RF Safety Concerns: Facts and Opinions

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Institute of Electrical and Electronics Engineers (IEEE)
Piscataway, NJ, USA

*Speaking as an individual and not for the IEEE
Know the facts

On a wall inside the “Chicago Tribune” downtown building

In science, what is a fact?
Can you prove it? (hypothesis testing)
Is it always true? (repeatability, consistency, know why)
Know what you know and know what you don’t know, that is knowledge.

Confucius
Outline

- History of the issues
- Key concepts
- Research (examples)
- Standards
- Regulations
- Risk communication
- Conclusions
- Q&A

A Global Issue
History of the issues

RF Sources (year)

- Radar (50-60’s)
- Radio and TV Broadcasting (60-70’s)
- Microwave Oven (70-80’s)
- Police Radar (80’s)
- Wireless Communication (90’s - ?) (mobile phones, base stations, Wi-Fi, WiMAX, smart meters, RFID, etc.)
- Wireless power transmission (2011-?)
Common understanding
(mainly from media or internet)

- Microwave (RF) radiation is dangerous
- We don’t have enough understanding of its effects
- Many reports show non-thermal effects
- Radiation can cause cancer, and many other diseases
- The standards are not protective
- Need precautionary measures to be safe than sorry
Radiation

Public Health

- UV
- Radon
- X-rays
- EMF

Public Concern

- EMF
- X-rays
- Radon
- UV
Root of Concerns: “Radiation”

RF Exposure ≠ Nuclear Radiation
Ionizing vs. Non-Ionizing Energy

- **Ionizing**
  - Sufficient energy to alter chemical bonds and atomic structures
  - Confirmed health effects include genetic damage
  - Effects can occur from cumulative exposure

- **Non-ionizing (including RF)**
  - Lower energy, insufficient to cause effects like those above
  - Only confirmed RF health effects relate to tissue heating at levels well above limits for wireless communication
  - No known chronic/cumulative effects
Steps to address safety concerns

1. Scientific research
2. Peer-reviewed publication
3. Consensus standards
4. Regulations
Study Strengths and Weaknesses

- **Epidemiological studies:** *(Greatest weighting WHO, IARC)*
  - Distribution of disease in human populations and factors affecting disease
  - BUT can be subject to bias and confounding factors

- **Human studies:**
  - Response of people to an agent such as RF
  - BUT short-term exposure and selection (usually healthy volunteers)

- **Animal studies:**
  - Responses of mammals to an agent such as RF
  - BUT differences in metabolism, physiology, lifespan, etc

- **In vitro studies:** *(Least weight)*
  - Rapid inexpensive testing for possible interaction mechanisms
  - BUT simple systems may not be applicable to whole organism
The biological effects of RF exposure have been studied for about 70 years.

Current IEEE EMF database contains 6722 entries, of which 3625 are relevant to biological effects of RF exposure (October 5, 2017)

http://ieee-emf.com/
## Mobile Telephony Related Studies

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<td><strong>Total</strong></td>
<td><strong>2960</strong></td>
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IEEE EMF Database (October 5, 2017)
WHO Comment on Database (2016)

“Scientific knowledge in this area is now more extensive than for most chemicals.”

“….current evidence does not confirm the existence of any health consequences from exposure to low level* electromagnetic fields.”

*Low level means below the current international exposure guidelines

http://www.who.int/peh-emf/about/WhatisEMF/en/index1.html
### Quality of Science

**(Established vs. Possible)**

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<td>B</td>
<td>Unconfirmed report (could be useful)</td>
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<td>C</td>
<td>Unconfirmed report contradicts A</td>
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<tr>
<td>D</td>
<td>Unconfirmed report with clear flaws and artifacts</td>
</tr>
<tr>
<td>E</td>
<td>Junk report in peer-reviewed literature</td>
</tr>
<tr>
<td>F</td>
<td>Junk report in non-peer-reviewed literature</td>
</tr>
</tbody>
</table>

