6th International NIR Workshop of ICNIRP
14 - 17 October 2008, Rio de Janeiro, Brazil

Abstracts

6th International NIR Workshop

14-17 October 2008, Rio de Janeiro, Brazil

International Commission on Non-Ionizing Radiation Protection
Ministry of Science and Technology of Brazil
Pontifícia Universidade Católica do Rio de Janeiro

PUC RIO Physics Department

International Commission on Non-Ionizing Radiation Protection ICNIRP

Ministry of Science and Technology
BRASIL BRAZILIAN GOVERNMENT

Workshop Chair: Paolo Vecchia

Wednesday, October 15

09:00	Opening	Welcome by ICNIRP and the Ministry of Science & Technology of Brazil	P Vecchia L Contier de Freitas

Session 1

The Role Of International Institutions

09:30	History and role of ICNIRP	P Vecchia
10:00	International partners of ICNIRP	A Peralta
10:30	Scientific uncertainty in developing exposure guidelines	A McKinlay

Session 2

Non-Ionizing Radiation In The Human Environment

11.30	Static and ELF sources - MRI, Power lines, etc	R Matthes
12:00	RF sources - why are cell phones special?	J Lin
12:30	New EMF technologies - a challenge for radiation protection?	J Lin
14:00	Lasers - sources of optical radiation only at the workplace?	K Schulmeister
14:30	Mobile phones and cancer - how does epidemiology investigate this?	A Swerdlow
15:30	Power lines and cancer - what has epidemiology found ?	A Ahlbom
16:00	Mobile phones and risk of cancer - what has epidemiology found?	M Feychting
16:30	Laboratory studies on static and ELF fields	R Saunders

Thursday, October 16

Session 3

The Scientific Evidence: Basis For The Health Risk Assessment

09:00	Biological studies on RF fields	B Veyret
09:30	UV: from molecular effects to immunologic and cancerous impact	F de Gruijl
10:00	Needs and possibilities to protect workers from UV radiation	M Hietanen
11:00	Ocular effects of optical radiation - cataract	P Söderberg
11:30	Laser radiation: bioeffects and protection	K Schulmeister

Session 4

Protection Measures And Recommendations

13:00	EMF health risk assessments: a WHO perspective	E Van Deventer
13:30	Basis for the development of protection standards	P Vecchia
14:00	Recommendations for static and ELF fields	R Matthes
15:00	Protection policies for RF fields	B Veyret
15:30	Recommendations for optical radiation	M Hietanen
16:00	Discussion	P Vecchia

Friday, October 17

Session 5 - The Latin American Approach

09:00	Overview of EMF standards in Latin America	J Skvarka
09:20	Standards for ELF fields: the experience of Argentina	P Arnera
09:40	ELF fields and health: activities in Brazil	H Moss de Souza
10:00	RF fields and health: activities in Brazil	M S Martinhão
10:20	Mobile telephony and health: the experience of Peru	V Cruz
10:50	Role and activities of CIER	JC Belza
11:10	Role and activities of CITEL	R Terán
11:30	The Latin American Scientific Expert Panel	R Sabbatini
11:50	The Epidemiological Project EMF-SP	F Barbieri

Closing Session

12:30	New challenges in NIR protection	P Vecchia

This ICNIRP Workshop is made possible by the following institutions, whose support is gratefully acknowledged by the International Commission on Non-Ionizing Radiation Protection (ICNIRP).

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Ministry of Science and Technology of Brazil

Ministry of Science and Technology

Workshop Co-Organizer:
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Physics Department

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History And Role Of ICNIRP

Paolo Vecchia
Department of Technology and Health, National Institute of Health, Rome, Italy

The International Commission on Non Ionizing Radiation Protection (ICNIRP) was established in 1992, but its roots date much more back. In 1974, the International Radiation Protection Association (IRPA) crated a working group on non ionizing radiation (NIR), to examine the scientific knowledge about biological and health effects of different kinds of NIR (electromagnetic fields, optical radiation, ultrasound), and to identify protection needs. In 1977 this working group became the International Non Ionizing Radiation Committee of IRPA (IRPA/INIRC). Finally, at the 8th International Congress of IRPA, IRPA/INIRC was dissolved and an independent commission, ICNIRP was created, with the explicit mandate to continue the work previously conducted by IRPA/INIRC. Therefore, ICNIRP represents today more than thirty years of experience in the field of NIR protection.

The Commission is composed by 12 members, plus a Chairperson and a Vice-chairperson, and a Scientific Secretary. The variety of types, sources, characteristics, and potential effects of NIR, requires the concourse of different competences and skills, and the membership includes experts in the areas of biology, epidemiology, toxicology, physics and engineering.

In the development of its tasks, the Main Commission is supported by four Standing Committees: three of them are specialised in epidemiology, biology/medicine, and physics/engineering, respectively; the fourth focuses on optical radiation, in its various aspects. For specific tasks, external experts are often involved as consultants, in order to have additional and often specific expertise, and to widen scientific input to the activities of ICNIRP.

ICNIRP was established for the purpose of advancing NIR protection for the benefit of people and the environment. Over the years, it has gained a high scientific reputation and is widely recognized as the reference non governmental organization for the evaluation of the research literature and the provision of guidance and advice on NIR protection. It maintains formal relationships with the World Health Organization (WHO) and the International Labour Office (ILO), and actively collaborates with other international or multi-national bodies, including the Commission of the European Union.

During about half a century, NIR protection has evolved from simple, sparse recommendations such for example maximum permissible exposure levels for specific sources of electromagnetic or optical radiation to comprehensive and advanced protection systems. These systems are different for the different kinds of NIR, but are based on a common scientific, rigorous, and transparent approach. This basic approach is described in detail in a scientific paper that is available in various languages at the ICNIRP's website www.icnirp.org.

The activities of ICNIRP include critical reviews of the scientific literature on physical characteristics, interaction mechanisms, and biological effects of NIR; assessment of health risks of NIR exposure; development of basic criteria for the development of protection systems; recommendation of practical measures, including exposure restrictions; guidance to national authorities and international agencies for the protection of workers, members of the public, patients and the environment; organization of workshops, conferences and other scientific events; issue of statements, recommendations or articles on selected topics of its competence.

The assessment of health effects, first step towards the development of protection standards, has regularly been carried out in collaboration with WHO. In general, the procedure starts with WHO appointing ICNIRP to review physical characteristics, sources, mechanisms of interaction, and biological effects of the specific type of NIR under consideration. Such reviews are published as ICNIRP reports (so-called “blue books”). The blue book, together with other relevant documents (e.g. the IARC monographs on possible carcinogenic effects) serves as an input for an expert group nominated by WHO to assess the evidence for any health risk. ICNIRP actively contributes to the working group with some of its competent members, and the final document is issued as a joint publication of WHO and ICNIRP, in the series of the Environmental Health Criteria (EHC) Documents.

EHC documents have been published for all kinds of NIR: static fields, extremely low frequency (ELF) electric and magnetic fields, radiofrequency electromagnetic fields, laser and optical radiation, UV radiation, and ultrasound. They form the scientific rationale for the ICNIRP guidelines.

The guidelines are developed following scientific criteria defined *a priori*. A basic condition is that a science-based standard should only be based on those effects that are considered as established according to commonly accepted scientific criteria. Such criteria include: quality of protocols, replicability of the studies and reproducibility of their results, coherence of findings across different areas of research, consistency with fundamental laws of physics and biology. Exposure restrictions are recommended to prevent adverse effects that occur above given exposure levels (threshold effects), or to reduce risks in the case of established stochastic effects.

ICNIRP guidelines are living documents. ICNIRP continuously monitors the advancement of science, and revises its recommendations when appropriate. A revision is necessary when new scientific data clearly and consistently indicate that the existing limits are inadequate (either too permissive or unduly restrictive), but is advisable after a certain time to update the scientific rationale, if the new findings confirm the validity of the guidelines.

In collaboration with international agencies or national institutions, ICNIRP also publishes reports on technical aspects of measurements, procedures for compliance tests, and protection measures at workplaces, or develops practical tools for individual protection (e.g. the Global Solar Index).

ICNIRP organizes workshops and seminars to promote scientific discussion, specially in areas where gaps and uncertainties in knowledge still exist. disseminates information about NIR through he organization of workshops and seminars is also an institutional activity of the Commission. Through these events, and on the other side stimulates scientific discussion, specially focusing on those areas where uncertainties and gaps in knowledge still exist.

The International NIR workshop, that is traditionally organized at the end of every Commission term, represents a special occasion for a comprehensive review of the status of the art in the different areas of NIR, and for a thorough discussion on the future perspectives of NIR protection.

Biographical Information

Paolo Vecchia graduated in Physics at the University of Rome in 1969. Since 1973, he has been serving at the National Institute of Health (ISS) in Rome, where is actually Research Director in the Department of Technology and Health. He has been working in the field of Non Ionizing Radiation (NIR), performing both basic research and control activity aimed at the protection of workers and of the general public. Responsibilities of Paolo Vecchia include advice to health and environmental authorities on any health problem related to NIR. In the field of basic research, he has been involved mainly in studies on possible effects of electromagnetic fields on the immune system as well as in theoretical dosimetry. He is also collaborating to epidemiological studies relative to both low- and high-frequency fields. He has organized and directed courses on different topics related to NIR at the Advanced School for Radiation Protection in, Italy. He has also been lecturer at several national and international schools, and Professor of "Fundamentals of Protection against

Non Ionizing Radiation" at the University of Pisa and at the post-graduate school of Health Physics of the University "Tor Vergata" in Rome. Paolo Vecchia has participated in a number of national and international commissions and expert groups. Past President of the Italian Radiation Protection Association (AIRP), and of the European Bioelectromagnetics Association (EBEA), he is presently Chairman of the International Commission on Non Ionizing Radiation Protection (ICNIRP), and Member of the International Advisory Committee of the International EMF Project of the World Health Organization.

International Partners Of ICNIRP

Agnette P. Peralta
Department of Health, Republic of the Philippines

Being a scientific organization which develops guidelines and provides technical advice on non-ionizing radiation protection. ICNIRP draws support from international organizations such as the World Health Organization, the United Nations Environment Program, the International Labor Organization, the European Commission, and the International Radiation Protection Association. ICNIRP also organizes scientific meetings with support from governmental ministries and institutes such as those of the German, Austrian, UK, Italian, Swiss, and Japanese Governments. It also maintains links with other standard setting and scientific bodies, and with organizations of professionals who work with electromagnetic fields. The relationship of these organizations and bodies vis-à-vis ICNIRP are discussed.

Biographical Information

Agnette P. Peralta received her BSc in Physics from the University of the Philippines and her M.Sc. in Medical Physics from the University of Wisconsin-Madison, USA. She is the Director of the Bureau of Health Devices and Technology of the Department of Health, Republic of the Philippines. She is also a Professorial Lecturer in the Medical Physics program of the Graduate School, University of Santo Tomas, Manila. Main research and work interests are radiation protection, radiation dosimetry, and radiation regulation. She is a member of the International Advisory Committee of the World Health Organization EMF Project. She has served the ICNIRP Commission since 2004.

Scientific Uncertainty in Developing EMF Exposure Guidelines

Alastair McKinlay
Health Protection Agency, UK

Guidelines for limiting exposure of people to electromagnetic fields (EMF) are intended to provide a framework for a system of protection by recommending limits, termed by ICNIRP 'basic restrictions', to avoid the adverse health consequences of exposure.

Fundamental to the development of exposure guidelines are thorough reviews of the science. This constitutes the basis for the EMF risk assessment process. In this respect the International Commission on Non-Ionizing Radiation Protection (ICNIRP) carries out and publishes scientific reviews on EMF and health and also contributes to the health risk assessments carried out by WHO that result in the publication of Environmental Health Criteria documents. These particular reviews and assessments and those carried out by national expert groups all inform the development of exposure guidelines.

Fundamental to the process is an overarching policy of cautious interpretation of the science. The exercise of caution is based on knowledge and understanding of the sources of uncertainty in the scientific data and is an intrinsic part of the EMF risk assessment process. The degree to which caution is applied in the interpretation of the scientific evidence is a matter of judgement and should be consistent. EMF exposure guidelines for the general public should ensure that general community protection is provided.

The primary source of information for a health risk assessment is the published scientific evidence from epidemiological studies, human (volunteer) laboratory studies, and animal (bioassay) laboratory studies. For better understanding of the biochemical and biophysical mechanisms that may be involved, the results of in vitro studies should also be included. Thus, a necessary part of EMF health risk assessment is the examination of the scientific data in a holistic manner, bringing together and assessing the evidence from the life sciences.

