The International EMF Project

Update on the Radiofrequency Fields Environmental Health Criteria

Dr E. van Deventer

Radiation Programme
Department of Public Health, Environmental and Social Determinants of Health
Geneva, Switzerland

World Health Organization
Function: act as the UN directing and coordinating authority on international health work

Objective: attainment by all peoples of the highest possible level of health

Definition: "HEALTH is a state of COMPLETE physical, mental and social well-being and not merely the ABSENCE of disease or infirmity" (Constitution, 1948)
The International Agency for Research on Cancer (IARC)

– coordinates and conducts experimental and epidemiological research on the causes of cancer and the mechanisms involved in carcinogenesis; and

– develops evidence-based strategies for cancer prevention and control.
WHO International EMF Project

- Established in 1996
- Coordinated by WHO HQ
- Objectives
  - Review the scientific literature on health effects of EMF exposure and formally assess health risks;
  - Promote a focused agenda of high quality EMF research;
  - Encourage internationally acceptable harmonized standards;
  - Provide information on risk perception, risk communication, risk management
Problem Formulation

Exposure Assessment
- Determine the amount, duration and pattern of exposure to the agent

Hazard Identification
- Review key research to identify any potential health problems that an agent can cause

Exposure-Response Assessment
- Estimate how much of the agent it would take to cause varying degrees of health effects that could lead to illnesses

Risk Characterization
- Assess the risk for the agent to cause cancer or other illnesses in the general population

Cancer
Health Risk Assessment (cont'd)

Problem Formulation

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Determine the amount, duration and pattern of exposure to the agent

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Review key research to identify any potential health problems that an agent can cause

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Assess the risk for the agent to cause cancer or other illnesses in the general population

All studied outcomes
Background
IARC Monographs

- Initiated in 1969
- Criteria established in 1971, last update January 2006
- Limited largely to the first step in risk assessment
- “Carcinogen”: exposure that is capable of increasing the incidence of malignant neoplasms (at any stage of the carcinogenesis)
- 970+ agents have been evaluated
- **Volume 80**: Non-Ionizing Radiation, Part 1: Static and Extremely Low-Frequency (ELF) Electric and Magnetic Fields, 2002
For each type of cancer, classify human and animal data separately as:

- Sufficient
- Limited
- Inadequate
- Lack of effect

**Group 1**: Is carcinogenic to humans
**Group 2A**: Probably is carcinogenic
**Group 2B**: Possibly is carcinogenic
**Group 3**: Not classifiable
**Group 4**: Is probably not carcinogenic
Background
WHO Environmental Health Criteria

- Original impetus for the Programme came from World Health Assembly resolutions and the recommendations of the 1972 UN Conference on the Human Environment

- Subsequently the work became an integral part of the International Programme on Chemical Safety (IPCS), including UNEP, ILO and WHO

- The EHC monographs have become widely established, used and recognized throughout the world
Environmental Health Criteria (EHC) documents provide international, critical reviews on the effects of chemicals or combinations of chemicals and physical and biological agents on human health and the environment.

Each EHC follows a standard outline or format, and you can expect to find a summary of the whole document followed by information on identity, sources of exposure, environmental transport, distribution and transformation, environmental levels, and human exposure, kinetics and metabolism in laboratory animals and humans, effects on laboratory animals and in vitro test systems, effects on other organisms in the laboratory and field. An overall evaluation and conclusions for the protection of human health and the environment is found at the end of each document together with needs for further research and details of previous evaluations by international bodies e.g. IARC, JEFCA.

Two different series of Environmental Health Criteria (EHC) documents are available: (1) on specific chemicals or groups of related chemicals; and (2) on risk assessment methodologies. Both are accessible from the numerical listing below. In addition, the EHCs on risk assessment methodologies are accessible from the listing of all IPCS methodology publications and projects.
Environmental Health Criteria

Electromagnetic Fields

- EHC 16 Radiofrequency and microwaves (1981)
- EHC 35 Extremely low frequency (ELF) fields (1984)
- EHC 69 Magnetic fields (1987)
- EHC 137 Electromagnetic fields (300 Hz-300 GHz) (1993)
EMF EHC Monographs

Comprise:

- Critical review of evidence for EMF effects on health
- Health risk assessment
- Risk management measures
- Research recommendations
Environmental Health Criteria

- **Target audience**
  - National and international authorities

- **Reason for development**
  - To assist them in making risk assessment and subsequent risk management decisions
  - Mandate
  - Update
WHO Monographs on Electromagnetic fields

- 2002
- 2006
- 2007
- 2013
- 2012-16
RF EHC ....