**Adapted from Osepchuk [2004]**

“Good science is never outdated.” -- Herman P. Schwan
Biological Complexity

- **In vivo study**
  - Species
  - Strain
  - Sex
  - Age
  - Extrapolation from animal to humans

- **In vitro study**
  - Monolayer
  - Cell suspension
  - Isolated tissue
  - Extrapolation to in vivo
Engineering Complexity

- Exposure systems
- Far Field
- Near Field
- Dosimetry
- Resonance
- Modulation
  - CW, Pulsed
  - AM, FM, TDMA, CDMA, LTE, 5G
- Experimental Artifacts
- Temperature Control
Going in circles

Unbalanced research ability in either biological science or engineering expertise (or both are weak) makes dealing with the complexities difficult.

“I've got it, too, Omar... a strange feeling like we've just been going in circles.”
Validity of studies

- Scientific studies must be repeatable, consistent, and confirmable
- Unique findings are not scientific (unlike in art)
- Any observed effects must have a reason (make sense)
- Scientists have the responsibility to ensure that their findings are robust before publication

(Old saying: It is easy for one man to throw a big rock into a well, but it will take 10 people and a long time to get it out.)
IARC: International Agency for Research on Cancer

IARC is an agency of the World Health Organization (WHO)

- IARC has so far classified 1003* agents, mixtures and exposures based on the strength of scientific evidence of their potential as human cancer hazards

- IARC assigns one of 5 classification groups:
  - 1 known carcinogen (120)
  - 2A probable carcinogen (81) (red meat)
  - 2B possible carcinogen (299)
  - 3 not classifiable (502)
  - 4 probably not a carcinogen (1)

- The IARC evaluation deals only with the hazard, not the risk
- 2B includes ELF magnetic fields and RF exposures

* As of October 5, 2017
Statements from WHO

WHO (June 22, 2011) Fact Sheet #193*
“Electromagnetic fields and public health: mobile phones”

Are there any health effects?
“*A large number of studies have been performed over the last two decades to assess whether mobile phones pose a potential health risk. To date, no adverse health effects have been established as being caused by mobile phone use.*”

*WHO Reviewed October 2014
Statements from ICNIRP

International Commission on Non-Ionizing Radiation Protection (July 1, 2011)
“Mobile Phones, Brain Tumours and the Interphone Study: Where Are We Now?”
http://ehp03.niehs.nih.gov/article/info%3Adoi%2F10.1289%2Fehp.1103693

- “In summary, Interphone and the literature overall have methodological deficiencies but do not demonstrate greater risk of either glioma or meningioma with longer or greater use of mobile phones, although the longest period since first use examined is <15 years.”
- “Although there remains some uncertainty, the trend in the accumulating evidence is increasingly against the hypothesis that mobile phone use can cause brain tumours in adults.”
30-Year Brain Cancer Trends

- **Taiwan**: “A slightly decreased trend in incidence of primary malignant brain tumors was observed in Taiwanese general population since 1999.” (2017)

- **New Zealand**: “...there has been no consistent increase in incidence rates of primary brain cancers.” during 1995-2010 (2015).

- **UK**: Examined time trends in brain cancer incidence rates in England from 1998 to 2007, “Increases in incidence should have begun to appear in cancer registry data if mobile phone use had an important impact on the cancer risk.” (2011)

- **United States**: “these incidence data do not provide support to the view that cellular phone use causes brain cancer” (2010)

- **Scandinavia**: “…No change in incidence trends were observed from 1998 to 2003, the time when possible associations between mobile phone use and cancer risk would be informative about an induction period of 5-10 years.” (2009)

- **Switzerland**: “…after the introduction of mobile phone…brain tumour mortality rates remained stable in all age groups.” (2007)
US NCI – brain and other neurological tumors

- Estimated New Cases in 2017: 23,800
- % of All New Cancer Cases: 1.4%
- Estimated Deaths in 2017: 16,700
- % of All Cancer Deaths: 2.8%

Percent Surviving 5 Years: 33.6%

2007–2013
Tumour occurrence in Sweden – age

Glioma incidence, Sweden 1970-2008, Men

Source: Cancer Register, The National Board of Health and Welfare
Taiwan brain tumor occurrence (2017)

Increase in brain tumour rates?