A major difficulty in the development of EMF exposure guidance has been that the interpretation of studies of potential health effects is controversial. There exists a spectrum of opinion within the scientific community resulting in divergent views on what adverse effects should constitute a basis for the setting of quantitative limits on exposure. Intrinsic to this is the degree of certainty of the effect being caused by exposure to EMF, as demonstrated in biological studies, or only associated with exposure such as from epidemiological studies. Thus, in developing their advice on limiting exposure, bodies such as ICNIRP have sought to clarify:

- effects that can be firmly concluded on scientific grounds as being caused by exposure to EMF where supporting scientific data are sufficient to provide insight into the mechanism underlying the effect and from which one can quantify appropriate restrictions on exposure and;
- effects where there is evidence of association with EMF exposure but where the scientific data are insufficient either to make a conclusive judgement on causality or to quantify appropriate restrictions on exposure.

Biographical Information

Alastair McKinlay is Head of the Physical Dosimetry Department at the United Kingdom Health Protection Agency's Centre for Radiation, Chemical and Environmental Hazards. He is a graduate of Strathclyde University Scotland where he received a B.Sc. (Hons.) in Natural Philosophy. He was awarded a Ph.D. by the UK National Council for Academic Awards for studies in thermoluminescence dosimetry. Appointments held previously included: Membership of the United Kingdom "Application of Radioactive Substances Advisory Committee" (ARSAC): President of the UK National Committee of the International Commission on Illumination (CIE): Chairman of the European Commission Expert Group on Mobile Telephony and Human Health: Founding member and immediate past President of the European Society of Skin Cancer Prevention (EUROSKIN): Past member of the Research Steering Committee of the UK National Adult Brain Tumour Study: Past member of the Programme Management Committee of the UK Mobile Telephone Health Research (MTHR) Programme. Alastair is a member of the International Advisory Committee of the WHO EMF Project and has served on three WHO Health Risk Assessment Panels. He was a Main Commission Member of ICNIRP from its inception in 1992 until 2004, its Vice-chairman from 1996 to 2000 and was Chairman of ICNIRP from 2000 to 2004.

Static And ELF Sources

Rüdiger Matthes
Federal Office for Radiation Protection, Germany

This presentation describes the most common sources of exposure to static and time-varying electric and magnetic fields up to 100 kHz. The sources are essentially divided into those of natural origin and man-made. Naturally occurring fields arise from electrical processes associated with the Earth and the atmosphere. Man-made exposure arises from the wide use of electrical energy at various frequencies and the field strengths generated usually by far exceed those of natural fields.

The chapter focuses in particular on the most important source of man-made static and ELF exposure – that associated with the generation, transmission and use of electricity at the power frequencies of 50 or 60 Hz. Some types of sources and electrical equipment can produce electromagnetic fields at other frequencies such as railway systems or diagnostic medical systems. These are also discussed. In order to give an overview of representative field levels data have been selected from a variety of national and international reports, mainly from Europe and the USA. They can be found in more detail in the ICNIRP ELF review “Exposure to Static and Low Frequency Electromagnetic Fields, Biological Effects and Health Consequences (0-100 kHz)”, in the WHO Environmental Health Criteria 232 “Static fields”, and in the Environmental Health Criteria 238 “Extremely low frequency fields”.

The data presented here have generally been selected to reflect peak or typical field levels. In the case of prolonged exposure, the time weighted average (TWA) is reported; in some cases the median or geometric means are preferred.

There are many aspects to consider in describing exposure. In assessing exposure levels account needs to be taken of spatial variation of the field and possible temporal changes; these often depend on the nature of the source and the way it is used. Although most assessments aim to reflect typical exposure conditions, they do not necessarily account for the field variation in time and space, which can be large. The field levels also depend not only on the individual source type but also on the technologies, which may vary from country to country.

Biographical Information

Rüdiger Matthes received his M.E. degree in electronic engineering from the Technical University in Munich. Since 1989 he is Head of the group "Non-Ionizing Radiation (Dosimetry)" at the German Federal Office for Radiation Protection. The interests of this group cover all aspects of NIR protection with the main focus on dosimetry. He has been the Scientific Secretary of ICNIRP since 1993. He has served the Standing Committee on Physics and Engineering (SCIII) as a Chairman since 2004 and the ICNIRP Commission since 2004

RF Sources - Why Are Cell Phones Special?

James Lin, Masao Taki and Soichi Watanabe
University of Illinois – Chicago, USA

Modern lives are greatly impacted by wireless technologies that utilize radiofrequency electromagnetic energy. Wireless communication was first achieved by Guglielmo Marconi in the last decade of the 19th century, only ten years after the Heinlich Herz 's discovery of electromagnetic waves. The explosive spread of cellular mobile telephones started, after another hundred years, during the last decade of the 20th century. This communication technology has brought drastic changes to human lives.

Wireless radio communications first aimed further and further distance transmission to achieve global communications. Output power of radio transmitters becomes higher to achieve longer distance communications, while the number of radio communication stations are limited to avoid interference with each other. Cellular phones, on the other hand, introduced a paradigm quite contrary to this aim, i.e., wireless communications over very short distances. The range of wireless communications is limited in the region called “cell” around a base station. The output power of transmitters is minimized to cover only within the cell. The system requires many antennas for each cell to cover a wide area. Communication takes place between the base station and mobile phones in the cell.

Human exposures to cell phone system are different from those due to conventional long distance radio communications. Exposure by cell phone system comes from two modalities: base stations and mobile-phone handsets. Exposure to base station transmitters is characterized by long-term low-level exposure. It should be noted that the exposure is quite low except in the very vicinity of the antenna, where the general public does not have access. It is often assumed that the exposure is the highest in the area closest to the tower. The actual distribution of electromagnetic field does not show such simple dependency on the distance from tower, instead the distribution is rather uniform. This meets the requirement of the system which aims toward homogeneous distribution of field strength to provide the uniform wireless service. The size of cells depends on the traffic. Busy area needs small cells to allow many calls, while base transmitters are sparse in rural area.

The exposure by mobile phone terminals is characterized by highly localized exposure on the side of the head. This kind of exposure has not been common until the advent of the explosive spread of mobile phones in the 1990’s. The highly exposed part of the head experience considerable magnitude of internal electromagnetic field during cell phone use. While the exposure complies with the current protection guidelines, the exposure is high compared to the exposure that the majority of public has experienced so far. It is also noted that the exposure is continual throughout one’s lifetime. This is the reason why the possible health risk is of concern. Thus, it warrants careful investigations. The INTERPHONE study was motivated in part by this concern.

Mobile communications has experienced rapid evolution. The first generation (1G) was the analog system mainly used from 1980’s to 1990’s. The 2G digital systems, such as the GSM system, have been used all over the world. Now 3G is in service in many countries.

Higher frequencies are employed in the newer generation to achieve higher transmission rates. The digital systems have introduced complex waveforms according to different system specifications. Whether different waveforms could affect neurological functions differently has become a question.

The exposure depends on the output power of the device. The output power varies for various reasons. Automatic power control (APC) plays a dominant role in deciding the output power. The

APC regulates the output power to optimize the signal strength. Thus, the output power depends on the distance to the base station.

New wireless technologies are rapidly emerging. Many of these are intended for wireless communication of very short range, around the user. These emerging technologies will be discussed in the next presentation.

In summary, cellular mobile telephone systems introduce a new kind of radio frequency exposure of a majority of world's population. However, there is little cause for concern about health risks due to exposure by base station transmitters, especially if one takes into consideration the low exposure level compared to the exposure by conventional radio broadcasting transmitters. Exposure by mobile phone terminals is of greater concern and warrants further scientific studies. It should be noted that the exposure is actually in compliance with the current guidelines.

Biographical Information

James Lin is a Professor of electrical engineering, bioengineering, physiology and biophysics at the University of Illinois-Chicago, where he has served as Head of the Department of Bioengineering, and as Director of Special Projects for the College of Engineering. He held an NSC Research Chair from 1993-97, a recipient of the d'Arsonval Medal of the Bioelectromagnetics Society and has served as its president. He is a past chair of IEEE Committee on Man and Radiation and URSI Commission on Electromagnetics in Biology and Medicine. He was a vice president of the US National Council on Radiation Protection and Measurements (NCRP). He is Editor-in-Chief of Bioelectromagnetics, and Editor of the Springer book series on Advances in Electromagnetic Fields in Living Systems. He is the author of numerous journal papers, book chapters, and several books. His column on telecommunication radiation safety and health is carried by four professional magazines.

New EMF Technologies - A Challenge for Radiation Protection?

James C. Lin
University of Illinois – Chicago, USA

Rapid development and deployment of wireless communication technology has led to increasing numbers of new devices and systems that emit radio-frequency (RF) electromagnetic (EM) energy. This has resulted in large numbers of individuals at the workplace or in the general public being exposed to RF-EM fields. In most cases, the RF sources are in close proximity to the human body. The increased exposures at the workplace or in daily life have prompted the need for further research to evaluate RF safety and health implications. It is estimated that more than 3.5 billion people have access to cellular mobile telephones--nearly half of the world population, at present. Worldwide mobile phone sales are increasing at the rate of about one billion units a year. By comparison, 20 percent of the population live without electricity and its services world wide but interestingly many have access to a mobile telephone. Indeed, at the current rate of growth more of the world's population will have access to mobile phone services than to electricity. However, exposure to RF-EM fields is not limited to mobile or wireless communication; widespread applications of RF-EM fields are found in RF article identification and surveillance, inductive heating devices and appliances, adaptive vehicular cruise control, advanced magnetic resonance imaging, on-body biomedical sensing and interrogation, novel active and passive security and detection technology, and proposed digital living network applications (DLNA). Given the technological, regulatory and marketing challenges, the timing of the introduction or deployment of many new applications is somewhat uncertain. It should be noted that the experience of the cellular mobile telephone industry indicates that once new technology is deployed, the adoption rate can easily explode. While it takes advanced technology to develop a product, the availability of low-price, high-quality and high-performance components from around the world brings down the cost of a new product through large-scale production. Without a doubt the total level of human exposure will rise because of the superposition of new and existing sources. There is a real need for reliable scientific answers on health effects associated with exposures resulting from widespread applications of RF-EM fields in new and existing devices and systems.

Biographical Information

James Lin is a Professor of electrical engineering, bioengineering, physiology and biophysics at the University of Illinois-Chicago, where he has served as Head of the Department of Bioengineering, and as Director of Special Projects for the College of Engineering. He held an NSC Research Chair from 1993-97, a recipient of the d'Arsonval Medal of the Bioelectromagnetics Society and has served as its president. He is a past chair of IEEE Committee on Man and Radiation and URSI Commission on Electromagnetics in Biology and Medicine. He was a vice president of the US National Council on Radiation Protection and Measurements (NCRP). He is Editor-in-Chief of Bioelectromagnetics, and Editor of the Springer book series on Advances in Electromagnetic Fields in Living Systems. He is the author of numerous journal papers, book chapters, and several books. His column on telecommunication radiation safety and health is carried by four professional magazines.

Lasers - Sources Of Optical Radiation Only At The Workplace?

Karl Schulmeister
Austrian Research Centers, Seibersdorf, Austria

For a long time lasers were only used for professional applications such as science, medicine, industry and military. Gas lasers such as CO2 and Argon lasers, as well as the solid state lasers Nd:YAG and Ruby were simply too expensive to be attractive to be marketed as consumer products for “everybody”. The closest a laser in the 1970s came to be considered a consumer product were HeNe Lasers used as laser pointers in lecture theatres. This scenario changed drastically, when laser diodes were mass produced, first used in laser printers and CD players, later on also, with higher power, for CD writers and DVD writers. However, these latter types of consumer laser products are enclosed products where eye safety is ensured because the laser radiation is not accessible. About 10 years ago, laser pointers were the first laser product that became widely available as consumer product and that used an open beam. With powers of a few Milliwatts, the risk for eye damage from these laser pointers is minimal, but some retinal injuries occurred following intentional exposures, i.e. misuse (see also ICNIRP Statement on Laser Pointers, Ref. 1). However, in the last couple of years, higher power laser diodes and laser diode pumped frequency doubled Nd:YAG lasers (532 nm wavelength, green) became available that are marketed as high power (but still battery driven) laser pointers or a laser shows, with prices that qualify them as consumer products and powers exceeding 100 mW (i.e. A 30 mW laser pointer, a laser show with 100 mW and a hair removal laser with a power of 500 mW). Laser projectors and TVs will also be available soon, either with back projection, where the laser radiation is not accessible or where the laser radiation replaces the broadband light source in a forward projection system. Other laser products for non-professional use can be grouped as health or cosmetic products, where lasers are for instance marketed for low level laser therapy (“stimulating” lasers) as well as for hair removal.