**INTERPHONE** multinational epidemiologic study (May 2010)

**IARC** evaluation of *carcinogenic* risks to humans from RF (May 2011)

**WHO** assessment of all health risks to humans from RF (2012–15)
IARC Monographs on RF


- Expert meeting, May 2011
- *The Lancet Oncology*, 22 June 2011
- Monograph publication, 24 April 2013

Carcinogenicity of radiofrequency electromagnetic fields

In May 2011, 30 scientists from 14 countries met at the International Agency for Research on Cancer (IARC) in Lyon, France, to assess the carcinogenicity of radiofrequency electromagnetic fields (RF-EMF). These assessments will be published as Volume 102 of the IARC Monographs.¹

Human exposures to RF-EMF (frequency range 30 kHz-300 GHz) can occur from use of personal devices (e.g., mobile phones, cordless telephones). The induced electric and magnetic fields and associated currents inside tissues. The most important factors that determine the induced fields are the distance of the source from the body and the output power level. Additionally, the efficiency of coupling and resulting field distribution inside the body strongly depend on the frequency, polarisation, and direction of wave incidence on the body, and antennae design of the device regarding associations between use of wireless phones and glioma.

The cohort study² included 257 cases of glioma among 420,095 subscribers to two Danish mobile phone companies between 1982 and 1995. Glioma incidence was near the national average for the subscribers. In this study, reliance on subscription to a mobile phone provider, as a surrogate for mobile phone use, could have resulted in bias and underestimated the risk.
RF fields classified as "possibly carcinogenic to humans" (Group 2B) based on

- **limited evidence in humans**, based on positive association between glioma and acoustic neuroma and exposure to RF-EMF from wireless phones (epidemiologic studies)
- **limited evidence in experimental animals** for the carcinogenicity of RF-EMF
- **weak mechanistic evidence** relevant to RF-EMF-induced cancer in humans

Evidence for other exposures (e.g. base stations, Wi-Fi) and outcomes (other cancers) considered insufficient for any conclusion.
### Agents Classified by IARC (971)

<table>
<thead>
<tr>
<th>IARC Classification</th>
<th>Examples of Agents</th>
</tr>
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</table>
| Carcinogenic to humans (114)  
(usually based on strong evidence of carcinogenicity in humans) | Asbestos  
Alcoholic beverages  
Benzene  
Mustard gas  
Radon gas  
Solar radiation  
Tobacco (smoked and smokeless)  
X-rays and Gamma |
| Probably carcinogenic to humans (69)  
(usually based on strong evidence of carcinogenicity in animals) | Creosotes  
Diesel engine exhaust  
Formaldehyde  
Polychlorinated biphenyls (PCBs) |
| Possibly carcinogenic to humans (283)  
(usually based on evidence in humans which is considered credible, but for which other explanations could not be ruled out) | RF fields  
ELF magnetic fields  
Coffee  
Gasoline engine exhaust  
Pickled vegetables  
Styrene |
6.1 Cancer in Humans

There is limited evidence in humans for the carcinogenicity of radiofrequency radiation. Positive associations have been observed between exposure to radiofrequency radiation from wireless phones and glioma, and acoustic neuroma.

6.2 Cancer in Experimental Animals

There is limited evidence in experimental animals for the carcinogenicity of radiofrequency radiation.

6.3 Overall Evaluation

Radiofrequency electromagnetic fields are possibly carcinogenic to humans (Group 2B).

