2011 International Scientific Conference on EMF and Health

Wednesday 16 November and Thursday 17 November 2011, Charlemagne Building, Brussels

Short summary

The 2011 International Scientific Conference on EMF and Health was organized under the auspices of the European Commission's Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), in the context of the periodic review of the scientific evidence on the potential health effects of electromagnetic fields (EMF) as mandated by EU Council Recommendation 1999/519/EC. The objective of the conference was to identify the main sources of uncertainty in EMF and health research, to identify the areas of scientific consensus on the potential health effects of electromagnetic fields, to define the key remaining knowledge gaps and to develop proposals on a strategy to address them. This strategy would prioritize research actions according to health relevance and health concerns. About 300 delegates from 34 countries attended the Conference that was structured in 5 Sessions.

Session 1 mainly discussed horizontal topics. It explored the fundamental physics of interaction, what are EMF, how they physically interact with the body and what are the limits/restrictions, what is a Health Risk Assessment process and what are the disciplines contributing to it. Finally, the main issues related to EMF exposure assessment and dosimetry for both laboratory and experimental studies were discussed.

Session 2 dealt with the main sources of uncertainty in EMF health research and how they are currently addressed. All sources of uncertainty must be carefully evaluated, considering possible distortion of results in any direction and to any degree. It should be taken into account that uncertainty impacts at all stages of risk assessment, from the single study to the interpretation of its result, including the generated databases and related interpretation. In epidemiological studies the main sources of uncertainties include random error, selection bias, information bias, such as recall bias, and confounding. These uncertainties can be addressed by optimizing design and conduction of studies, including subject selection and enrolment, valid exposure assessment and correction, appropriate analysis and bias correction, based on additional information, such as e.g., validation studies. Moreover, uncertainties and biases should be considered in the interpretation of studies.

In experimental studies the main sources of uncertainty are linked to technical aspects (e.g., exposure systems, dosimetric models, confounding due to data acquisition, different protocols, etc.) and statistical aspects (e.g., use of appropriate statistical tools, detection of small effects, statistical power of the study). Aspects should be taken into account, such as inter and intra individual variability and different endpoints. These uncertainties can be addressed mainly by implementing good laboratory practice, an uncertainty evaluation, an interdisciplinary approach, replication of studies and harmonization of both protocols and endpoints.

Session 3 dealt with the current state of knowledge and identification of the main areas of scientific consensus. As to laboratory studies, for exposure to extremely low frequency EMF no dose response relationship and no known mechanisms for interactions at cellular level can be identified. There is some evidence for genotoxicity, tumor promotion, changes in the cell redox homeostasis, differentiation status of cells at flux densities greater than 0.1 mT and effects on neurobehaviour at levels greater than 1 mT. No consistent evidence and no causal mechanism has been established for carcinogenicity. As to static magnetic fields, effects on neurobehaviour at levels greater than 1 mT have been found. The perception of phosphenes in humans has been established for extremely low frequency (ELF) exposure. As to radiofrequencies (RF) exposure, apart from the well-known thermal effects for exposure to levels above the critical levels, no consistent evidence on effects on cancer or behaviour, blood brain barrier, auditory system, and teratology in animals, or on gene and protein expression have been found.

The results of many epidemiological studies are consistent with an association between childhood leukaemia and exposure to average ELF magnetic fields. Some evidence has been also found on a possible association between ELF exposure and some neurodegenerative diseases (e.g., Alzheimer disease, Amyotrophic Lateral Sclerosis ALS), whereas no substantial evidence of association has been found with adult leukaemia and

brain tumors. The overall balance of evidence does not support an increased risk of breast cancer, Parkinson disease and cardiovascular diseases.

No association has been consistently demonstrated between short term exposure to radiofrequencies RF and brain tumors. Uncertainty in the interpretation still exists regarding the risk from high exposure levels and long-term exposure (>10 years), owing to a complex mixture of biases affecting the various available studies in different directions. In addition, few studies have evaluated the cancer risk for children and adolescents. For RF and childhood leukaemia, the cluster and ecological studies have been uninformative. Case-control studies do not show consistent risk with RF exposures. However, only a few informative studies are currently available and the exposure assessment is challenging and problematic even in the best studies. As to childhood development, no effect has been found with gross development, although this is mostly based on cross-sectional studies that are weak.