The development that higher power lasers became cheap enough for non-professional use is some cause for concern and has to be dealt with by product safety legislation and market control authorities (what products are allowed to be put on the market) as well as by technical standardisation, the latter at the moment not really being adequate in all cases. The main issue here is what types of lasers (safety classes, or output power) are considered acceptable for private use. It should be added that the exposure limits that are specified by ICNIRP for exposure to laser radiation of the eye and the skin are defined for both private as well as professional use. Since the effects of optical radiation on the eye and the skin are well known, there is no need to use a larger safety factor for the general population as compared to exposure at the workplace, as is done for other fields of radiation protection. However, the safety criteria for consumer products are higher than for products used at the workplace and this affects what is considered as acceptable in terms of output power of a laser for private use. For instance, in Europe, there is a special “General Product Safety Directive” that regulates the criteria for product safety of consumer products (in terms of putting products on the market) and in Austria is the basis for a special “Laser Pointer By-Law” limiting the class of laser pointers placed on the market to Class 2. Consumer products need not be “safe” in the sense of “no risk for injury”, but the usual criterion, in a simplified way is that a consumer product needs to be as safe as it is expected. For instance, a knife is known to be sharp and parents keep knifes away from children. A knife according to product safety legislation is “safe” because everybody knows it is sharp and there is not even a need for a warning label. On the other hand, for most products that are not tools, it is generally expected that the risk for injury is low even without special precautions or training, and this also applies to products containing lasers.

Traditional Laser Safety Concept

It is important to differentiate between legal requirements regarding product design (legal requirements that are addressed to the manufacturer and placing products on the market) on the one hand and user safety issues (what the user “has to do”, such as wearing personal eye protection) on the other. Regarding the latter - user requirements - only for the workplace there are legal systems that regulate what the user has to do, which is then also controlled by governmental workplace health inspectors; for private persons using lasers, such a legal system does not exist and also would not be practical. There are national differences in the details of legal of requirements and governmental control of the market and the workplace, respectively, but to some degree, in principle all industrialised countries have such a legal system in place.

For lasers, specifically, a system of “laser safety practice” developed in the early 1970s in the US which was soon adopted on an international level and by many countries as a practical system to fulfil the respective national legal requirements. The system in principle consists of a classification system and manufacturer requirements such as labelling and interlock connections, in parallel with a list of user measures. Following this system, laser products are assigned to hazard classes from Class 1 (safe even for prolonged exposure) to Class 4 laser products with the highest hazard for the eye and potentially also the skin2,3. For the higher hazard classes, Class 3B and Class 4, a default system of user measures (controls) was historically established that included defining a hazard area around the laser with access control and warning labels on doors, training of the users, and personal eye protection4,5. Also a so called “Laser Safety Officer” often is given the task of overseeing the user measures. This system was mainly developed for higher power lasers with open (non-enclosed) beams that were usually collimated, as used for scientific research, medical applications and also for materials processing (before it became good engineering practice to enclose materials processing stations.)

This system, however, only makes sense for professional laser users at the workplace where user measures are legally enforced by national occupational health and safety legislation6,7. These occupational health and safety laws, if they do specify exposure limits for the eye and skin, are either well harmonised with the ICNIRP exposure limits (EL) or adopt the ICNIRP ELs 1:1 (EU Directive). The laser product hazard classes help the employer or workplace safety inspector to determine if the EL can be exceeded or not, since the emission limits of the lower hazard classes Class 1, Class 2 and Class 3R are directly derived from the ICNIRP ELs8. This “Laser Safety” system was developed in the 1970’s and was adopted in many countries, with some variation in national implementation.

Shortcomings for Laser Consumer Products

Since user safety measures can really only be relied upon in professional laser applications, the existing “Laser Safety System” has some shortcomings when higher power lasers are marketed as consumer products, i.e. for private use. For instance, it is not realistic that a 16 year old who buys a 200 mW laser show for a basement disco-room also attends a laser safety officers training course. It follows that for consumer products, if the laser beam is accessible, the output power has to be restricted so that exposure of the eye and skin above the EL does not occur. International standardisation does not provide for such a restriction: the basic laser safety standard, IEC 60825-1 does not restrict the output power of laser products, it just calls for warning labels on the more hazardous laser products. However, a warning label “Avoid eye or skin exposure” does not make the product “safe”, at least not when it is a consumer product. A regular user in a household can not cope with the hazards and pure information and warning is not acceptable - a consumer product has to be engineered so that it is adequately safe, i.e. safe by design of the hardware, not by warning. This same shortcoming of IEC 60825-1 is also found in the US national (CDRH) regulation for laser products. In many countries, general product safety legislation is in place which requires that only “safe” products are placed on the market (for instance in Europe the

General Product Safety Directive, or the Low Voltage Directive and their national implementations). In Europe, the legal requirements are very general and the system (the so called New Approach) relies on (non-binding) technical standards to specify detailed technical requirements (see for instance the “Blue Guide”9,10 and reference 11 for a discussion on laser related issues). While the legal requirements are adequate (because they are general), the technical standards that are historically based on professional laser users are not adequate when it comes to Class 4 and Class 3B laser products. The traditional system places a considerable share of the burden to avoid eye damage on the user, which only is acceptable for professionally used products. While product safety legislation for instance in Europe would provide the basis for restricting the output emission to safe levels (and an enforcement is for instance considered by the Austrian Ministry of Consumer Protection), a technical standard would provide a useful means for international harmonisation and specifying technical details. While for some products categories, such as audio visual products, IT products, and toys12,13,14, specific requirements for lasers exist that typically limit the output, if any, to Class 1, other types of products such as measurement lasers15 or medical laser products16 are not restricted and some types of laser products such as laser pointers or laser shows currently do not appear to be in the scope of any product specific technical standard. While in the end technical standards are non-binding (voluntary) and the only binding code is national product safety legislation, it would be beneficial to make sure that all types of laser products are covered by product specific standards and that these standards also specify adequate emission levels or acceptable hazard classes, which might for consumer products be more restrictive than for professional laser products such as medical lasers or scientific lasers.

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Biographical Information

Karl Schulmeister received his MSc in physics in 1992 from the Vienna University of Technology and his PhD in biophysics in 2001. Since 1994 he is head of the „Laser and Optical Radiation Safety" group in the Austrian Institute of Technology in Seibersdorf, Austria. His team has developed a probabilistic risk analysis model for space based lasers, as well as computer and ex-vivo models for laser induced ocular damage. He is co-author of the book „Laser Safety". He also serves as lecturer for Non-ionizing Radiation Protection at the University of Technology in Graz. Dr. Schulmeister is head of the Austrian delegation to IEC TC 76 (Laser), where he is also the technical secretary of Working Group 1 on radiation safety standards. Since 2002 he serves as Associate Director of Division 6 "Photobiology" of CIE, the International Commission on Illumination. He has been serving on ICNIRP SCIV since July 2003 and on the Commission since 2008.

Epidemiology Of Risks Of Cancer In Relation To Mobile Phone Use

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There are now more than 2 billion users of mobile ("cellular") phones in the world. The possibility of health ill-effects from radiofrequency exposure during the use of the phones has received wide publicity from the media in many countries. Epidemiology is the scientific discipline that investigates directly whether there is an association between exposures or behaviours and risks of disease in man, and specifically that has investigated whether there is an association between mobile phone use and the risks of cancer and other diseases in man. The focus of interest has been on risks of cancer, especially brain and other head tumours because the exposures of radiofrequencies from the phones is primarily to the head. In order to be able to construct policy and to respond to public anxieties, it is important to be able to interpret published epidemiological studies on mobile phones and cancer, and to assess the literature overall.

The first lecture by A. J. Swerdlow will address the methods by which epidemiologists have investigated the risks of cancer in phone users, the strengths, weaknesses and interpretation of these types of study, and how one can evaluate published papers on this subject as they appear in the literature, in order to make informed judgments about the published results.

The second lecture by M. Feychting will describe the results of studies published to date, what can be concluded from them at present, and the likely future course of research in this area. The studies discussed include both individual studies in particular countries, and pooled analyses bringing together results from several countries.

Biographical Information

Anthony Swerdlow was educated in medicine at the universities of Cambridge and Oxford. After junior posts in clinical medicine, epidemiology and public health in the Oxford region and London, he worked in epidemiology at the University of Glasgow and at the Office of Population Censuses and Surveys before moving to the London School of Hygiene and Tropical Medicine in 1987. He has been Professor of Epidemiology at the Institute of Cancer Research since July 2000. His research is in chronic disease epidemiology, mainly on cancer. His research interests have for many years included non-ionising radiation and he is currently Chair of the Health Protection Agency Advisory Group on Non-ionising Radiation. Dr. Swerdlow has been a member of ICNIRP since May 2000.

Maria Feychting is a Professor of Epidemiology at the Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden. Her research is focused on environmental risk factors for chronic diseases, primarily cancer but also neurodegenerative diseases. She has been involved in epidemiologic research on non-ionising radiation since 1987, covering both ELF and RF electromagnetic fields. She has a specific interest in adult and childhood brain tumour aetiology, both environmental and genetic factors, as well as gene-environment interactions. She participates in the work of the WHO EMF programme, as well as other national and international scientific committees. She is scientific secretary of the Swedish Radiation Protection Authority's independent scientific expert group on electromagnetic fields.

Power Lines And Cancer – What Has Epidemiology Found?

Anders Ahlbom
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A study by Wertheimer and Leeper in 1979 planted the seed to a long period of extensive research about the possibility that magnetic fields of the type generated by power lines could have health effects (1). Wertheimer and Leeper found an increased risk of cancer mortality in children who lived close to power lines relative to children who lived further away. They postulated that the magnetic fields that were generated by the currents in the power lines was the cause of this increase. This was questioned by large parts of the scientific community because the study was unorthodox in many respects and because the the interpretation was considered implausible. Yet, this original study was followed by other studies aimed to see whether the original results could be replicated or not. Perhaps to the surprise of many, the follow up studies found a fairly, consistent pattern of associations between magnetic fields and childhood leukemia although some studies did not see this association (see e.g. (2-4). A systematic pooled analysis of the highest quality studies resulted in a relative risk of 2.0 (95% CI: 1.3-3.1) for children living in homes with fields above 0.4 microtesla (5).

In parallell with the quest for an understanding of the observed associations between childhood leukemia risk and exposure to magnetic fields also cancer in adults were investigated. This research included cancers of the breast, prostate, brain, and leukemia in adults. While several positive results were found at first, they were never as convincing as the childhood leukemia findings. At present, breast cancer is mainly written off as the result of later large negative studies. For the other cancers the case remains open but the available evidence for an association is weak.

The epidemiologic findings have also prompted extensive experimental research aiming to find supporting evidence. Several mechanistic hypotheses have been presented and tested but to date no biological or biophysical explanation to the results seen in childhood leukemia have been found.

A comprehensive review and analysis of both the epidemiologic and experimental research relating to power frequency magnetic fields and cancer can be found in the monograph produced by the International Agency for Research on Cancer (IARC) in connection with its evaluation of the carcinogenicity of power frequeny magnetic fields (6). The evaluation classified magnetic fields in category 2B, which translates to ”possibly carcinogenic to humans”. Very similar conclusions have been reached in other evaluations such as the WHO's Environmental Criteria and the European Commission's Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR).

It is perhaps worth noting that this risk evaluation of magnetic fields and cancer does not in itself automatically lead to any type of risk management decision. For example, before some precautionary action is implemented, also other factors such as economical consequences and public's concerns have to be considered.

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Biographical Information

Anders Ahlbom is a Professor of Epidemiology, Head of the Division of Epidemiology and deputy director of the Institute of Environmental Medicine at the Karolinska Institute, Stockholm, Sweden. Main research interests are environmental epidemiology with an emphasis on cancer, in particular non-ionizing radiation and cancer. He has a longstanding interest in cardiovascular diseases and their relation to the interaction of environmental factors and biomedical risk factors. His work spans epidemiologic theory and methods, including the basis for causal inference. Dr. Ahlbom is Chairman of the ICNIRP Standing Committee on Epidemiology and has been an ICNIRP member since 1995.

Laboratory Studies On Static And ELF Fields

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This paper draws extensively on a number of recent reviews of laboratory studies of the biological effects of static and extremely low frequency (ELF) fields by various national and international expert groups, particularly those by World Health Organisation (WHO) Task groups and by the International Commission on Non-ionizing Radiation Protection (ICNIRP).