All users at increased risk after 10 years

Glioma

International Agency for Research on Cancer

Delcourt et al., Epidemiology, 2012
Little et al., BMJ, 2012
### Hyperplastic Brain Lesions in Male Rats

<table>
<thead>
<tr>
<th></th>
<th>Control (0 W/kg)</th>
<th>GSM Modulation (1.5, 3.0, 6.0 W/kg)</th>
<th>CDMA Modulation (1.5, 3.0, 6.0 W/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number examined</td>
<td>90</td>
<td>90, 90, 90</td>
<td>90, 90, 90</td>
</tr>
<tr>
<td>Malignant glioma‡</td>
<td>0*</td>
<td>3 (3.3%), 3 (3.3%), 2 (2.2%)</td>
<td>0, 0, 3 (3.3%)</td>
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<tr>
<td>Glial cell hyperplasia</td>
<td>0</td>
<td>2 (2.2%), 3 (3.3%), 1 (1.1%)</td>
<td>2 (2.2%), 0, 2 (2.2%)</td>
</tr>
</tbody>
</table>

‡ Historical control incidence in NTP studies: 11/550 (2.0%), range 0-8%

* Significant SAR-dependent trend for CDMA exposures by poly-6 (p < 0.05)
NTP study (2016)

General public exposure limit is 0.08 W/kg (75 X higher)

Higher exposure groups live longer

68%
55%
50%
28%

Greater survival in all groups of exposed males compared to controls
Electrohypersensitivity EHS

- EMF Refuge Zone in France

- “Wi-Fi refuge” shelter in mountains of Green Bank, West Virginia, USA
EHS or IEI

- **World Health Organization: Fact Sheet #296 (2005)**
  - A more general term for sensitivity to environmental factors is *Idiopathic Environmental Intolerance* (IEI).
  - EHS has no clear diagnostic criteria and there is no scientific basis to link EHS symptoms to EMF exposure.

- **European Union:** On November 16-17, 2011 the European Commission hosted an international scientific conference on electromagnetic fields (EMF) and health in Brussels.
  - The *nocebo effect* (an ill effect caused by the suggestion or belief that something is harmful) is a major contributor to EHS.
The results of ELF-MF exposure and symptoms from a Dutch cross-sectional survey of 5933 adults have been described (Baliatsas et al., 2015)

- None of the modelled RF-EMF exposure sources was related to the occurrence of symptoms, whereas consistent associations of self-reported RF-EMF exposure with all symptoms were observed.

Brain cancer: “… not convincing in linking mobile phone use to the occurrence of glioma or other tumours of the head region among adults. Recent studies described in this report do not change this conclusion although these have covered longer exposure periods.” “It is also too early to draw firm conclusions regarding risk of brain tumours in children and adolescents, but the available literature to date does not indicate an increased risk.”

EHS: “While the symptoms experienced by patients with EHS are real and some individuals suffer severely, studies so far have not provided evidence that exposure to electromagnetic fields is a causal factor. Several studies have indicated a nocebo effect, i.e. an adverse effect caused by an expectation that something is harmful.”

Transmitters: “In line with previous studies, new studies on adult and childhood cancer with improved exposure assessment do not indicate any health risks for the general public related to exposure from radiofrequency electromagnetic fields from far-field sources, such as base stations and radio and TV transmitters. There is no new evidence indicating a causal link to exposure from far-field sources such as mobile phone base stations or wireless local data networks in schools or at home.”

