

The urgent need to apply the ICRP criteria to Non Ionizing Radiation

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Abstract

Although the IARC has classified EMF, both ELF and RF, as a possible carcinogen, the main reference organization (ICNIRP) does not promote the principle of justification neither the principle of optimization because he considers it not practicable, and bases its recommendations solely on the application of exposure limits, developing a policy that is closer to promotion than to the protection against radiation..

Nor does the ICNIRP recommends the use of dose constraints for public exposure.

This policy determines that the public is not adequately protected or even informed to protect themselves.

There is no doubt that the widespread use of the ICRP philosophy would improve the protection of the public and employees of any risks derived from exposure to electromagnetic fields.

The Principle of Precaution establishes that “when an activity represents a threat or damage for the human health or the environment, it is necessary to take measurements of precaution even when it could not have demonstrated the cause-effect relationship in a scientific and conclusive form”.

This declaration implies acting even in presence of uncertainty, deriving the responsibility and the safety to who creates the risk, to analyze the possible alternatives and to use participative methods to take decisions.

This presents practically two dilemmas:

- How to perform a cost-benefit analysis when the relation cause-effect is not even established for the health of the exposed persons? (In case of ionizing radiations a factor α is in use, that represents the economic cost of the dose received by a person)
- Which criterion must to be used in case of ionizing radiation act synergically with non ionizing radiation? How to integrate the quantitative optimization criterion with a qualitative criterion of precaution?

It will have to appear some temporary hypotheses in order to be able to perform the quantitative evaluations.

One possible solution is to consider the results of the Interphone study that show an increase in the highest decile in the frequency of glioma (1.4) and meningioma (1.15).

In the case of the low frequencies we can consider that the exposure can increase the risk of leukaemia in children.

The use of such hypothesis of work to perform the cost - benefit studies allow us to compare different alternatives for the systems of communication to reduce the human exposure and establish criteria to limit the use of the mobile phones to groups of persons, especially the children and teenagers, to the as low as possible level.

The precautionary approach must be used until more detailed information on health effects becomes available.

KEYWORDS: precautionary approach; non ionizing radiation.

Introduction

The precautionary approaches, such as the Precautionary Principle are applied just in the cases of possible but unproven adverse health effects and where action is deemed necessary to protect the people. That's exactly the situation in the case of Electromagnetic fields (EMF)

Then, **What are the reasons of the ICNIRP for not recommending the application of the precautionary principle?**

The objective of a cost / benefit assessment is to facilitate the practices, keeping all benefits and minimizing the possible risks when they are not justified.

We think that the two basic criteria of the ICRP, justification and optimization of practice, are readily applicable in this case without affecting the benefits currently available.

For example, the preferential use of a telephone line rather than a cell phone or turning off electrical equipment when not in use or avoidance of the use of a cell phone to play a child are measures that do not affect the practice and avoid undue exposure.

The application of the precautionary principle and the use of constraints to limit the public exposure, following the criteria recommended by the ICRP, is used by some countries such as Switzerland for several years with satisfactory results (30).

But to achieve these measures is necessary that the public is properly informed and that electrical and communications utilities assume their own responsibility.

The operators' arguments are similar as ICNIRP arguments and on the whole can be summed up as follows:

- The threshold values recommended by the ICNIRP are values ensuring health security;
- Child mobile phone users are no more sensitive than adults;
- There are no significant biological effects apart from thermal effects;
- If there were any possibly harmful biological effects, moreover, there would be no scientifically acceptable mechanism of action to account for them.

But we believe that the current state of scientific knowledge does not reflect these assertions.

The current state of knowledge on health and electromagnetic fields:

Very low frequency and childhood leukemia

Numerous studies in many countries have been undertaken since then of possible increased cancer risks in children and adults from ELF magnetic field exposures. Special attention has focussed on leukaemia and on brain tumours, which early reports had suggested might be increased.

Pooled analyses of data from a number of well-conducted studies show a fairly consistent statistical association between a doubling of risk of childhood leukaemia and power-frequency (50 or 60 Hz) residential ELF magnetic field strengths above 0.4 microTesla.

Using the standard IARC classification that weighs human, animal and laboratory evidence, ELF magnetic fields were classified as possibly carcinogenic to humans based on epidemiological studies of childhood leukaemia.(31)

After this published work of IARC, other studies were performed, in exposed personnel of the Swiss (29) , Norwegian and Swedish railways, with the same conclusions of the IARC study, although in this case, instead of 50 Hz the frequency was 16 Hz.

