ITU Workshop on “Practical measurement of EMF exposure”
(Gaborone, Botswana, 25-26 July 2011)

Electromagnetic Fields and Health: A WHO Perspective

Dr E. van Deventer
Radiation Programme
World Health Organization
OUTLINE

- Introduction
- Assessing the health risk
- Managing the potential risk
- Conclusions
Blood test to diagnose tuberculosis can be dangerous

20 July 2011 -- A 12-month analysis reveals that currently available commercial blood tests for diagnosing active TB often lead to misdiagnosis, mistreatment and potential harm to public health. WHO is urging countries to ban these tests and instead rely on accurate microbiological or molecular tests.
Radio Frequency Fields
(100 kHz – 300 GHz)

- Wi-Fi
- Telecommunications
- Broadcasting
- Residential sources
- Commercial
- Security scanners
- Navigation/Radar
- Emerging technologies
The Present EMF Context

- Increasing EMF human exposure due to electricity demand, medical technologies and wireless devices
- Increasing concern from the public
Mobiles ‘boost cancer’
Radiation may make tumours grow faster

By Tim Utton
Science Reporter

NEW safety fears about mobile phones emerged yesterday over a possible link with cancer.
Radiation from the phones could promote the growth of tumours, according to scientists.
A new study suggests the radiation can kick cancer cells into ‘high gear’

use are still unclear.
The biggest British study, led by Sir William Stewart two years ago, could find no evidence of a risk to health. But Sir William still recommended a precautionary approach, particularly in children.
The World Health Organisation has called for more research and has urged people to limit mobile use.

Now Italian scientists believe they could be closer to the truth.
Dr Fiorenzo Marinelli, of the National Research Council in Bologna, exposed leukaemia cells in the laboratory to 48 hours of continuous radio waves at a similar power and frequency to mobile phone emissions.
Initially, the radiation killed the cancer cells. But then the scientists noticed this lethal effect had gone into reverse as a ‘survival mechanism’ was triggered, which made them replicate at a ferocious speed.

Dr Marinelli said: ‘We don’t know what the effects would be on healthy human cells.
‘But in leukaemia cells the response is always the same.’
The radiation may initially damage

Cancer develops when control signals in a normal cell go wrong and an abnormal cell results. Instead of destroying itself the mutant cell keeps on dividing and forms a lump or tumour.
The results of the Italian study support the belief of some scientists who say radiation can damage DNA and destroy the cell repair system - making tumours more deadly.

Dr Peter de Pomerai of the University of Nottingham, who studied effects on the body earlier this year, said the research was ‘intriguing’.
Radiation may indirectly damage DNA by affecting its repair system, he said. If the DNA repair mechanism does not work as it should, mutations in cells could accumulate - with disastrous consequences.

‘Cells with unrepaired DNA damage are likely to be far more aggressively cancerous,’ said Dr de Pomerai. Dr Marinelli presented his results at the International Workshop on the Biological Effects of Electromagnetic Fields held in Garmisch.
The Present Scientific Knowledge

- Large and increasingly sophisticated database
- Known mechanisms
- Health effects not established below international guidelines
- Scientific uncertainty
WHO International EMF Project

- Established in 1996
- Coordinated by WHO HQ
- A multinational, multidisciplinary effort to create and disseminate information on human health risk from EMF
WHO Partners in Radiation

International Organisations

International Advisory Committee

National Authorities

Collaborating Centres
Do EMFs pose a health risk?

Risk Assessment
The Evidence

Risk Perception
The Public Concern

Risk Management
The Policies
OUTLINE

- Introduction
- Assessing the health risk
What do we know?