*2016 report reaffirms the 2015 results.
Japanese Experience (2016)

- The RF studies reviewed are mainly conducted in the framework of research program by the Ministry of Internal Affairs and Communications (MIC) started in 1997.
- The results of these studies consistently showed no hazardous effect of RF-EMF within the exposure levels of internationally accepted guidelines.
- Especially, the studies in this program did not reproduce any of previous studies suggesting the existence of health effects when the experiments were carefully performed with the collaboration of biology/medicine and engineering to improve reliability of the experiments.

Bioelectromagnetics Researches in Japan for Human Protection from Electromagnetic Field Exposures
IEEJ TRANSACTIONS ON ELECTRICAL AND ELECTRONIC ENGINEERING IEEJ Trans 2016
Wireless Devices and Health Concerns

- “According to the FDA and the World Health Organization (WHO), among other organizations, to date, the weight of scientific evidence has not effectively linked exposure to radio frequency energy from mobile devices with any known health problems.”
- “...currently no scientific evidence establishes a causal link between wireless device use and cancer or other illnesses.”
- “…there is no basis on which to establish a different safety threshold than our current requirements.”


Statements from Governments and Expert Panels Concerning Health Effects and Safe Exposure Levels of Radiofrequency Energy (69 citations)
http://www.ices-emfsafety.org/expert-reviews/

Adverse health effects have not been confirmed for RF exposures that comply with contemporary science-based safety guidelines, such as those developed by ICNIRP and IEEE/ICES.
Three Types of RF Safety Standards

- **Exposure standards** for limiting human exposures
  - Two tiers
    - General public
    - Occupational (in controlled environments)
- **Assessment standards** for radiating source compliance
  - Measurements
  - Computations
- **Interference standards** with medical devices
Who Set RF Exposure Standards?

- **ICNIRP** (International Commission on Non-Ionizing Radiation Protection)
  - guidelines developed by a committee of appointed experts, no industry representatives
  - endorsed by WHO

- **IEEE-ICES** (International Committee on Electromagnetic Safety) TC95
  - large committee open to anyone with a material interest
  - about 130 members from 26 countries
  - open consensus process
Who set RF Assessment standards?

- International Electrotechnical Commission (IEC)
  - Close to 20,000 experts from industry, commerce, government, test and research labs, academia and consumer groups participate in IEC Standardization work.

- IEEE ICES TC34
  - IEEE is the world’s largest professional association dedicated to advancing technological innovation and excellence for the benefit of humanity, with 426,000 members in more than 160 countries.
ICES as the Focal Point in the Global Program for EME Safety Standards

Liaison with International Groups:
ICNIRP, WHO, IEC, NATO……

Liaison with National Groups:
NCRP, ACGIH, US Fed. Agencies, Canada, China, Ireland…….

IEEE SASB

SCC39 ICES (AdCom)

Management, Oversight, Fundraising, etc.

Promoting safe use of electromagnetic energy

Exposure Standards
TC-95

SC-1: Measurements & Calculations
SC-2: Warning Signs/Hazard Communication
SC-3: 0-3 kHz exposure limits
SC-4: 3 kHz - 300 GHz exposure limits
SC-5: Electro-explosive devices
SC-6: EMF dosimetry modeling

Product Standards
TC-34

SC-1: Experimental
SC-2: Numerical
IEEE Exposure Standards History

1960: USASI C95 Radiation Hazards Project and Committee chartered
1966: USAS C95.1-1966
   10 mW/cm² (10 MHz to 100 GHz)
   based on simple thermal model
1974: ANSI C95.1-1974 (limits for E² and H²)
1982: ANSI C95.1-1982 (incorporates dosimetry)
2002: IEEE C95.6-2002 (0-3 kHz)
2014: IEEE C95.1-2345-2014 (0-300 GHz) (NATO/IEEE agreement)
2015: NATO adopted C95.1-2345-2014
Weight of evidence

IEEE committee reviewed*:

- Quality of test methods
- Size and power of the study designs
- Consistency of results across studies
- Biological plausibility of dose-response relationships
- Statistical associations