6.4 Rationale of the evaluation of the epidemiological evidence

The human epidemiological evidence was mixed. Several small early case–control studies were considered to be largely uninformative. A large cohort study showed no increase in risk of relevant tumours, but it lacked information on level of mobile-phone use and there were several glioma and acoustic neuroma and mobile-phone use; specifically in people with highest cumulative use of mobile phones, in people who had used mobile phones on the same side of the head as that on which their tumour developed, and in people whose tumour was in the temporal lobe of the brain (the area of the brain that is most exposed to RF radiation when a wireless phone is used at the ear). The Swedish study found similar results for cordless phones. The comparative weakness of the associations in the INTERPHONE study and inconsistencies between its results and those of the Swedish study led to the evaluation of limited evidence for glioma and acoustic neuroma, as decided by the majority of the members of the Working Group. A small, recently published Japanese case–control study, which also observed an association of acoustic neuroma with mobile-phone use, contributed to the evaluation of limited evidence for acoustic neuroma.

There was, however, a minority opinion that current evidence in humans was inadequate, therefore permitting no conclusion about a causal association. This minority saw inconsistency between the two case-control studies
The RF EHC

Environmental Health Criteria No. ???

Radiofrequency Fields

World Health Organization
Scope

- **Frequency range:**
  - 100 kHz - 300 GHz
  - Include UWB, pulses, mm-waves

- **Sources:**
  - RFID, EAS, mobile telephony, radars,…

- **Health benefits not included**
  - Hyperthermia, MRI, medical treatments, diathermy, RF ablation surgery
Kick-off meeting
Jan 2012

First draft consultation
Sept –Dec 2014

Task Group meeting
Fall 2015

Monograph publication
2016
Environmental Health Criteria
Contributors

- Chapter authors, expert working group members (~ 25)

- Task Group members
  - Individual scientists, not representatives of their organizations
  - Composition dictated by range of expertise and views, gender and geographical distribution
  - Membership approved by Assistant Director General
  - Role: assess risks to health, reach agreements by consensus, make final conclusions and recommendations that cannot be altered after the Task Group meeting

- Observers

- Secretariat
Core group

- Physics, dosimetry: S. Mann, UK
- Epidemiological studies: M. Feychting, Sweden
- Humans studies: G. Oftedal, Norway
- Animal studies: E. van Rongen, Netherlands
- In vitro studies: M. R. Scarfi, Italy
- Public health: D. Zmirou, France

- Monthly teleconferences
- Annual face-to-face meetings
## Assistance

- Additional experts to help drafting sections

<table>
<thead>
<tr>
<th>Name</th>
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<tbody>
<tr>
<td>Azadeh Peyman</td>
<td>Martin Röösli</td>
</tr>
<tr>
<td>Olga Zeni</td>
<td>James Rubin</td>
</tr>
<tr>
<td>Giorgio Aicardi</td>
<td>Minouk Schoemaker</td>
</tr>
<tr>
<td>Jukka Juutilainen</td>
<td>Brahim Selmaoui</td>
</tr>
<tr>
<td>Kerstin Hug</td>
<td>René de Sèze</td>
</tr>
<tr>
<td>Sarah Loughran</td>
<td>Zenon Sienkiewicz</td>
</tr>
<tr>
<td>Carmela Marino</td>
<td>Myrtill Simko</td>
</tr>
<tr>
<td>James McNameee</td>
<td>Susanna Lagorio</td>
</tr>
<tr>
<td>Jonne Naarala</td>
<td>Vijaylaxmi</td>
</tr>
<tr>
<td>Giuseppe Curcio</td>
<td>Lawrie Challis (reviewer)</td>
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Declaration of Interests

DECLARATION OF INTERESTS FOR WHO EXPERTS

WHO's work on global health issues requires the assistance of external experts who may have interests related to their expertise. To ensure the highest integrity and public confidence in its activities, WHO requires that experts serving in an advisory role disclose any circumstances that could give rise to a potential conflict of interest related to the subject of the activity in which they will be involved.

All experts serving in an advisory role must disclose any circumstances that could represent a potential conflict of interest (i.e., you must disclose any circumstances that may, directly or indirectly, affect the objectivity of your work). You must disclose all interests and relationships of the work, the experts, and the organization they represent (see definitions). If a conflict cannot be avoided, appropriate measures are to be taken to resolve it (i.e., you may have to resign from the advisory role).