- Frequency: 100 kHz, 300 MHz, 10 GHz

?
What do we know?
Mechanisms of interaction

100 kHz  300 MHz  10 GHz

Induced currents

Induced currents and heating

Surface heating

Non-thermal effects??
Reference Levels

Gaborone, Botswana, 25–26 July 2011
How do we evaluate the health risk from EMF?
Research

Balance of studies needed

### RF Studies

(WHO Database, March 2009)

<table>
<thead>
<tr>
<th>Type of study</th>
<th>Ongoing</th>
<th>Not yet published</th>
<th>Published</th>
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<tr>
<td>Physics</td>
<td>77</td>
<td>14</td>
<td>538</td>
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<tr>
<td>Epidemiology</td>
<td>41</td>
<td>12</td>
<td>311</td>
</tr>
<tr>
<td>Human</td>
<td>44</td>
<td>11</td>
<td>256</td>
</tr>
<tr>
<td>Animal</td>
<td>42</td>
<td>28</td>
<td>834</td>
</tr>
<tr>
<td>Cellular</td>
<td>60</td>
<td>28</td>
<td>503</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>264</strong></td>
<td><strong>93</strong></td>
<td><strong>2442</strong></td>
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</tbody>
</table>
Laboratory Studies

- **Cellular studies**
  - Genotoxicity
  - Gene expression

- **Animal studies**
  - Cancer
  - Behaviour
  - BBB
  - Skin

- **Human studies**
  - Sleep
  - EEG
  - Hormones
  - EHS
Short-term effects
(WHO fact sheet 193, June 2011)

To date, research does not suggest any consistent evidence of adverse health effects from exposure to RF fields at levels below those that cause tissue heating.

Research has not been able to provide support for a causal relationship between exposure to EMF and self-reported symptoms, or “electromagnetic hypersensitivity”.

Gaborone, Botswana, 25–26 July 2011
Conclusions: “EHS is characterized by a variety of non-specific symptoms that differ from individual to individual... EHS has no clear diagnostic criteria and there is no scientific basis to link EHS symptoms to EMF exposure.”
Epidemiology
Studies on mobile phones

Tumours in head and neck
- Glioma, meningioma, acoustic neuroma, parotid gland

Around 15 studies on the use of mobile phones
- **Published:** USA, Nordic countries, Hardell, INTERPHONE
- **Ongoing:** Cefalo, MOBI-Kids, COSMOS
Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case–control study

The INTERPHONE Study Group*

Corresponding author. Elisabeth Cardis; CREAL, Doctor Aiguader 88,
*List of members of this study group is available in the Appendix.

Accepted 8 March 2010

Cases:
- 2,765 gliomas
- 2,425 meningiomas
- 1,121 acoustic neuroma
- 109 malignant parotid gland

Controls:
- 7,658
Long-term effects
(WHO fact sheet 193, June 2011)

- No increased risk of glioma or meningioma with mobile phone use of more than 10 years
- Indications of increased risk of glioma for heavy users
  - Biases and errors prevent a causal interpretation.
- No available data for long-term use (15-20 ans)
- No available data for children
Media centre

Electromagnetic fields and public health: mobile phones

Fact sheet N°193
June 2011

Key facts

- Mobile phone use is ubiquitous with an estimated 4.6 billion subscriptions globally.
- The electromagnetic fields produced by mobile phones are classified by the International Agency for Research on Cancer as possibly carcinogenic to humans.
- Studies are ongoing to more fully assess potential long-term effects of mobile phone use.
- WHO will conduct a formal risk assessment of all studied health outcomes from radiofrequency fields exposure by 2012.

Some studies have been performed

- Well-being and performance
- Cancer

Conclusions:
“Considering the very low exposure levels and research results collected to date, there is no convincing scientific evidence that the weak RF signals from base stations and wireless networks cause adverse health effects”
WHO Health Risk Assessment

Risk assessment of all health outcomes (Environmental Health Criteria)

Hazard identification and classification of possible carcinogens (Monographs)

International Agency for Research on Cancer (IARC)
Centre International de Recherche sur le Cancer (CIRC)

Gaborone, Botswana, 25–26 July 2011
Background
IARC Monographs

The *IARC Monographs* are a series of scientific reviews that identify environmental factors that can increase the risk of human cancer.

National and international health agencies use the *Monographs*:
- As a source of information on potential carcinogens
- As scientific support to guide their actions to prevent exposure to potential carcinogens
Background
IARC Monographs

- Initiated in 1969
- 950+ agents have been evaluated
- **Volume 80**: Non-Ionizing Radiation, Part 1: Static and Extremely Low-Frequency (ELF) Electric and Magnetic Fields, 2002
Overview of the evaluation process

Cancer in humans
- Sufficient evidence
- Limited evidence
- Inadequate evidence
- Evidence suggesting lack of carcinogenicity

Cancer in experimental animals
- Sufficient evidence
- Limited evidence
- Inadequate evidence
- Evidence suggesting lack of carcinogenicity

Mechanistic and other relevant data
- Mechanistic data “weak,” “moderate,” or “strong”?
- Mechanism likely to be operative in humans?

