnetic pollution. In order to protect medical staff and patients, we recommend checking the level of polluting electricity with Graham Stetzer meter devices, as well as lowering the cables temperature, by installing special devices or sockets/extension cords with built-in filters. We also recommend the application of protective coatings for active electromechanical parts and special foils for table protection, respectively electrostatic equipment for staff.

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