REFLEX project.

But to support a causal hypothesis of EMF-ELF it was necessary to determine the existence of a biological mechanism of carcinogenesis initiated by ELF-EMF and to that end, it was design the REFLEX project.

Therefore, in vitro studies using the most modern molecular biological techniques such as genomics and proteomics are urgently needed in order to create at least a hypothetical basis for the understanding of disease development through EMF-exposure.

In the REFLEX project, biological effects of extremely low frequency electromagnetic fields (ELF-EMF) and radio frequency electromagnetic fields (RF-EMF) are studied using sophisticated and diverse research methodologies separately since it is assumed that the generation of effects, if verifiable at all, may be based on different mechanisms

The REFLEX project was developed in 12 research institutes and universities in Europe exposing to EMF different types of tissues and cells of human and animals. The REFLEX project results showed that, both, EMF-ELF and EMF-RF can produce damage at exposure levels below the limits recommended by the ICNIRP.

Genetic damage is varied and observed effects equivalent to those produced by ionizing radiation, such as chromosomal aberrations, single and double break of strands of DNA and the appearance of binucleated cells, micronuclei and comet assay as well as changes in the expression of genes.

The data strongly indicate a clastogenic potential of intermittent electromagnetic fields, which may lead to considerable chromosomal damage in dividing cells.

A strong positive correlation was observed between both the intensity and duration of exposure to ELF-EMF and the increase in single and double strand DNA breaks and micronuclei frequencies. Surprisingly this genotoxic effect was only found when cells were exposed to intermittent ELF-EMF, but not to continuous exposure.

Between 3 and 550 Hz the largest DNA breaking effects were seen at 16.66 and 50 Hz, the most commonly used frequencies of alternating current in Europe.

ELF-EMF may affect, at least transiently, fundamental cellular processes including programmed cell death and cell cycle regulation.

The induced DNA damage was not based on thermal effects and arouses consideration about environmental safety limits for ELF-EMF exposure.

The effects were clearly more pronounced in cells from older donors, which could point to an age-related decrease of DNA repair efficiency of ELF-EMF induced DNA strand breaks.

An important conclusion of the REFLEX project is that many tissues were sensitive only to CEM discontinuous allowing explain the existence of positive and negative studies in the literature

Conclusion: Taken together, the results of the REFLEX project were exclusively obtained in in vitro studies and are, therefore, not suitable for the conclusion that ELF-EMF exposure below the presently valid safety limits causes a risk to the health of people. They move, however, such an assumption nearer into the range of the possible. Furthermore, there exists no justification anymore to claim, that we are not aware of any patho-physiological mechanisms which could be the basis for the development of functional disturbances and any kind of chronic diseases in animal and man.

Interphone study

.Concerning the Interphone study, the biggest epidemiological survey carried out on mobile phone users and their exposure to glioma, meningioma, acoustic neuroma and tumours of the parotid gland after protracted use of their mobile telephones, the partial early results published on 18 May 2010 by IARC more than ten years after the commencement of the study point to profound disagreement between the different teams of researchers (16 teams from 13 countries) over the interpretation of these results. The study coordinator, Ms Elisabeth Cardis, summed up a kind of compromise by saying that the study did not reveal an increased risk, but one could not conclude that there was no risk because there were sufficient results suggesting a possible risk. Indeed, some results show that lasting intensive use very significantly increases the risks of glioma (40% and even 96% looking at ipsilateral use, that is to say where the glioma has appeared at the side of the head to which the telephone was held) and the meningioma risks (15%; 45% for ipsilateral use).

The rapporteur feels that one of this epidemiological study's principal weaknesses lies in the fact that the period of mobile phone use analysed, extending until the early years of the 21st century, is probably too short at less than 10 years to reach altogether conclusive results given the period of latency and growth of cerebral tumours. In fact, ionising radiation

(radioactivity) is recognised as a cause of brain cancer, *but cases due to radioactivity rarely become apparent before 10 or 20 years of exposure.*

The Interphone study, performed solely on adults, nevertheless raises serious speculation as to what will happen, after 15 or 20 years of intensive use, to the young adults, teenagers or even children who are currently the biggest users and in whom absorption of the radiation is still greater and more problematic.

The majority of subjects were not heavy mobile phone users by today's standards. The median lifetime cumulative call time was around 100 hours, with a median of 2 to 2½ hours of reported use per month. The cut-point for the heaviest 10% of users (1640 hours lifetime), spread out over 10 years, corresponds to about a half-hour per day.