The surface electric charge induced on the human body by exposure to static and ELF electric fields is perceptible above an electric field strength of about 10 kilovolts per metre (kV m-1) and can be annoying above this value. Similar phenomena occur in animals.

Short-term exposure to static magnetic fields up to 8 tesla (T) and movement within associated static field gradients induce a number of acute effects. Cardiovascular responses, such as changes in blood pressure and heart rate, have been occasionally observed in human volunteer and animal studies but were within the range of normal physiology. Physical movement in static magnetic fields gradients can induce transient sensations of vertigo and nausea in volunteers and aversive behaviour in animals. There have been insufficient long term animal studies from which to draw conclusions.

Exposure to ELF magnetic fields of sufficient intensity can stimulate nerve tissue in humans causing nerve and muscle stimulation; threshold induced electric fields are approximately a few volts per metre up to a few kilohertz. In addition, the sensation of flickering light can be induced by stimulation of electrically excitable cells in the retina; induced electric field levels are as low as 50-100 mV m-1 at 20 Hz. It is less clear whether brain function and the neuroendocrine system is affected by exposure to less intense ELF fields. For hypersensitive people, the evidence suggests that the reported symptoms are unrelated to EMF exposure.

Otherwise, the exposure of mammals to ELF magnetic fields does not result in developmental abnormalities. In contrast to epidemiological evidence suggesting an increased risk of childhood leukaemia associated with prolonged exposure to relatively high environmental power frequency magnetic field levels (> 0.4 μT), the animal cancer data are almost universally negative although there is no good animal model for this particular cancer. The data from cellular studies are generally supportive of this view, though more equivocal.

Research recommendations for laboratory studies of static and ELF fields are available on the WHO EMF Project website (http://www.who.int/peh-emf/research).

Biographical Information

Richard Saunders graduated from the School of Biological Sciences at Birmingham University in 1969 and received a PhD in Zoology and Comparative Physiology in 1973. He then worked briefly at the Institute of Human Physiology, Milan University, Italy, and at the Neurocommunications Research Unit, Queen Elizabeth Hospital, Birmingham. In 1975 he joined the National Radiological Protection Board. He now works part-time in the Radiation Effects Department, having previously headed the Non-Ionising Radiation Effects Group at the Radiation Protection Division of the United Kingdom Health Protection Agency. His main research interests are in the biological effects of EMFs. In 2004, he spent a sabbatical year working for the WHO EMF Project in Geneva, Switzerland, and has been a member of several WHO EMF Environmental Health Criteria Task

Groups. Dr Saunders is Chairman of the ICNIRP Standing Committee on Biology and has been a member of the ICNIRP Commission since October 2006.

Biological Studies On RF Fields

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Biological studies are taken here to include laboratory experiments using volunteers, as well as those using various animal species such as rats or mice, and those using cultured cells.

WHO (1993) reviewed a large number of biological studies of the effects of exposure, often at levels sufficient to induce considerable heating, to RF radiation at frequencies commonly used for industrial, scientific and medical purposes, most commonly 915 and 2450 MHz.

The rapid increase in wireless telecommunications, particularly those used in mobile telephony has resulted in health concerns regarding the ubiquitous exposure to complex but generally low level RF signals emitted by such devices. A number of large, well-coordinated research programmes have been undertaken, often at RF of around 900 MHz and 1800 MHz, typical of GSM systems and more recently at around 2100 MHz, typical of the 3G systems. Much of this effort has been centred in Europe. A coordinated approach has promoted replication studies of notable positive outcomes.

Mechanisms

There are several theoretical hypotheses describing potential mechanisms for low-level RF biological effects. Some have been tested experimentally, but so far there has been no compelling evidence that they might plausibly account for such effects. Further biological hypotheses currently being pursued include the possible effects of RF exposure on neuronal networks and on sleep EEG; both topics await the results of the RF demodulation experiments. The plausibility of non-thermal mechanisms induced in tissues by low-level RF exposure is very low. Mechanistic research will be reactivated only if new experimental evidence of low-level biological effects is gathered.

Cell studies

Potentially, cell studies give insight into the basic mechanisms by which effects might be induced in more complex animal or human subjects. Interpretation is, however, limited by anomalous cell behaviour generated by the culture conditions and other factors which limits the extrapolation of such data to humans. The studies conducted so far, have not provided consistent evidence of biological effects under non-thermal RF exposure conditions. There have been, for example, studies of possible genetic effects but in most cases where positive findings were made these could be attributed to a thermal insult rather than to the RF-exposure as such. The same holds true for other endpoints.

Animal studies

Overall, the conclusions of WHO (1993) that the most consistent and reproducible responses of animal to acute RF exposure result from RF-induced heating remain unchanged. Deficits in learned behaviours, particularly the disruption of on-going operant behaviours, occur mainly when core temperatures are increased by about 1℃ or more.

There is no consistent evidence of effects at nonthermal exposure levels. Relatively few studies have evaluated possible effects of prenatal exposure on postnatal development; results from such studies have not shown consistent effects on developmental indices or behaviour at exposure levels that do not induce hyperthermia. However, to date, there remains insufficient evidence to form a conclusion regarding the possibility of effects from such exposure.

The results of recent carcinogenicity studies are rather consistent and indicate that carcinogenic effects on rodents are not likely at SAR levels up to 4 W kg-1. Genotoxicity studies also generally indicate a lack of effect. A notable positive finding was of a two-fold increase in lymphoma incidence in a strain of lymphoma-prone transgenic mice following exposure to 900 MHz RF fields with a signal similar to that used in GSM mobile phones. However, this finding was not confirmed in two subsequent replication and extension studies.

Human studies

The advantage of laboratory studies using human volunteers is that the results indicate the likely response of other people exposed under similar conditions, but the disadvantages include the often short duration of investigation, the small number and larger heterogeneity of volunteers compared to inbred animal strains. One consequence is the often low power to detect any effect. Furthermore, the subjects are usually chosen healthy and are therefore unlikely to reflect the range of responses of encountered within a population. For example, the very young and the elderly, or people on medication, have rarely be included within experimental study groups. Nevertheless, within this limited context, volunteer studies can give valuable insight into the physiological effects of exposure in normal, healthy people.

The most consistent effects of acute RF exposure on human subjects are the thermoregulatory responses to RF-induced heating.

Most volunteer studies have investigated the effects of RF exposures characteristic of mobile phone use, usually to the head, on a number of physiological parameters including brain electrical activity and blood flow, cognition, and more generally on the endocrine and cardiovascular systems. Children and adolescents have become an increasingly important focus of RF studies, given the increasing awareness of the continued maturation of the brain into late adolescence, and a several recent studies using school children have been carried out. In addition, some studies have addressed adults who report themselves to be 'electrosensitive'.

There is some evidence which suggests that exposure to a GSM-type signal may affect the spontaneous EEG in volunteers. A similar conclusion of variable and inconsistent results can be drawn with respect to the effects of exposure to GSM-type signals on EEGs generated during sleep. Despite there having been a large number of studies of cognitive function, no consistent effects on cognitive performance have been found, although the use of a large variety of techniques to assess cognitive performance increases the difficulty with which the results of different studies may be directly compared.

With regard to more general physiological endpoints, the weight of evidence from the studies on auditory and vestibular function indicates that neither hearing nor the sense of balance is influenced by short-term exposure to mobile phone signals. In addition, there is no clear evidence of mobile phone type RF exposure on resting heart rate or blood pressure, nor is there consistent evidence of any effect on serum melatonin, or on pituitary hormone levels. However, small but inconsistent variations on heart rate variability were reported in two studies.

Conclusion

There is so far no evidence of a mechanism for low-level RF effects. In the laboratory, no biological effects have been established, but there are still some questions and concerns regarding long-term exposure, children, and the issue of extrapolation of the knowledge acquired with 2G signals to 3G and other wireless communications signals.

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Biographical Information

Bernard Veyret belongs to the Centre National de la Recherche Scientifique (CNRS) as “Directeur de Recherche” (senior scientist) at the “Laboratoire de l’Intégration du Matériau au Sytème”, within the College of Chemistry and Physics at the University of Bordeaux, France. Trained as an engineer in Physics and Chemistry at ESPCI in Paris, he joined the CNRS in 1979, did research on the physical chemistry of the troposphere. Since 1984, Bernard Veyret has turned towards the new field of bioelectromagnetics. He is now head of the Bioelectromagnetics Laboratory of the ‘École Pratique des Hautes Études’. His research team in Bordeaux is composed of about 15 scientists, biologists and physicists. He was one of the founding members of the European Bioelectromagnetics Association (EBEA) in 1989. He spent a sabbatical year at the University of Rome “La Sapienza” during the school year 2005-2006. Bernard Veyret has authored 80 papers in peer-reviewed journals and co-authored several national and international expert-group reports on EMF and health. He has been an ICNIRP member since May 2000.

UV: From Molecular Effects To Immunologic And Cancerous Impact

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A century ago ultraviolet (UV) radiation used to be referred to as ‘chemical rays’ for good reason: many organic molecules absorb radiation with wavelengths below 315 nm (UVB and UVC) and react ‘photochemically’. Most of these reactions are detrimental, especially those involving DNA, but a notable exception is the UVB-driven formation of pre-vitamin D3 in the skin.

Action spectral analyses in the 1920s and 30s showed that DNA was the target molecule for cell killing and genetic mutation by UV radiation. In parallel, animal experiments showed this radiation to be carcinogenic in skin: next to proving tobacco tar to be carcinogenic, the Argentinian Angel Roffo proved UV in sunlight to be carcinogenic in rats. Later on, the wavelength dependence of the induction of skin carcinomas was shown to be similar to that of sunburn (erythema), and to that of the formation of pyrimidine dimers (PDs) in the skin (PDs are the predominant DNA lesions caused by UVB and UVC radiations). Human skin is very well adapted to the (geno-) toxicity of the ambient UV radiation, and has high fidelity repair mechanisms to eliminate the DNA damage, or removes overly damaged cells entirely. Nevertheless, skin carcinomas may develop in the long run with typical ‘UV signature’ mutations (related to PDs) in the P53 tumor suppressor gene. Epidemiologic studies have clearly shown that the most fatal skin cancer, melanoma, is positively correlated with sun (UV) exposure in childhood years and intermittent (over-) exposures in leisure time, but the wavelength dependence is uncertain (conflicting data from animal models, but a correlation with sunburns in humans would suggest UVB radiation). Presumably because of increases in sun exposure, the incidences of skin cancer have been steadily rising in fair-skinned Caucasian populations.

UV radiation was found to be immunosuppressive in animals and men, which in animal models was a major factor in skin carcinogenesis and aggravated infections. Various target molecules (e.g., DNA, urocanic acid, pro-vitamin D3) appeared to be involved, which outlined the complexity of the immunosuppressive effects. The fact that humans all display UV-induced suppression of sensitization and ensuing contact allergies indicates that this suppression is a physiologically sound reaction to prevent illicit allergic reactions to the sun (analyses of UV-induced immunologic reactions in patients with polymorphic light eruption – ‘sun allergy’- appear to confirm this inference).

In contrast to these UV-related adverse effects, there is mounting evidence for the fundamental and diverse physiologic importance of vitamin D3, beyond the well-known importance for bone health; cells in various tissues contain functional vitamin D receptors. UV exposure and in some cases corresponding vitamin D levels are found to be negatively correlated with autoimmune diseases like MS and diabetes, heart and vascular diseases, mental disorders and various types of internal cancer, most notably colorectal cancer. However, with the possible exception of mortality from rectal cancer, long term increases in sun exposure and skin cancers do not appear to have been matched by corresponding decreases in internal cancers (clearer effects from screening programs). As people on ‘western diets’ depend for 80-90% of their vitamin D3 production on solar UV exposure, there is a clear balance to be struck between the adverse and beneficial effects of (solar) UV radiation. Although adequate exposure levels are still very much debated on, there is consensus that overexposures leading to sunburns should definitely be avoided.

Biographical Information

Frank R. de Gruijl is currently working as an associate professor at the Dermatology department of the Leiden University Medical Center, Netherlands. He received his Master of Sciences in Physics (1977) and his Ph.D. on 'experimental UV carcinogenesis' (1982). Dr. de Gruijl's main research interests are UV carcinogenesis, UV-induced modulation of immune responses(some 135 peer-reviewed papers and about 80 book-chapters on these subjects)and more recently, vitamin D photobiology. The research has branched from quantifying visible skin reactions into the basic (molecular) biology behind these reactions. He is regularly asked to participate in national and international committees to advise on UV risks. He is currently a member of the committtee on "Effects of a Stratospheric Ozone Depletion" of the United Nations Environmental Programme (UNEP), member of the Dutch Health Council's "Radiation and Health" group, and he is chairing an advisory group for the Dutch Cancer Society on "UV, vitamin D and Cancer". He is also Associate Editor of "Photochemistry and Photobiology". Frank de Gruijl has been a member of ICNIRP since May 1997.