WHO values and relies upon the normative and technical advice that is provided by leading subject matter experts in the context of similar processes. Such advice contributes to the development and promulgation of WHO's policies and guidelines, which may be described as "confidential information" or "proprietary to the WHO.

Code of Conduct for WHO Experts

Should be sent with the DOI form

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Should be sent with the invitation or appointment letter

1. The World Health Organization (WHO), acting through its Department of [ ], has access to certain information relating to [ ], which information WHO considers to be proprietary to itself or to parties collaborating with it (hereinafter referred to as "the Information").

2. The undersigned, as a member of the [ ] advisory meeting, group or committee (collectively referred to as the "the Advisory Process"), may have access to the Information in the course of his/her participation in the Advisory Process (whether
EHC on RF Fields

Preamble
1. Summary and recommendations for further study
2. Sources, measurements and exposures
3. Electric and magnetic fields inside the body; SAR and heat
4. Biophysical mechanisms; tissue heating
5. Brain physiology and function
6. Auditory, vestibular and ocular function
7. Neuroendocrine system
8. Neurodegenerative disorders
9. Cardiovascular system and thermoregulation
10. Immune system and haematology
11. Fertility, reproduction and development
12. Cancer
13. Health risk assessment
14. Protective measures

Annexes
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Annexes
Research
Balance of studies needed

Relevant studies

- Epidemiological studies
  - Diff. categories of study designs (no case-report or case-series)

- Human studies
  - Laboratory, intervention studies

- Animal studies
  - Laboratory (including ex vivo studies), observational studies (domestic animals)

- In vitro studies
  - Cell cultures, isolated tissue samples
<table>
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<tr>
<th>Ch</th>
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<th>Epidemiologic studies</th>
<th>Human studies</th>
<th>Animal studies</th>
<th>Cellular studies</th>
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<td>Y</td>
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<td>Neurodegenerative disorders</td>
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<td>-</td>
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<td>Cardiovascular system and thermoregulation</td>
<td>Y</td>
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<td>Immune system and haematology</td>
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<td>Fertility, reproduction and development</td>
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<td>Cancer</td>
<td>Y</td>
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Development of an extensive database

- Peer-reviewed scientific publications
- Meta-analyses not included at this stage
- Time period: Jan 1992-Dec 2012
- Geographical inclusion (UN languages, challenge)
Screening Process

- Health outcomes
- Inclusion criteria
- Quality criteria
- Selected papers
Exposure + Specific outcome

Apply search strategy

Crude list

Screen by title, abstract

Possibly relevant papers, full text obtained

Remove when not relevant upon further inspection

Relevant papers

Remove when not compliant with inclusion criteria

Papers included in Monograph

Apply quality criteria

Selected papers

Health outcomes

Inclusion criteria

Quality criteria

PubMed, ISI Web of Science, Embase, EMF Portal, ELMAR

Search for related papers

Search in reference lists

From different topic

Papers in full compliance with inclusion and quality criteria

Epidemiological and volunteer papers with uncertainties related to inclusion and quality criteria

Animal and in vitro papers not to be included in overall analysis
Inclusion criteria

- **Epidemiological studies**
  - Study base identified (to allow assessment of the representativity of the participants)
  - Exposed and unexposed groups considered
  - Relevant statistical analysis performed

- **Laboratory studies**
  - At least two exposure levels, whereof one could be a sham exposure under otherwise similar conditions
  - Exposure conditions blinded to the participants (human studies only)
Quality criteria

- Epidemiological studies
  - STROBE checklist, GRADE, Newcastle-Ottawa Scale

- Volunteer studies
  - CONSORT statement and checklist, Gold Standard Publication Checklist

- Animal studies
  - Gold Standard Publication Checklist

- In-vitro studies
  - Dosimetry, statistical analysis, T control, …
Quality criteria (cont'd)

• Statistical precision/statistical power (width of confidence intervals when provided, primarily study size)