The WHO/International Agency for Research on Cancer (IARC) has classified radiofrequency electromagnetic fields as possibly carcinogenic to humans (Group 2B), based on an increased risk for glioma, a malignant type of brain cancer, associated with wireless phone use (32)

Possible synergy between ionizing and non ionizing radiation

Potential conflict of causalities for stochastic effects

The effects on human and animal cells are the same as seen with exposures to ionizing radiation. Therefore, in the case of mixed fields is not possible to determine the source of damage

A new approach (29) considers ***breaking the barrier mechanisms of a cell as key feature of carcinogenesis***. That model also has a potential for forecasting risks of children's cancers. The barrier mechanisms (e.g., antioxidant defense, repair, apoptosis) represent the complex of cell responses to primary cell damages caused by exogenous and endogenous factors. Detrimental phenotypic changes in the cells result from insufficiency of respective barrier mechanisms.

The concepts of barrier mechanisms as a basis for the approach to the mathematical model of carcinogenesis are formulated on the basis of numerous observations collected in modern science on intracellular processes occurring in the normal and in the pathology states including malignant tumors.

While in both cases there is a DNA damage, the mechanisms of action are very different.

The ionizing radiation produces a direct breaking of chemical bonds and DNA strands, while the electromagnetic fields interferes the enzymatic process of DNA repair, probably due to the vibration produced by the EMF in dipole molecules, troubling the positioning of the functional groups and delayed the production of chemical bonds.

One can imagine a complex scenario where ionizing radiation produces DNA damage which is magnified by the presence of an electromagnetic field that interferes with enzymatic repair process. It's a classic case of synergy, whose feasibility, must necessarily be evaluated.

It's very necessary for the health-physics be aware of this situation to prevent future legal disputes.

The greatest risk in children

Unfortunately the Interphone study did not include children and adolescents although it is known that they receive more SAR for the same exposure to EMF. Following the Interphone study, currently carried out an epidemiological study in children and adolescents to determine if there is a link between cellphone use and cancer (Mobi-Kids. 2010).(6)

The child population has a greater life expectancy than adults, and cumulative exposure over time will be higher, also have important anatomical differences from adults, increased brain penetration of radiation to which they are exposed and more electrical conductivity resulting in a greater SAR (7).

The SAR for a 10-year old child is up to 153% higher than the SAR for the Specific Anthropomorphic Mannequin (SAM) model. When electrical properties are considered, a child's head absorption can be over two times greater than adults, and absorption of the skull's bone marrow can be ten times greater than adults...!!(8)

Recent studies in mice at the University of Yale (Hugh Taylor et al) which shows the increase in childhood behavioral disorders clearly show the convenience to also include case studies of pregnant women.

Changes in the electroencephalogram (EEG)

An electroencephalogram (EEG) is a recording of brain electrical activity. Provides a picture of brain activity. It is very useful because it is a representation of the synchronous activity of a relatively large number of nerve cells in the cortex, the outer layer of the brain (12).

We reviewed three reported studies.(13, (14), (15). One of the most important objectives was to investigate whether the patterns found in adults occur also in children.

This provides information on functional brain development and is important for interpreting the effects of exposure of children.

The results suggest, among others, that exposure to (RF EMF) alters the brain responses significantly during a memory task.

In France, concerns about health risks to children arising from the use of cell phones has meant specifically prohibiting the use in kindergartens, primary schools and colleges as a precautionary measure to reduce potential risks to health. Any advertising campaign promoting the use of cell phones by children below 14 years is banned. Providing radio equipments designed for children under 6 may be banned by ministerial order. In kindergarten primary school and junior high, the use of cell phones is banned for kids during all teaching activities.(19) .

The Committee of Ministers of the European Council adheres to this policy. (20).

In addition there are many countries that generated precautionary policies to limit the use of (TC) by children. Canada (21), Finland (22), India (23), Israel (24), Britain (25), Russia (26), and Switzerland (27) are some of the most prominent examples.

Also the coordinator of the Interphone project, Elizabeth Cardis, said the importance of taking measures to prevent exposure of children.

Measures applied for risk control (ICRP criteria)

The "justification" of practices is the first criterion to be applied to get the public and workers exposures properly justified.

To allow an exposure we must get a net benefit and the value of the benefit must outweighs the cost of risk involved.