No adverse effects of ELF exposure have been found in animal studies on reproduction and development. RF fields are teratogenic when the temperature is above 40 °C for maternal exposure (due to thermal effects) but no effect has been demonstrated at low RF exposures. Thermal effects of RF fields have been demonstrated on male fertility. No consensus has been found for maternal exposure to ELF magnetic fields, whereas few data are currently available for intermittent and static magnetic fields. Some acute effects have been demonstrated of RF exposure on certain waking EEG characteristics and in sleep EEG, even though no effects have been found on sleep quality. Altered neural activity in terms of regional cerebral blood flow, and brain glucose metabolism has been shown from RF EMF exposure but the mechanism is yet unknown, whereas no consistent results on cognitive function has been found. The overall balance of evidence does not indicate an association between self-reported symptoms and exposure to electromagnetic fields.

In *Session 4* the areas of scientific inconsistency and the knowledge gaps were discussed. The main uncertainties related to ELF exposure and in–vitro studies can be found in genotoxicity, apoptosis, epigenetics (gene and protein expression), combined exposure of EMF and other agents, radical pair mechanisms and degenerative processes. Several factors are likely to contribute to the inconsistencies including: i) (too) large number of variables included in the experiments; ii) experimental protocols not adequately described; iii) lack of replication and confirmation studies. The main uncertainties and gaps regarding biological effects of low level RF EMF relate also to the limited range of signals tested and in the lack of systematic means of exploring various exposures, biological models, or endpoints. Gaps in laboratory studies include the study of effects on young and juvenile animals (brain development, mechanisms, and cancer), ageing and neurodegenerative disease, thresholds for behavioural modifications, use of relevant and responsive in-vitro models for in-vivo findings, methods for identifying localized heating in the brain and the influence on medical implanted devices. The main uncertainty and knowledge gap in both epidemiological case-control and cohort studies are related to RF exposure assessment (dosimetry aspects). The methods so far used are prone to bias and objective measures of exposure are needed to reduce uncertainty interpretation of the study results, e.g., by prospective cohort studies. Studies on the effect of ELF exposure on neurodegenerative diseases should be reinforced, with improved exposure assessment. Moreover, effort should be placed in incrementing replication studies. Finally, the new technologies represent a challenge for researchers. At radio frequencies the communication industry is introducing systems working at frequencies and modulations not yet fully investigated (LTE, WiFi, high frequency RFID). At ELF and intermediate frequencies (up to about 10 MHz) a continuous introduction of new devices and appliances is also modifying the exposure scenario and exposing the population to frequencies and harmonics not yet investigated. These include, for example, for power line communication PLC, super grid and (U)HCDV power lines, body worn devices (smart clothes), electric vehicles, systems for remote controlling household appliances (smart home), smart grid and smart meters. Finally, the increase of the static magnetic field generated by MRI devices (ultra-high-field MRI, even higher than 12 T) needs to be addressed with additional effort.

The final discussion (Session 5) dealt mainly with lessons learned and recommendations for the future. In this session, an interesting discussion about the link between the issues and information presented during the two-day conference and their possible influence on research strategies took place. This included also issues related to risk communication and transfer of scientific information as input to the risk management processes.

It was noted by several of the presenters that some general issues have to be addressed to take the research area forward. This includes understanding interaction mechanisms, by performing hypothesis-driven research, not least in the face of future technological developments. Other general items that were raised included more comprehensive and rigorous exposure assessment, studies of long-term effects, studies of neurodegenerative diseases in all frequency bands, and the need for an inter-/multidisciplinary approach.

Regarding areas where there is a need for additional epidemiological research, the possible relationship between ELF magnetic field exposure and neurodegenerative diseases was highlighted, in particular to clarify appropriate methodology and investigate the replicability of previous findings. Regarding epidemiological studies of Intermediate Frequency and static magnetic field exposures, effects of long-term exposures have not been studied. The inconsistencies and uncertainties in epidemiological studies of RF effects could be addressed by focusing on shortcomings in present data and by performing prospective cohort studies.

Factors that influence risk assessment of EMF was brought into the discussion, from the perspective of value focused thinking. This implies that the risk assessment should start with policy issues rather than identifying knowledge gaps. A consequence would be that risk management could be easier. Furthermore, it was noted that risk assessment in this area is especially difficult due to variability issues, both regarding individuals and exposure. Therefore, it was argued that there is a need for an assessment of the public health impact of new technologies on all levels of development. This also includes extended public exposure monitoring.