Needs And Possibilities To Protect Workers From UV Radiation

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The increasing solar exposure as well as the increasing use of artificial UV sources is a cause for concern at various workplaces. In many populations, skin cancer incidence continues to rise, due in large part to a poor understanding of the health risks and protection needs among the population. It is recognized that the risks of UV exposure differ greatly depending on skin phototypes. For dark skin people, the melanin provides a very important shield against UVB; however, this absorption minimizes the production of Vitamin D in this population. Therefore, it is important that UV exposure of dark skin phototypes not be too much limited, whereas skin protection must be emphasized for light skin phototypes.

Reduction of risk by avoidance of needless sunlight exposure and by physical means of protection should be an important occupational health goal. The Global UV Index can be a useful tool in educating persons who are outdoors as to the changing level of overhead UV radiation. As for ocular exposure, it is, however, not very predictive, since it is a measure of the UV radiation incident on a horizontal surface.

Solar UV radiation exposure of outdoor workers depends on three primary factors: (a) the ambient solar UV radiation, (b) the fraction of ambient exposure received on different anatomical sites, and (c) behavior and the duration spent outdoors. Thus, hazard assessment for specific outdoor work environments can only be semi-quantitative. A study of the worksite and tasks can provide an indication of individual worker exposure. The value of site-specific measurements is limited, since exposure will vary so much with time-of-day and season.

The data on ambient UV radiation monitored in an outdoor work environment are scanty, and estimates of personal exposure are usually relegated to research results. Past studies have employed UV radiation sensitive dosimeters (e.g. film badges) or carried out determination of UV exposure by measurement, modelling, or by a combination of both. Such studies show that indoor workers, as with most of the population, may typically experience about 300 standard erythemal doses (SED) per year from solar exposure (mostly from weekends and holidays). Outdoor workers at the same latitudes receive about 5 times these exposure doses, but the health impact may be somewhat less because of adaptation. Ocular exposure rarely exceeds the ICNIRP guidelines for daily exposure, except in unusual conditions, e.g. reflections from snow fields.

Several methods of reducing personal exposure to solar UV radiation are available. The UV radiation exposure of the eye and skin can be attenuated by the use of personal protective equipment (PPE) such as sunglasses, goggles, hats, clothing and sunscreens.

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Biographical Information

Maila Hietanen is a Research Professor and Leader of Non-Ionising Radiation (NIR) Group at the New Technologies and Risks-team of Finnish Institute of Occupational Health (FIOH). Her research interests cover investigations on human exposure to both EMFs and optical radiation, in particular the evaluation and prevention of health risks related to occupational exposures. In addition to research, her work also comprises training and advisory assignmnets on NIR health issues globally. She is actively involved in research co-operation within the EU COST Actions, and she is a member of several European and international committees and advisory groups, such as the International Commission on Occupational Health (ICOH) and International Advisory Committee of the WHO EMF-Project. Dr. Hietanen has been a member of ICNIRP since May 1996, and the Vice-Chair in 2004-2008.

Ocular Effects Of Optical Radiation - Cataract

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The human eye is every day exposed to optical radiation. The sun is the main source of optical radiation but increasing abundance of artificial ultraviolet (UVR) and infrared radiation (IRR) sources increases the potential for exposure of the eye to both UVR and IRR. The location of the eye in the orbit shields the eye from external exposures to UVR and IRR. The spectral transmittances of the eye tissues determine the radiant exposure at different depths into the eye. If the eye is exposed to just above threshold dose of UVR, several toxic reactions are expressed in the eyelid, the conjunctiva, the cornea and the lens. The ocular surface has a maximum sensitivity around 270 nm, the lens around 300 nm and the retina of a normal eye has a maximum sensitivity at around 440 nm (type 1) and around 505 nm (Type 2) for photochemical damage. There is experimental evidence that wavelength additivity is a good model for threshold estimation for broad band exposures of the lens. It takes around 1 week for UVR damage in the lens to become expressed after close to threshold damage. The dose-response function for UVR induced damage in the lens is continuous and threshold can be expressed as Maximum Tolerable Dose (MTD2.3:16) There is a strong age dependence of the sensitivity in the lens for UVR. At repeated damage, approximately 18 % of the damage in the lens is repairable with a repair rate of 8 days. For daily exposures, the total threshold for damage in the lens increases with the number of days exposed. Epidemiological data has demonstrated an association between chronic exposure to infrared radiation and cataract. A few experimental studies indicate a possible photochemical effect of IRR in the ocular lens which would suggest a potential cumulative effect of sub threshold exposures.

Biographical Information

Per Söderberg is a Professor of Ophthalmology. He is now working at the University Hospital in Uppsala, Sweden in the Department of Ophthalmology, Neuroscience and is a visiting professor at Dept. of Biomedical Engineering, University of Miami, Florida, USA, College of Optometry, University of Houston, Texas, USA, and Dept. of Ophthalmology, Dalian Medical University, Dalian, China. His main research interests are effects of optical radiation in the eye with an emphasis on ultraviolet radiation, infrared radiation, cataract measurement, and anterior segment surgery. His work includes exploration of the pathophysiological mechanism for UVR induced cataract, development of a new model for determination of UVR and infrared toxicity in the eye, determination of the influence of variables such as age, gender, pigmentation, exposure time and fractionation of exposure, on UVR induced cataract and effects of chronic daily exposures to UVR on the lens. Dr Söderberg is an ICNIRP commission member since 2002.

Laser Radiation: Bioeffects And Protection

Bruce E. Stuck
U.S. Army Medical Research Detachment, Walter Reed Army Institute of Research, USA

During the past 40 years, extensive biomedical research has been conducted to understand the biophysical factors which influence laser-tissue interactions. Acute ocular and skin injury thresholds have been determined for exposure wavelengths from the ultraviolet to the far infrared, for exposure durations from femtoseconds to thousands of seconds, and for a wide range of irradiance diameters. The additive effects of repetitive pulses and repeated exposure have been examined for some exposure conditions. This data set along with an understanding of the underlying interaction mechanisms (e.g. thermal, photochemical, photo-mechanical, et cetera) form the basis for protection guidelines as published by the International Commission on Non-Ionizing Radiation Protection. The focus of much of this research has been on laser-induced retinal injury for wavelengths in the retinal hazard region because of small amount of laser energy required through the ocular pupil to produce a retinal lesion due to the focusing of this radiation to a small irradiance diameter at the sensory retina. In addition, the visual consequences of laser-induced injury to the fovea as evidenced by laser accident cases emphasize the importance of protection requirements. Although the optical effects which influence the retinal imaging and the initial physical events which lead to the absorption and dissipation of the laser energy are well understood, the stages of biological damage which take place after the deposition of energy and for hours or even days later are not so well understood. Occupational health and safety standards which provide maximum permissible exposure (MPE) limits are based both upon the theoretical understanding and a large body of experimental data and human accident case experience. Laser bioeffects research in the past 8-10 years has focused on defining the injury thresholds for ultrashort pulses (exposure durations less than 1 nanosecond), determining the dependence of the retinal injury threshold on retinal irradiance diameter, refining the understanding of the wavelength dependence of the ocular injury threshold (corneal, lens and retinal) as a function of wavelength and exposure duration for wavelengths in the 1.1 to 1.4 μm wavelength region. These current results are summarized with respect to considerations of changes in the exposure guidelines for these specific exposure conditions. Protection guidelines for cutaneous exposure are also examined as a function of wavelength since recent research describes injury threshold for more penetrating infrared wavelengths. Laser applications are becoming more ubiquitous in their use in academia, industry, military, entertainment, and medicine. Advanced protections guidelines along with barrier protection which limits exposure to doses at or below the MPEs are required in occupational health settings.

Biographical Information

Bruce E. Stuck is the Director of the U.S. Army Medical Research Detachment of the Walter Reed Army Institute of Research, where he has programmatic responsibilities for laser and microwave biological effects research program. He has 32 years experience in laser hazards research experience and is the author/co-author of numerous papers on ocular and cutaneous effects of laser and radio frequency radiation. His primary interests are in the biological effects of visible and infrared laser radiation on the retina and cornea and the assessment of laser-induced eye injuries and their treatment. He is the Chair of the Biological Effects and Medical Surveillance Technical Subcommittee of the American National Standards Institute's (ANSI) Z136 Standard for the Safe Use of Lasers. He is a member of the Association for Research in Vision and Ophthalmology, the Laser Institute of America, the Biomedical Optical Society of the SPIE and the editorial board of the

Journal of Laser Applications. He has served on ICNIRP SC IV since 1999 and on the Commission since 2004.

EMF Health Risk Assessments: A WHO Perspective

Emilie van Deventer
World Health Organization

Understanding the health impact of electromagnetic fields falls within the mandate of the World Health Organization (WHO) in the area of environmental health, which aims to help Member States achieve safe, sustainable and health-enhancing human environments, protected from biological, chemical and physical hazards. This goal is achieved, in part, through the monitoring and assessment of the impact of environmental risks on human health, and the provision of advice, guidance and technical assistance to its Member States.

WHO publishes its scientific health risk assessments and advice in documents such as its monograph series, the Environmental Health Criteria (EHC). The EHC monographs on EMF are being published as a set of three documents spanning the relevant EMF frequency range (0 - 300 GHz). A monograph on static fields has been published in 2006, and an assessment of extremely low frequency (ELF) fields was issued in 2007. An evaluation of the health effects from radiofrequency fields (RF) will be performed in the coming couple of years.

The EHCs are the result of in-depth critical reviews conducted through independent, scientific peer-review groups on various topics related to the exposure of people to environmental hazards. The process includes a review of the physical characteristics of EMF fields as well as the sources of exposure and measurement. An extensive review of the scientific literature on the biological effects of exposure to EMF fields is provided to assess any health risks from exposure to these fields. The outcome of the health risk assessment forms the basis of evidence-based recommendations to national and international authorities on radiation health protection.

The presentation will provide an overview of the process of developing EMF health risk assessments. It will summarize the main conclusions and recommendations from recently published documents.

Biographical Information

Emilie van Deventer is the Team Leader of the Radiation program at the World Health Organization (WHO) in Geneva, Switzerland. She also heads the WHO International EMF Project and the INTERSUN programmes. Her activities focus on the development of scientific documents, policy frameworks and information brochures relating to public health protection from non-ionizing radiation. She participates in various scientific and public meetings to discuss the position of the WHO International EMF Project on health effects from electromagnetic fields. Dr van Deventer received her PhD in electrical engineering from the University of Michigan, USA in 1992. She is an adjunct Professor of Electrical Engineering at the University of Toronto in Canada where she taught from 1992 to 2000.

Basis For The Development Of Protection Standards

Paolo Vecchia
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Standards for the protection of workers and the general public against exposure to non ionizing radiation have been developed by a number of international bodies, and national regulations are being issued in an increasing number of countries.

Institutions such as the World Health Organization and the European Union have repeatedly stressed that such regulations should be based on the best available science, and on a common framework of protection criteria. Harmonization of standards is in fact of paramount importance for scientific, ethical, economic, and practical reasons.

Indeed, international standards and recommendations that have been developed for the various kinds of non ionizing radiation are based on similar approaches and on the same scientific database, although a few governments and local authorities throughout the world have adopted more or less diverging regulations, largely based on social – rather than scientific – considerations.

The International Commission on Non Ionizing Radiation Protection (ICNIRP) has issued a number of guidelines and statements for the safe exposure to the different kinds of non-ionizing radiation, namely static and extremely low frequency electric and magnetic fields, radiofrequency electromagnetic fields, incoherent optical radiation including infrared and ultraviolet radiation, laser radiation, an ultrasound.

Each guideline presents obvious specificities, taking into account the basic differences of physical characteristics and interaction mechanisms. However, a common fundamental approach is adopted, based on rigorous scientific methodology. This approach has been formalized and described in detail in a scientific document (General Approach to Protection against non Ionizing Radiation), available in different languages at the ICNIRP website (www.icnirp.org).

The first step in the development of guidelines is a review of the appropriate literature. Such review is at the same time comprehensive and selective. Only studies that meet adequate quality criteria are in fact considered for risk assessment. In a first phase of the review, single studies are evaluated in terms of their relevance to the health effects. Normally, separate reviews are carried out for epidemiological studies, for human laboratory studies, for animal studies and for in vitro studies. The outcomes of these steps are finally combined into an overall evaluation including an evaluation of consistency across the different research areas.