• Potential biases

• Consistency and plausibility of results and, when relevant, dose-response relationship

• Directness (validity in relation to, e.g. study population, exposure, time lag between exposure and outcome assessment, and endpoints)
Criteria for ‘grey zone’

- **Epidemiological studies**
  - Insufficient information provided

- **Experimental studies**
  - No relevant statistical analysis
  - Exposure level not sufficiently controlled and documented

- **Human volunteer studies**
  - Exposures given in fixed order
  - Insufficient information on blinding of subjects

- **Animal studies**
  - Exposures given in fixed order

- **In vitro studies**
  - Biological assay not properly carried out
Chapter 1
Summary and Research recommendations

- Executive summary
  - Translated in several UN languages
  - Developed after the Task Group meeting

- Research recommendations
Risk Management Policies regarding Radiofrequency Electromagnetic Fields

There has been growing concern about the possibility of adverse health effects resulting from exposure to radiofrequency (RF) electromagnetic fields, such as those emitted by wireless communication devices and networks. In response to such concern, the World Health Organization is assessing health risks that may be associated with exposure to RF fields in the frequency range of 100 kHz to 300 GHz.

This survey seeks to gather information on current risk management policies on RF fields at national level from relevant governmental bodies (e.g. Ministry of Health, Ministry of Environment, Ministry of Telecommunications, Ministry of Labor, Radiation Protection Agency, ...). Please feel free to forward this survey to whom it may concern in your country.

The survey has 3 sections reflecting the following RF exposure categories:

- **personal exposures** associated with the use of mobile devices (such as cell phones)
- **environmental exposures** associated with fixed installations transmitting signals from radio, television and wireless communication networks, and
- **occupational exposures** in the telecommunication, industrial and medical sectors

The results of this survey will be made publicly available on WHO’s website. If you have questions, please contact us at emfproject@who.int

Thank you in advance for completing this survey by **30 October 2012 (note the extended deadline!!)**.

**NOTE:** The mention of actions/policies in this survey does not constitute endorsement by WHO that risks exist or that the actions are appropriate. Merely, they represent examples of actions/policies that are in effect or that have been proposed in some countries.
Chapter 14
Policy measures

Announcement of
International Stakeholder Seminar
5 June 2013, 9:00
French Agency for Food, Environmental and Occupational Health & Safety (ANSES)
27-31 avenue du Général Leclerc
92200 Clichy, France

Call for examples of good risk management practices

Electromagnetic fields (EMF)

International Stakeholder Seminar on Radiofrequency Policies

French Agency for Food, Environmental and Occupational Health & Safety (ANSES)
Paris, France, 5 June 2013

Workshop background information

The World Health Organization (WHO) is preparing an Environmental Health Criteria monograph on radiofrequency (RF) fields. The monograph will include a scientific review of all studied health outcomes and it will provide an overview of risk management policies and practices around the world. WHO convened a seminar on 5 June 2013 at the French Agency for Food, Environmental and Occupational Health & Safety (ANSES) in Paris, France, to provide an opportunity for stakeholders to present their views on specific questions to be addressed during the course of this project. The discussions at the seminar and their conclusions will be considered carefully in the development of the WHO monograph.
Next steps

- 30 September 2014: upload draft chapters on web for public comments for 6 weeks until 31 October 2014
- 15 December 2014: Deadline of expert consultation
- January-March 2015: Core Group review comments and meeting to finalize second draft for Task Group
- Fall 2015: Task Group meeting
Radio Frequency fields: Environmental Health Criteria Monograph

Consultation on the scientific review for the upcoming WHO Environmental Health Criteria

The consultation is open until 15 December 2014

The World Health Organization is undertaking a health risk assessment of radiofrequency electromagnetic fields, to be published as a monograph in the Environmental Health Criteria Series. This publication will complement the monographs on static fields (2005) and extremely low frequency fields (2007), and will update the monograph on radiofrequency fields (1993).

The draft chapters of this document containing the scientific content are now open for consultation by RF experts. We are seeking comments on the accuracy and completeness of these chapters. Please note that the final monograph has been extended until 15 December 2014.