Overall evaluation
- Group 1: Carcinogenic to humans
- Group 2A: Probably carcinogenic to humans
- Group 2B: Possibly carcinogenic to humans
- Group 3: Not classifiable as to its carcinogenicity to humans
- Group 4: Probably not carcinogenic to humans
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 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 regarding associations between use of wireless phones and glioma.

The cohort study4 included 257 cases of glioma among 420955 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

Gaborone, Botswana, 25–26 July 2011
RF fields classified as Group 2B “Possible Carcinogenic” based on

- **limited** human data on association between glioma and acoustic neuroma and exposure to RF-EMF from wireless phones (epidemiologic studies).
- **limited** animal data

Evidence for other exposures (e.g. base stations, wifi, ...) and outcomes (other cancers) considered insufficient for any conclusion.
<table>
<thead>
<tr>
<th>IARC Classification</th>
<th>Examples of Agents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Carcinogenic to humans (107)</strong></td>
<td>Asbestos</td>
</tr>
<tr>
<td>(usually based on strong evidence of</td>
<td>Alcoholic beverages</td>
</tr>
<tr>
<td>carcinogenicity in humans)</td>
<td>Benzene</td>
</tr>
<tr>
<td></td>
<td>Mustard gas</td>
</tr>
<tr>
<td></td>
<td>Radon gas</td>
</tr>
<tr>
<td></td>
<td>Solar radiation</td>
</tr>
<tr>
<td></td>
<td>Tobacco (smoked and smokeless)</td>
</tr>
<tr>
<td></td>
<td>X-rays and Gamma</td>
</tr>
<tr>
<td><strong>Probably carcinogenic to humans (59)</strong></td>
<td>Creosotes</td>
</tr>
<tr>
<td>(usually based on strong evidence of</td>
<td>Diesel engine exhaust</td>
</tr>
<tr>
<td>carcinogenicity in animals)</td>
<td>Formaldehyde</td>
</tr>
<tr>
<td></td>
<td>Polychlorinated biphenyls (PCBs)</td>
</tr>
<tr>
<td><strong>Possibly carcinogenic to humans (267)</strong></td>
<td>Coffee</td>
</tr>
<tr>
<td>(usually based on evidence in humans which</td>
<td>Gasoline engine exhaust</td>
</tr>
<tr>
<td>is considered credible, but for which other</td>
<td>Pickled vegetables</td>
</tr>
<tr>
<td>explanations could not be ruled out)</td>
<td>ELF magnetic fields</td>
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<tr>
<td></td>
<td>Styrene</td>
</tr>
<tr>
<td></td>
<td>RF fields</td>
</tr>
</tbody>
</table>
IARC Classification

Los Angeles Times | BOOSTER SHOTS

LOCAL U.S. WORLD BUSINESS SPORTS ENTERTAINMENT HEALTH LIVING TRAVEL

HEALTH TOPICS: CELL PHONE RADIATION | HEALTHCARE LAW | E. COLI

BOOSTER SHOTS: ODDITIES, MUSINGS AND NEWS FROM THE HEALTH WORLD

If cellphones cause cancer, how do they do it? No one knows (i.e. don't panic)

Gaborone, Botswana, 25–26 July 2011
What has been done?

• WHO Research reviews
• Health Risk Assessments

Gaborone, Botswana, 25–26 July 2011
Environmental Health Criteria
Electromagnetic Fields

ICNIRP Guidelines

GUIDELINES ON LIMITS OF EXPOSURE TO STATIC MAGNETIC FIELDS
International Commission on Non-Ionizing Radiation Protection®

INTRODUCTION
The rapid development of technologies in industrial medicine using static magnetic fields has resulted in an increase in human exposure to these fields and in the need for up-to-date guidelines.