In such evaluation, a decision is made whether the data considered allow the identification of an exposure hazard, i.e., an adverse health effect that is caused by the exposure. By this identification, the effect becomes “established”. This evaluation is at least partly based on scientific judgements, since a certain degree of uncertainty and inconsistency always exists in comparative evaluations of the literature.

Based on the nature of the established health effects, the most appropriate protection system is selected. A threshold-based system is the choice when effects are established that become apparent only above given exposure levels. In this case, total prevention of the effects can be achieved setting exposure limits that are below the threshold. If adverse effects exist that have been scientifically established, but do not exhibit a threshold, other systems based on an acceptable level of risk are more adequate. In this approach, social and economic considerations are of importance, besides scientific evaluations. Finally, if health risks have been suggested, but not adequately confirmed by research, strategies based on precaution can be considered, where socioeconomic considerations prevail over science.

The above systems are not mutually exclusive. In some cases, both deterministic threshold effects and stochastic effects have been established for the same exposure. On the other side, the definition of exposure restrictions based on established thresholds does not prevent in principle the adoption of precautionary measures with respect to possible long-term effects of chronic exposures below the threshold levels. However, the way such measures are implemented should be such as not to undermine science-based recommendations.

In general, the nature and the magnitude of a biological effect depends on the interaction mechanism, and on the exposure conditions, and can be better related to a biologically effective quantity internal to the body, rather than the intensity of the external field or radiation. Therefore, basic restrictions are recommended in terms of values of the appropriate biologically effective quantity that should not be exceeded. For practical reasons, reference levels are derived in terms of measurable characteristics of the external field of radiation. This step generally introduces a high grade of conservatism, since worst-case conditions are assumed for each of the many factors characterizing the exposure.

In most cases, an exposure may result in a variety of biological effects. The effect that becomes apparent at the lowest level of exposure is termed the critical effect. Exposure limits are derived with reference to the critical effect, with the obvious assumption that such limits a fortiori protect against any other established effect.

To account for scientific uncertainties related e.g. to extrapolation from animal studies to humans, or uncertainty in dosimetry, reduction factors are introduced when deriving basic restriction from the thresholds for health effects.

Finally, it is recognized that different groups of the population, that includes childre, elders, ill individuals etc. may exhibit different susceptibility to NIR exposure. ICNIRP guidelines are developed in such a way as to protect all categories, and are therefore conservative also in this respect.

For similar reasons, a two-tier system has been adopted, with different basic restrictions and reference levels for the exposure of workers, and the general public.

ICNIRP continuously monitors the progress of research, and updates its scientific advice when necessary, either with a global revision of guidelines or with refinements or clarifications through statements that are published in scientific journals and made available on the ICNIRP website.

Recommendations For Static And ELF Fields

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In 1994 the International Commission on Non-Ionizing Radiation Protection (ICNIRP) issued "Guidelines on limits of exposure to static magnetic fields" (Health Physics, Vol. 66,No 1, pp 100-106, 1994). Up to now, the database for deriving limits for static electric fields is not convincing, and thus, no such limit has been suggested by ICNIRP so far. In 1998 ICNIRP issued "Guidelines on limiting exposure from time-varying electric, magnetic, and electromagnetic fields ranging up to 300 GHz" (Health Physics, Vol. 74,No 4, pp 494-522, 1998). These guidelines replaced older ones and were developed based on an extensive scientific review process to provide protection against all known adverse health effects.

Since their publication, the ICNIRP guidelines have been endorsed by many countries worldwide and have, for example, served as basis for an European Council Recommendation on the protection of the general public as well as an European Directive for the protection of workers.

The ICNIRP limits for static magnetic fields were derived to prevent transient sensory effects and to limit exposure to values considered save, based on theoretical considerations and sparse experimental data. In the ELF range interference with nervous tissue function from currents induced in the body should be prevented. In addition indirect effects like discharge currents from touching conductive objects in the field, were considered. Not considered by ICNIRP so far were electromagnetic interference problems e.g. in medical devices or in implants.

Based on such considerations an ELF limit was set for the current density induced in central nervous tissue. With the available dosimetry so called reference levels for the external electric and magnetic field were derived to ease compliance testing. All values incorporate large reduction factors to account for various scientific uncertainties. Additional reduction factors were incorporated for the exposure of the general public. The reason is that, in contrast to the occupationally exposed population, the public comprises individuals of all ages, of varying health status, and may equally include particularly susceptible groups. Exposure to the public generally occurs under unknown conditions, and the individuals exposed are not trained to be aware of the potential risks and to take the appropriate precautions.

Currently, these recommendations for static and ELF fields are under revision. This effort is based on recent scientific reviews such as e.g. by ICNIRP and the World Health Organization. Some of the fundamental decisions to be taken will include selection of the basic dosimetric quantity (induced current or electric field), consequence of the IARC classification of ELF magnetic fields as a possible human carcinogen for the guidelines, or the consideration of non-CNS tissue.

Protection Policies For Radiofrequency Fields

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Exposure to electromagnetic fields in the radiofrequency (RF) range has been increasing steadily due to the multiplication of sources. Following the introduction of radars, radio, and television, wireless communication devices have been deployed and mobile telephony in particular.

To protect the public and workers, RF guidelines have been issued and national and international regulations implemented. There are several approaches used to protect the population and all of those are and must be based on scientific knowledge. In the RF frequency range, a health threshold-based system is adequate as biological effects that might affect health have been established, and thresholds for such effects have been identified (caused by temperature elevation in the tissues and organisms). The protection is provided through exposure limits to assure that exposures are below the threshold.

Risk assessment and exposure guidelines

At the present time, the two main sets of guidelines are those of ICNIRP[1.] and IEEE[2.]. They are both based on the same principles and scientific database: All papers published in peer-reviewed journals are analysed and a "weight-of-the-evidence" approach is used to determine the threshold of the field level that should not be reached in order to protect the public. This systematic procedure is obviously used across the electromagnetic spectrum and not only the RF.

Up until now the metric that has been used in RF guidelines and regulation to quantify the field level is the specific absorption rate (SAR) expressed in watts per kilogramme (W/kg). Extensive analysis of the literature on RF effects has provided a SAR threshold at the level of 4 W/kg (for whole-body exposure). This level is termed the "critical-effect level" by ICNIRP and serves as the basis for setting the guidelines. The SAR maximal admissible level, called "basic restriction" is calculated by dividing the critical-effect level by an uncertainty factor which is 10 for occupational environments and 50 for the public. The next step is to define the "reference levels" which are exposure limits calculated based on SAR induced by exposure. An example is the basic SAR restriction of 0.08 W/kg for whole-body exposure of the public, which translates into a reference level of 4.5 W/m2 at 900 MHz. This strategy is conservative. The use of reference levels assures compliance with the basic restriction, since the relationship between them has been developed under worst-case hypotheses.

In the case of local exposure (e.g. mobile phone next to the head), the basic restriction is 2 W/kg over 10 g of contiguous tissue. The IEEE guidelines are derived in a similar manner and are almost identical to that of ICNIRP.

Regulations and precautionary measures

In the RF range most of the world's countries have adopted one of the two guidelines (more than 30 countries in the case of ICNIRP, including the EU, China and India). Implementation of the European recommendation of 1999 has been reviewed recently[3.]. It appears that many member states have reduced the limit values expressed in terms of reference levels, as a precaution.

Precautionary measures, which may be adopted in case of uncertainty, have been suggested, but not established by scientific research. Most frequently, these measures are implemented or invoked in observance of the ill-defined precautionary principle.

WHO provides a framework to countries that want to build their own RF exposure regulations.

Risk communication

In spite of the concerns expressed by the public regarding the rapid deployment of wireless communications devices, it seems that these fears are not consistent with the technology and the scientific knowledge (Eurobarometer [4.]). Risk communication is a major endeavour to avoid crisis and funds are being provided to increase the effort in that respect. An example is that of the German research programme which just ended: out of 52 research projects none yielded positive results. As a consequence, much less money will be devoted to research and more to risk communication in Germany.

Conclusion

At this time in the development of RF technology and public concern, health risk assessment is one of the most important tasks facing governing bodies. The process was initiated in 1993 when funding of the research began and we are now in the "evaluation" phase: several high-quality reports have been published and ICNIRP recently provided WHO with a review document that will serve as the basis of the EHC[5] on RF (2010?). IARC may decide to issue a monograph on RF and cancer (2009?) and both documents will be used by ICNIRP to revise its 1998 guidelines (2012?). However, awaiting the outcome of several laboratory and epidemiological studies, the expert committee of the EC (SCENIHR) has concluded that there is no need to modify the 1999 EC recommendation, which is based on the ICNIRP guidelines.

1. ICNIRP Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). Health Physics April 1998, Volume 74, Number 4:494-522 www.icnirp.de/PubEMF.htm

2. C95.2-1999: "IEEE Standard for Radio-Frequency Energy and Current Flow Symbols" (Reaffirmed in 2005) www.ices-emfsafety.org/index.php5

3. Report from the commission on the application of Council Recommendation of 12 july 1999 (1999/519/ec) on the limitation of the exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) http://eur-lex.europa.eu/COMMonth.do?year=2008&month=09

4. www.ec.europa.eu/public_opinion/archives/ebs/ebs_272a_en.pdf "When citizens are asked which factors they believe affect their health, items linked to EMF are not perceived to potentially affect health to the same extent than other sources of health risks, such as chemicals (64%) or the quality of food products (59%). […] Mobile phone masts follow close at 36%. Mobile phone handsets are some way behind at 28% while the least concerns about potential health damage are reserved for computers (18%) and household electrical equipment (14%). […] There is a general dissatisfaction among respondents regarding the efficiency with which public bodies protect citizens from potential health risks linked to electromagnetic fields. 60% of EU25 citizens take a negative view on the action of public authorities in this field and an additional 15% give a 'don't know' response. This means that just one in every four EU citizens is happy with the current status."

5. Environmental Health Criteria

Recommendations For Optical Radiation

Maila Hietanen
Institute of Occupational Health, Finland

The ICNIRP guidelines for optical radiations represent conditions under which it is expected that nearly all individuals may be repeatedly exposed without acute

adverse effects and, based upon best available evidence, without noticeable risk of delayed effects. The Exposure Limits (EL) values for exposure of the eye or the skin may be used to evaluate potentially hazardous exposure from arcs, gas and vapor discharges, fluorescent lamps, incandescent sources, and solar radiation. The incoherent radiation limits do not apply to lasers. Most incoherentradiation sources are broadband, although single emission lines can be produced from low-pressure gas discharges. The values should be used as guides in the control of exposure to both pulsed and continuous sources. The ELs are below levels that would be used for exposures of patients required as a part of medical treatment or for elective cosmetic purposes. The ELs should be considered absolute limits for direct exposure of the eye and “advisory” for skin exposure because of the wide range of susceptibility to skin injury depending on skin type. The ELs for UV radiation should be adequate to protect lightly pigmented individuals.

Industrial workers in very hot environments, such as in the glass, steel, and aluminium industries have traditionally had to deal with excessive IR exposure. Heat strain and discomfort (thermal pain) normally limit skin exposure to IR radiation levels below the threshold for skin-thermal injury. Furthermore, limits for lengthy IR exposures would have to consider ambient temperatures. Therefore, ICNIRP provided guidelines to limit skin exposure to pulsed sources and very brief exposures where thermal injury could take place faster than the pain response time. Hence, current exposure limits for the skin are to protect against thermal burns within exposure durations less than 10 s.

ICNIRP guidelines and other advice for optical radiation are listed below, and will be discussed in more detailed at the workshop.

Guidelines

Guidelines on Limits of Exposure to Ultraviolet Radiation of Wavelengths Between 180 nm and 400 nm (Incoherent Optical Radiation). Health Physics 87 (2): 171-186; 2004.

Revision of the Guidelines on Limits of Exposure to Laser radiation of wavelengths between 400nm and 1.4µm. Health Physics 79 (4): 431-440; 2000.

Guidelines on Limits of Exposure to Broad-Band Incoherent Optical Radiation (0.38 to 3µm). Health Physics 73 (3): 539-554; 1997.

Guidelines on UV Radiation Exposure Limits. Health Physics 71 (6): 978; 1996

Guidelines on Limits of Exposure to Laser Radiation of Wavelengths between 180 nm and 1 mm. Health Physics 71 (5): 804-819; 1996

Statements

ICNIRP Statement on Far Infrared Radiation Exposure. Health Physics 91(6) 630-645; 2006.