The emissions limitations must follow the general criteria that are technically feasible, practically possible and economically acceptable. This is the approach used by the Swiss authority (Ordinance 814,710) (30) relating to the protection of non-ionizing radiation, and applied successfully for more than 12 years

The restrictions set for each issuer of CEM can be challenged by those responsible in cases where compliance is technically impracticable (waiver request).

The restrictions apply only in so-called sensitive sites where there is regular public presence.

The ordinance Swiss use the "precautionary principle" following an assessment of the technical and economic consequences. Thus the exposure of the population in Switzerland will remain as low as reasonable achievable.

These values reinforce the exposure limit levels for the general population as recommended by the ICNIRP.

The ICNIRP rejects the use of constraints. ICNIRP think that the use of other values arising from the optimization "Tends to increase public concern 'Rather Than Reducing worries and

controversies and Tends to create confusion and mistrust of the science, and in the authorities". This position of the ICNIRP probably arises from the confusion between the use of limit values and the constraints arising from the implementation of an optimization process. Unfortunately, this position leads to a control system based only on the use of individual levels determined increased exposure and increased risk of people.

It seems appropriate to take some precautions to prevent possible risks not yet known and prevent the consequences of exposing children from an early age.

Convenience of an agreement ICRP-ICNIRP

Having determined that the EMC "may be causing injury to the health of the people" and because the scientific evidence may be delayed in time due to the need for assessments that exceed the temporal latency of some types of tumors seems reasonable avoid exposures which are not justified to achieve the objectives of the practice, whether good communication or provide adequate power.

Moreover, there are facilities that have equipment that generates ionizing radiation and equipment producing electromagnetic fields (MRI + PET case) so it is desirable that the authorities of the ICRP and ICNIRP reach an agreement to avoid conflicts in the implementation of control measures of these facilities.

The ICNIRP uses the terminology of "science-based Exposure Limits" for individual limits and "arbitrary cautionary approaches" or "inappropriate arbitrary adjustments" for the constraints, suggesting that the process of optimization practices is not really a scientific procedure ...!

It should clearly differentiate the limits to avoid thermal effects that must not be overcome and the permissible values or constraints used to ensure that public exposures are as low as reasonably achievable. In one case are real limits that can not be overcome and the other are values that the practice indicates that it is reasonable to achieve in a particular installation. The limits represent a threshold above which may appear acute or deterministic (thermal effects), whereas the permissible values or "restrictions" are the result of a cost-benefit in reducing the likelihood of possible stochastic effects in the population as is the case of cancer (non-thermal effects).

Optimization of the practices

The optimization and cost / benefit analysis is the appropriate tool to apply the ALARA principle and make rational decisions.

The ICNIRP assures that "it is not possible to optimize a facility that produces electromagnetic fields because " the Cost of Health Detriment is unknown" and "the Cost of protection is country dependent". This situation is no different to the case of radioactive facilities. When one optimizes a facility that produces low doses, of the order of 10 mSv, using a factor that is derived from a causal relationship (5% / Sv) which is not proved or demonstrated experimentally because it is derived from measured effects at higher doses that cannot be extrapolated. But the target is to compare different alternatives..., and it's not necessary that the relationship has been demonstrated. The important thing is to make the best choice from a menu of options.

In the case of EMF-ELF can be used as a working hypothesis, the cause / effect relation derived from the frequency doubling of childhood leukemia ($Pr = 4 \times 10^{-5}$ / man year). By continuous exposure to a 1 μ T field. corresponding to a constant of 1 μ T Exposure during the whole human life. We can use ELF-EMF factor $\alpha = 100 \text{ U } \$ \text{ S} / \mu\text{T. man life}$

You can also use the best estimate of the dose-relation Mortality Given by C. E. Minder and D. H. Pfluger (Leukemia, in Swiss Railway Employees) (29) That is a value of 1% / μ T-year of cumulative thorax exposure.

Also we can use for EMF-RF optimization the relation of increase in glioma or meningioma , etc.

Related with the cost of protection, of course is country dependent , But this is not a hindrance for performing a cost / benefit assessment. The cost of human life can be also country dependent.

The Need to properly inform the population:

There should be a balance in communicating with citizens in order to avoid panic, but without hiding the information that may be useful for them to take action and adopt preventive behaviors.

WHO recommends establishing appropriate lines of communication between specialists and the public to avoid a wrong perception of risk and improve knowledge of the effects of NIR disseminating practices to minimize unnecessary risks.

Sometimes the economic greed of companies and governments not allowed them to inform the public about the risks properly.

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