ICNIRP Guidelines

GUIDELINES FOR LIMITING EXPOSURE TO TIME-VARYING ELECTRIC AND MAGNETIC FIELDS (1 Hz TO 100 kHz)
International Commission on Non-Ionizing Radiation Protection®

INTRODUCTION
In this document, guidelines are established for the protection of humans exposed to electric and magnetic fields in the low-frequency range of the electromagnetic spectrum, with a conducting object where the electric potential of the object is different from that of the body. Results of laboratory and epidemiological studies, basic exposure assessment criteria, and reference levels for practical hazard assessment criteria are in discussion, and the guidelines presented here are applicable.
What has been done?

- WHO Research reviews
- Health Risk Assessments

What needs to be done?

- WHO Research Agenda
- WHO and EMF Research

Gaborone, Botswana, 25–26 July 2011
Introduction

Assessing the health risk

Managing the health risk
  - Communicating the scientific knowledge
  - Developing standards and regulations
For programme managers who need basic information on EMF risk perception, communication and management

Available in English

Translated into Spanish, Italian, German, French, Russian, Bulgarian, Dutch, Polish, Portuguese, Hungarian and Japanese

Available on the web www.who.int/emf
Elements of Risk Perception

- Extent of health risk
- Probability of occurrence
- Uncertainty
- Ubiquity
- Pattern of exposure
- Delayed effect
- Inequity and injustice
- Voluntary vs. involuntary exposure
Managing EMF Risk Communication

COMMUNICATING ON THE EMF RISK ISSUE

WHAT?
WITH WHOM?
HOW?
WHEN?
The Message
What to Communicate?

- Communicating the science
- Putting the EMF risk in perspective
- Explaining policy measures
Stakeholders
With whom to communicate?

- Scientific Community
- Health Community
- Associations
- General Public
- Industry
- Law
- Government
- Media
WHO and STANDARDS

- WHO does NOT develop EMF standards but facilitates international consensus on standards.

- International bodies, ICNIRP and IEEE/ICES, develop international guidelines for human protection from EMF exposure.
Emission standards have specifications that limit the EMF emissions from devices.

Exposure standards have specifications that limit EMF exposure to people.
Relevant Authorities
Non-governmental and international organizations

- Emission standards
- Measurements standards
- Exposure standards
Relevant Authorities
National bodies

Ministry of Health
Ministry of Labour
Ministry of the Environment
Ministry of Transport
Ministry of Energy
Ministry of Telecommunications
....
Policy documents ....

http://www.who.int/peh-emf/standards/

Gaborone, Botswana, 25–26 July 2011
Concerns about public safety because of increasing EMF exposures from new technologies

Many countries currently considering EMF standards

Large differences between national standards

Model Legislation

To assist countries without appropriate legislation to protect their population from EMF

Provides a legal framework to provide protection from EMF

Model Legislation

Purpose

to establish limits on human exposure to EMF that will provide protection against known adverse health effects from any installation or device emitting such fields.

Scope

Minimum requirements for the protection of the public and workers.
Model Legislation

- **Purpose**
  - to establish limits on human exposure to EMF that will provide protection against known adverse health effects from any installation or device emitting such fields

- **Scope**
  - Minimum requirements for the protection of the public and workers
  - EMF frequency range 0 to 300 GHz
Model Legislation

EMF limits:

- Adoption of international standards to limit
  - EMF exposure of people (ICNIRP guidelines)
  - emissions of EMF from devices (IEC and IEEE device emission standards)
- Uniform application of the Act across the national jurisdiction
Model Legislation (cont'd)

Compliance
- Range of options that the Minister may consider appropriate
- Establish or nominate an agency to administer compliance

Enforcement
- Owner of installation to ensure compliance in public places and to provide training to workers (else general public status)

Record keeping
- Maintenance of records of exposure measurements
- Information provision as appropriate
OUTLINE

- Introduction
- Assessing the health risk
- Managing the potential risk
- Conclusions
Challenges to governments....

- Rapidly evolving RF technologies
- Launched on the market before health evaluation
- Disparities in risk management measures and regulations around the world
- Concern from the public
Conclusions

- Need for clear roles and responsibilities in government on this topic
- Need for adoption and compliance of health-based standards
- Need for a public information program and dialogue with stakeholders
- Need for promoting research to reduce uncertainty

We are a "global village"