Health Issues of Ultraviolet Tanning Appliances used for Cosmetic Purposes. Health Physics 84 (1): 119-127; 2004.

Light-Emitting Diodes (LEDS) and Laser Diodes: Implications for Hazard Assessment. Health Physics 78 (6): 744-752; 2000.

Laser Pointers. Health Physics 77 (2): 218-220; 1999

Health Issues of Ultraviolet "A" Sunbeds Used for Cosmetic Purposes. Health Physics 61 (2): 285-288; 1991.

Other Publications

Global Solar UV Index - 2002.

Protecting Workers from UV Radiation. Blue Book. International Commission on Non-Ionizing Radiation Protection, International Labour Organization, World Health Organization; 2007.

Overview of EMF Standards In Latin America

Eng. J. Skvarca
Member of the WHO/PAHO Expert Advisory Panel on Radiation

Research and applications of technologies using electromagnetic fields have provided nowaday immense benefits to the mankind. From extremely low frequencies (ELF) up to microwave range (300 GHz) the applications such as power lines, industrial and home electrical appliances, telecommunications with mobile telephones, radar and radio and TV broadcasting as well as modern medicine are some of these examples. For the other hand, some of this research has suggested that exposure to electromagnetic fields may potentially produce a broad range of adverse health effects such as cancer, leukemia, changes in behavior etc.. No sufficient research has been conducted up today to prove these effects at low level exposures, such are those recommended by ICNIRP, but concerns and perception of risk especially among population have been raised that there is an urgent need to provide a scientific consensus and adequate safety regulation.

The responsibility to develop these standards and guidelines belongs to International Agencies and Organizations such as ICNIRP/IRPA and national authorities such as Ministries of Health or similar bodies. The role of WHO throw International EMF Project established in 1996 is to conduct and harmonize updated critical reviews of scientific research and information pushing towards international consensus on guidelines and standards. Many countries especially from European Community have now established EMF health protective standards or guidelines.

The regulations on this field in Latin American countries such as Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico, Peru, Venezuela and Uruguay just starting, are usually based on the United States (ANSI/IEEE, FDA, FCC etc..) standards. So ANSI C-95.1-1979 was the first reference document for these countries. Later in 1988, Argentina published the reference manual “Prospección de radiación electromagnética ambiental no ionizante” – Manual de estándares de seguridad para la exposición a radiofrecuencias comprendidas entre 100 kHz y 300GHz – (A. Portela at al), which was established as law in this country in 1995. The same time in 1988 the ICNIRP/IRPA guidelines for frequencies between 100 kHz and 300GHz were published and used as reference levels in some Latin American countries.

The purpose of this summary is also to present the differences between these different standards.

Nevertheless, the future of these guidelines and standards in Latin America, are based on updated information provided by WHO’s International EMF Project as a framework from which harmonized EMF National standards can be developed.

Biographical Information

Present Position: Adviser Department of Radiophysics, Ministry of Health and Environment, Buenos Aires, Argentina. Member of the WHO/PAHO Expert Advisory Panel on Radiation

Standards For ELF Fields: The Experience Of Argentina

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The use of electricity involves a wide range of activities that, because of its diversity, characteristics and relative importance causes different environmental impacts during the extraction, processing, transport and consuming activities.

It is the role of the government to elaborate the rules for the incorporation of environmental aspects in the different segments of the market for different electrical energy sources and in all the stages of the process, from the initial evaluation to the construction and exploitation phases.

Among the environmental key aspects to considerate, are the electric and magnetic fields, in which society has taken special interest as they are believed to be involved in health hazard.

The faculties of the regulatory authority is dictate regulations and technique procedures to be fulfilled by the agents, and check their compliance.

In the year 1996, there were severe conflicts in Argentina, where the population opposed to the installation of new high voltage facilities in various locations of the country.

Conflicts of this nature, required the immediate action by national authorities in developing a design standard for transmission systems and electricity distribution, which considered the possible effects on public health, as well as standards for environmental and public protection.

From the data analysis it was concluded that there was insufficient evidence to determine a health risk due to long term ELF-EMF exposure. Based on the regulations issued in other countries, the Secretaria de Energia (Energy Department)developed a resolution that would cover environmental aspects of overhead lines as whole thing, and not as a health policy.

These aspects are: the space occupation, visual impact, crown effect (radio and audible noise), electric field and magnetic field induction and cater to establish the compatibility of the transmission and distribution facilities with the environment. The regulation was published in 1998 as Resolution 77/98 of the Ministry of Energy and includes electrical voltage equal to or greater than 13.2 kV.

The limit values given in Resolution 77/98 resulted: for electric field (E) 3kV/m, and for field magnetic induction (B) 25□T. The given values should not be exceeded at the edge of the right of way, outside perimeter edge and transformer stations. If a right of way is not defined, these values must not be exceeded in the points resulting from the minimum security distances. At the same time contact currents should not exceed the limit of 5mA (according Norma IRAM 2371 - PARTE I: Efectos fisiológicos del paso de la corriente alterna (15-100 Hz) por el cuerpo humano, based on IEC 479 -- 1 year 1984). The values for both electric and magnetic induction field, provide a temporary rule that prevents unnecessary increases in existing levels of exposure to magnetic fields.

Exposure guidelines based on health criteria can only be generated when health risks have been determined. In conclusion this legislation must come from health authorities.

Whereas the Secretaría de Energia (Energy Department) determines, the environmental regulations, is the ENRE who compels the electric companies to meet these requirements.

Among the faculties of the Ente Nacional Regulador de la Electricidad (Electricity National Regulatory) it is consider dictating regulations and technique procedures for the fulfillment by the agents, of the environmental rules and must check the fulfillment.

Biographical Information

Patricia Liliana Arnera got her degree in Electrical Engineering from the National University of La Plata, Argentina (UNLP) in 1981. She is Head of Institute for Technological Research Network and Electrical Equipment - High Voltage Laboratory by the Faculty of Engineering at the National University of La Plata (IITREE-LAT FI-UNLP). Her special field of interest includes electrical power systems, dynamic studies, insulation coordination, reliability of supply, planning and economic development of electric power networks, electromagnetic compatibility, environmental impact of power lines, and working in Electromagnetic Fields and health. Mapping and surveys in electrical installations. Advice to local control and the generation of regulatory and safety aspects of exposure to low frequency fields. She is Full Professor of Power System and Postgraduate courses for racing Master's and Doctorate at the EE Department of Faculty of Engineering at UNLP. Prof. Arnera is Member of the Buenos Aires Academy of Engineering in Argentina. She is Senior Member of IEEE (Institute of Electrical and Electronics Engineers). President of the Argentine Chapter PES (Power Engineering Society) 2001 and 2002, receiving two years the "High Performance Chapter Award" and in 2002, the prize "Outstanding Large PES Chapter of the World", by actions during the 2001. She is an active member of CIGRE (Conseil International des Grands Reseaux Electriques). Since 2007, she is the Secretary of the National Committee of CIGRE Argentine. In the 2004-2007 period also served as Pro Secretary of Science and Technology Policy, National University of La Plata.

ELF And Health: Activities In Brazil

Hamilton Moss de Souza*
CEPEL (Electrical Power Research Center)

The presentation drafted in cooperation with the Ministry of Mines and Energy EMF *Working Group* gives an overview on the latest developments related to the ELF and Health issue in Brasil. Presentation topics include research, legislation efforts, risk perception and communication.

About research, the main project to be reported is the EMF-São Paulo Research Project (EMF-SP), that includes a large EPI study on childhood leukemia. This study started in 2005 and is expected to present final results on 2009. The EMF-SP also includes occupational and adult disease studies, field level assessment and a risk perception study. The results so far achieved on the Project are helping to improve the level of knowledge on ELF health assessment in Brazil. More information about the EMP-SP Project can be found at www.emf-sp.com.br and in a specific presentation of this Workshop. In field calculation area CEPEL (Electrical Power Research Center) is improving application of computational dosimetry studies to assess electromagnetic fields exposure conditions near overhead transmission lines.

The Bioelectromagnetic Commission, installed in Brazil late 2005 to deal with issues related to EMFs, did an important job reviewing a Federal Law on EMFs (Law project PL 2576/2000), as a request of the Congress, and presented suggestions, at the beginning of 2007. The Commission has an advisory character, it means can suggest laws, standards and procedures submitted to the Congress and governmental organisms that takes the final decision. It is composed by representatives of the following Ministries: Civil House, Health, Mines and Energy, Science and Technology, Environmental, Labor, Communication, Cities and Justice. ICNIRP and WHO recommendations served as basis for the Commission suggestions. The Law Project was approved in the Justice and Constitution Commission of the National Congress, the last step before goes to the Senate. A “fast track” discussion phase in the Senate is no more expected. Under request, the PL will pass trough many Senate commissions before it goes to the final approval section. As the PL 2576/2000 is a result of a deep discussion, including a Seminar in April 2007 at the Congress, with the participation of WHO and ICNIRP (Emilie van Deventer and Paolo Vecchia as representatives) and stakeholders, the “fast track” was expected, but this is no more the case.

In Brazil, as a whole, the risk perception of the general public, related to ELFs, seems to reach a lower degree of concern. This statement comes not from a formal pool, but from a perception shared many by experts that deal with different aspects of the problem. These experts are reporting less demand for explanation about the ELF issue. Parallel to this, two new utilities substations and its associated transmission lines, respectively in Rio de Janeiro and Florianópolis (South Region of Brazil), did not demand to much efforts to be approved in public audiences. Fact Sheet 322 of WHO, seems to be accepted by the population as a basis for less fear about the ELFs, at least on these two cases. The participation of WHO and ICNIRP´s staff and other well known international experts in many workshops and seminars in Brasil, helped a lot to set up a new standard of discussion of the ELF issue among the stakeholders, including Federal Congressmen. But a recent publication of a large article in a important newspaper in São Paulo, dealing with a Justice decision obliging lowering ELF values produced by a transmission line, clamming a Precautionary Principle, has a potential to restart fears and concerns that were expected to be overcome, and drives to the conclusion that is necessary a permanent effort on risk communication, at least for the next few years.

RF Fields And Health: Activities In Brazil

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Regulation on Non Ionizing Radiation (NIR) limits related to radiocommunication stations operation for the safe exposure of workers and general public has been issued by the National Telecommunications Agency (ANATEL) in Brazil, following the International Commission on Non Ionizing Radiation Protection (ICNIRP) guidelines. Besides the NIR limits, Anatel established procedures for evaluate the compliance with the threshold adopted, calculations, measurement and enforcement.

Anatel is developing many activities related to Non Ionizing Radiation – NIR, e.g. an EMF database, a new automated NIR monitoring network system and regular enforcement activities.

The EMF database will be available in the Anatel electronic address and will be a useful source of information for general public, once it will present the radiofrequency (RF) exposure levels from radiocommunication stations. The NIR assessment will be made based on theoretical methods or field measuring, i.e., in the first stage, the assessment will be based on theoretical calculations, and after, critical points will be measured in the field by Anatel enforcement staff, and then the database will be updated with real exposure values. This database will be released next year.

Non Ionizing Radiation Monitoring systems are employed as a part of management risk information system used by national regulators in order to promote conscious awareness on the subject and deal with people concerns on this matter. The automated NIR monitoring network will be composed by 52 complete equipments that can be used in cars or fixed in lampposts or any other fixed places. It will be in operation in the end of 2008 and the results from measurements are expected to be publicized by the beginning of 2009.

Every year, ANATEL performs more than 1000 NIR measurements planned on its annual enforcement plan or in response to specific demands, coming from the society and collected from different sources, such as call center, web services and other public relations channels.

Currently, another subject of concern is the visual impact related to base stations installations in urban areas. The management of visual impact has been focus of local governments, which has held public hearings to know the views of the population and minimize their concern.

Anatel is also following the Project of Federal Law about NIR level that is in the Senate for approval. This law project supports the international standards following the World Health Organization (WHO) recommendations.

Finally, ANATEL is working together with all the stakeholders to seek the best approach to establish a dialogue on risks from electromagnetic fields.

Biographical Information

Maximiliano Salvadori Martinhão, Telecommunication Engineer, Graduated at National Telecommunication Institute, Master in Communication Management at Strathclyde University - United Kingdom. General Manager for Spectrum and Certification at ANATEL – National Telecommunication Agency.

Maria Aparecida Muniz Fidelis da Silva, Telecommunication Engineer, Graduated at Telecommunication University and Public Administration, Pos Graduation in Telecommunication – Brasilia-Brazil. Intermediate Manager for Spectrum Engineering at ANATEL – National Telecommunication Agency. She is interested of this group because her work is related to aspects of NIR health protection especially in the telecommunication systems.

Agostinho Linhares received the Electrical Engineering degree from Federal University of Pará (UFPA) in 2001 and the M.Sc. degree in Telecommunications from the State University of Campinas (UNICAMP) in 2003. He then worked briefly as a System Engineer at Fiberwork Optical Communication and from 2004 to 2005 he was a Telecommunications Engineer at Petrobras, developing radiocommunications, IP and optical networks projects. Currently, he is pursuing his Ph.D. degree in Telecommunications at Unicamp and works at National Telecommunications Agency (Anatel) with technical issues in spectrum engineering, non ionizing radiation, NIR measurements and efficient spectrum use.

Mobile Telephony And Health: The Experience Of Perú

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In this document it is summarized the most important actions performed on the issue of non-ionizing radiations from mobile telephony in Peru. The main objective of this work is to give an overview of the research carried out on the evaluation of non ionizing radiation levels from mobile telephony. It includes the results of the main Peruvian assessments on telecommunications services (Radiofrequencies) and systems carried out from 2000- 2006, and the studies on health effects, which was based on several important international documents specially from the World Health Organization (WHO).

Others objectives includes the assessment of the ICNIRP limits compliance in Peru giving conclusions and recommendations on the subject.

This work was carried on a nationwide basics through representative samples of the sources including the measurements at more than 500 points for telecommunications networks.

The measurements were broadband using electromagnetic field analyzers and narrow band using spectrum analyzers.

Finally this paper provides some important conclusions and recommendations.

KEY WORDS

Electromagnetic fields, non-ionizing radiations, radiofrequencies, telecommunications, mobile telephony, base stations.

Biographical Information

Victor Cruz is a Researcher on Non Ionizing Radiations of the National University of Engineering (INICTEL-UNI) in Lima Peru. Besides that he is Professor of the universities San Marcos and Ricardo Palma in Lima. Main research interests are the evaluation of non ionizing radiations from mobile and electricity networks and their importance in the risk evaluation. He is member of the International Advisory Committee of the EMF Project (WHO) since 2001 and participates of the Latin American Scientific Expert Panel since 2007.

Role And Activities Of CIER

Juan Carlos Belza
Regional International Energy Commission (CIER)

Mr. Belza will present CIER constituency´s experience and lessons learned regarding EMF´s people´s perception and social conflicts in some countries in South America and Central America. Several workshops were held by CIER in the last three years and important findings are going to be presented in this workshop: need for communication improvement, regulatory armonization, management of people´s expectations, the European experience for South America, etc.

Biographical Information

Juan Carlos Belza is an Economist from the University of the Republic of Uruguay (UDELAR) and has been working for the Regional International Energy Commission (CIER) since 2000. CIER is a non-for-profit, non-governmental international organization with headquarter in Montevideo, Uruguay. CIER gathers almost 225 electricity companies (public and private), Universities, Regulators and some of the Ministry of Energy´s offices from South America and Central America. CIER´s main objective is to support South America and Central Americas´ energy integration efforts, improve electricity sector´s quality service and business management in a sustainable way. Mr. Belza is CIER´s International Coordinator and his main interest is the study of the legal and regulatory environmental framework in South America and Central America, energy sector´s environmental impacts and prevention, climate change and energy, business sector´s regulation and share business knowledge and experiences among its constituency.

Role And Activities Of CITEL

Ricardo Luis Terán
CITEL

Work of CITEL/OAS on the Technical and Regulatory aspects related to the Effects of Non-ionizing Electromagnetic Radiations The permanent evolution of technologies used for wireless communications, has increased the need to set up antennas and their associated elements, especially in densely populated areas. This network development has raised concerns in the population about the possible effects of NIR. In many locations of the Americas Region these concerns have also stifle the development of wireless communication systems. In many countries of the region, neither the health sector, nor the environment sector or the telecommunications sector have established regulations regarding NIR.

The Inter-American Telecommunication Commission (CITEL), an entity of the Organization of American States (OAS) has created the Working Group on Technical and Regulatory Aspects related to Non-ionizing Electromagnetic Radiations. The objective of this working group is to work together with the administrations of the region in order to establish regulations related to NIR.

The work of CITEL is carried out according to the recommendations of the World Health Organization, the ICNIRP, and the International Telecommunication Union. Among other activities, CITEL, together with the ICNIRP and other organizations, organizes regional seminars, compiles information, and prepares Recommendation Projects for the Administrations. CITEL also provides advice on the development of regulations to all countries that may require it and at the moment is developing recommendations on continuous monitoring systems and elaborating codes of good practices regarding the deployment of mobile telephony infrastructure.

Biographical Information

Ongoing studies in Electronic Engineering Universidad Nacional of Rosario, Argentina. Consultant in the field of Regulations and Technologies Telecommunications and Informatics of Governments Provincial, Cooperative Services and various Telecommunications companies. Involved, among other activities, such as Collaborator Expert in the Working Group on Technical Aspects and Relating to the regulatory effects of the RNI Inter-American Commission (CITEL) of Telecommunications Organization of American States (OAS). It was performance on several occasions as Adviser and Head Cabinet of the Secretary of Communications of the Nation Argentina, integrating various delegations and preside Country meetings of ITU (WRC), CITEL, MERCOSUR and others. It was also carrying on different occasions and currently plays as an advisor to the Committee on Communications and Information Technology of the Chamber of Members of the Argentine Nation, as well as the Bicameral Commission for Monitoring of Faculties Delegates to the National Executive in relation to the Emergency Law. It is an advisor to the Minister of Defense of the Republic Argentina in the development and deployment of the Radar National System. Perform different tasks of advising and consulting as ITU expert in various countries of the Region especially in the Area of Administration and Management Control of the radio spectrum.

The Epidemiological Project EMF-SP

Flávio Eitor Barbieri
ABRICEM, Brazil

Introduction

The project EMF-SP involves several epidemiologic and exposure assessment studies in the State of São Paulo. These studies are designed to evaluate possible effects of low frequency electric and magnetic fields on general populations and in the occupational setting. It is expected that the project will acquire unique data about EMF exposures in the Brazilian population not available now.

International context

It is outlined how the ELF effects have been treated in the world and how research and regulation articulate.

Our challenges

- Brazilian society confused about scientific truths, international regulations and arbitrary precaution measures.
- The lack of a national scientific capability based on our context and with internationally recognized protocols that can dialogue with legitimacy with the society.

The Project objectives

- Epidemiologic geo-processed studies on risk of exposition of general and occupational public to 60 Hz generated by electric power systems.
- Studies of risk perception

Organization

The Project involves leading institutions and scientists in the State of São Paulo and is managed by ABRICEM, an exempt research institution, with the direct participation of: Escola Politécnica/USP, Faculdade de Saúde Pública/USP, Faculdade de Medicina/USP, Faculdade de Ciências Médicas/Unicamp,, Pontifícia Universidade Católica de Campinas, Instituto de Pesquisas tecnológicas –IPT, Instituto Nacional de Pesquisas Espaciais – INPE.

The research lines

LPC - Case Control Study of childish leukemia and ELF

LPD - GIS Study of Adult Diseases

LPE - Occupational Study

LPF - Psychological Effects

LPH - Urban Fields

For each project research line are briefly descript: objectives, methodology, present outputs and evaluation

Overall project evaluation: project remarks, effects and deployments.

Biographical Information

Flávio Eitor Barbieri received his B.E degree in electronic engineering from ITA Brazil in 1964, M.E. in Epistemology from PUC in 1978, and Ph.D. in Education from Unicamp 1998. He has been a researcher in electronic packaging in CPqD till 2000 and currently is the Technical Director of ABRICEM, São Paulo, Brazil, an engineering and research institute about electromagnetic compatibility. His interests focus on evaluation of ELF and RF electromagnetic fields, mainly about human health effects. Now he is managing the Brazilian EMF-SP Project, an epidemiologic project which focuses on the health risks associated with exposure to ELF in São Paulo.

New Challenges In NIR Protection

Paolo Vecchia
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After several decades of scientific research, and through progressive methodological refinements, the protection against non ionizing radiation (NIR) has reached the stage of a mature discipline. Basic concepts are well established, many effects are clearly identified, and the corresponding interaction mechanisms are well understood. Appropriate physical quantities to characterize exposure and related effects have been identified and valid dosimetric tools have been developed.

Nevertheless, some uncertainties and open question still remain, that require additional work in various areas, including scientific research, health risk assessment, health policies, and social responses.

In the area of non-optical electromagnetic fields, ICNIRP is revising the whole set of its guidelines, from static fields to microwaves. The intense research carried out in the last years, and the accumulation of new data, require an update of the scientific rationale of present guidelines, and a careful verification of their validity with respect to those effects that have been scientifically established.

In the case of static magnetic fields, a reconsideration of the guidelines is justified inter alia by the recent development of magnetic resonance systems for medical diagnostics, that operate with field intensities above the exposure limits presently recommended. However, these limits were conservatively established in the absence of data at high field intensities; they shall therefore be revised in the light of new research findings, and taking into account the corresponding benefits.

The progress of research, though still limited, justifies a revision of guidelines in the region of the so-called intermediate frequencies, that are increasingly used in a number of new technologies. Given the scarcity of data, basic restrictions and reference levels in this area had been derived mainly through interpolation from limits at lower and higher frequencies. A better understanding of interaction mechanisms, biological effects, and related exposure-effect relationships should allow the definition of more scientifically based limits.

Technological developments are specially rapid and evident in the area of radiofrequencies, in particular in telecommunications. ICNIRP has recently issued a statement in which the potential hazards related to new sources are examined. Intensive research is still in progress in different areas: exposure assessment, dosimetry, biological effects, and human epidemiology. There is therefore a need for continuous monitoring of its findings.

While ICNIRP guidelines are – and will continue to be – based on scientifically established effects only, two issues are of special concern for the public and cannot be ignored: the possibility of long term effects of low-level exposures, and the possibility of higher health risks for children. The role of a scientific body like ICNIRP is to provide a clear, balanced and comprehensive picture of present knowledge, including gaps and uncertainties. Such information should be used by national and local authorities to develop their protection policies that may include, if deemed appropriate, precautionary measures that should be additional, but not alternative, to science-based standards.

The choice of precautionary measures is essentially a political issue, involving socioeconomic aspects that are outside the competence of ICNIRP. In addition, the balance of risks and costs varies between countries and social groups, and no universally valid recommendation can be provided by an international body. However, several sociological studies have shown that precautionary measurements may increase risk perception and related worries, with a negative health impact. In a broad perspective of health protection, these effects should be taken into consideration, and some collaboration of protection agencies with experts in social sciences should be established.

So far, the scope of ICNIRP has been almost completely limited to direct effects of electromagnetic fields on humans. It was considered that issues of electromagnetic compatibility, such as the interference with implanted medical devices, should the considered the responsibility of competent technical bodies only. In addition, it seemed not appropriate that a general standard included specific recommendations for a small minority of the population, who were aware of their condition and could receive the best advice from their medical doctors. The very large – and ever increasing – number of implanted devices may require a different attitude, and more explicit consideration for indirect effects also in health standards.

The practical implementation of ICNIRP guidelines shall overcome a number of problems, some of which have already been identified and discussed, especially in relation to the expected endorsement of the European Directive by the Member States of the European Union. ICNIRP, as well as other international bodies, is expected to provide a major input to this process.

As for optical radiation, there are a number of important challenges for ICNIRP in near future, such as the revision of the current statement on solaria equipments and the provision of guidance to health authorities about risks and benefits of solar UV exposure. At present, the boundaries between risks and benefits of UV radiation are not clearly defined. Although the UVR health risks associated with excessive exposure to the eye and skin are known, it is not clear whether there are benefits from UVR exposure at levels above the ICNIRP guidelines.

Lamp designs and infrared technology are undergoing continuous evolution, with the introduction of newer and often more powerful sources of optical radiation. Because of the rapid growth in the use of new types of special-purpose radiant heaters and warmers, the importance of exposure limits for infrared radiation will increase. There is an urgent need for research related to damage mechanisms of infrared cataract and the dose response curve for producing erythema ab igne. Research is also needed to assess potential delayed effects (and benefits) of IR-C cabins, in order to revise the relevant ICNIRP guidelines.

Finally, it is recognized that the determination of appropriate viewing durations and distances under different conditions of use is needed for any optical radiation hazard assessment. The future development of ICNIRP guidelines, which should be applied to realistic viewing conditions, would contribute to reduce unnecessary concerns, as regards for instance the safety of lasers and light-emitting diodes (LED).