*Reviewed all literature (including both positive and negative effects, thermal and non-thermal effects)
Percentage evaluation

- Count percent of published positive reports on a subject
- vs. percent of negative reports
- Assuming some of the positive reports are correct
- Apply precautionary principle
- More research is needed
Positive effects evaluation

- Collect and emphasize only positive effects
- Apply precautionary principle
- Demand a much lower exposure limit (0.3 nW/cm²)

“Picking Cherries in Science: The Bio-Initiative Report”
by Kenneth R. Foster & Lorne Trottier, February 15, 2013 in Science-Based Medicine
Risk profile for adverse effects (C95.1-2005)

1. RF shocks and burns
2. Localized RF heating effects
3. Surface heating effects
4. Whole body heating effects
5. Microwave hearing effects
6. Low-level effects
   *(previously ‘non-thermal effects’)*
No adverse effects have been established from low-level exposures despite 50 years of research.

- No known interaction mechanisms.
- No meaningful dose-response relationship.
- Speculative.
- Inappropriate for standard setting.

*The committee is unaware of any more recent studies that would change the conclusions reached in the 2005 version of the standard. (2011 June meeting conclusion)*
Safety factors
[SAR applies 100 kHz- 3 GHz]

- **Whole body averaged**
  Behavioral effects in animals over many frequencies, threshold at 4 W/kg
  10X - 0.4 W/kg for upper tier
  50X - 0.08 W/kg for lower tier

- **Localized exposure** (averaged in 10 g)
  Cataract observed in rabbits, threshold at 100 W/kg
  10X – 10 W/kg for upper tier
  50X – 2 W/kg for lower tier
IEEE Std. C95.1-2345-2014
pp 1-57

IEEE Standard for Military Workplaces—Force Health Protection Regarding Personnel Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz

IEEE Technical Committee 95

Sponsored by the
IEEE International Committee on Electromagnetic Safety (SCC39)
IEEE Recommended Practice for Radio Frequency Safety Programs, 3 kHz to 300 GHz

IEEE Standards Coordinating Committee 39

Sponsored by the
IEEE International Committee on Electromagnetic Safety

IEEE
3 Park Avenue
New York, NY 10016-5997
USA

IEEE Std C95.7™-2014
(Revision of
IEEE Std C95.7-2005)
RF Safety Program Exposure Categorization

Range of Potential Maximum Exposure Conditions
(Nonlinear scale)

Recommended Signage

DANGER
[Contact currents/RF burns]

WARNING

CAUTION

NOTICE

INFORMATION

No Signage Required

Category 1 2 3 4

10x Upper Tier
Upper Tier
Lower Tier

IEEE ICES
Experimental methods for mobile phone compliance test

- Revised IEEE 1528-2013 to address 0.3 - 6 GHz measurement methods

- Collaborates with IEC 62209-1 – measurements 0.3 – 6 GHz

- Efforts to develop IEC/IEEE dual logo standard
**ICES exposure and assessment standards**

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* At the end of 10 years, IEEE standards must be reaffirmed, revised or withdrawn
Free IEEE C95 Safety Standards


- **IEEE C95.1™-2005**  
  Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz
- **IEEE C95.1a™-2010**  
  Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Field, 3 kHz to 300 GHz. Amendment 1: Specifies Ceiling Limits for Induced & Contact Current
- **IEEE C95.1-2345™-2014**  
  Military Workplaces--Force Health Protection Regarding Personnel Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz
- **IEEE C95.2™-1999**  
- **IEEE C95.3™-2002**  
  Measurements and Computations of Radio Frequency Electromagnetic Fields with Respect to Human Exposure to Such Fields, 100 kHz-300 GHz
- **IEEE C95.3.1™-2010**  
  Measurements and Computations of Electric, Magnetic, and Electromagnetic Fields with Respect to Human Exposure to Such Fields, 0 Hz to 100 kHz
- **IEEE C95.4™-2002**  
- **IEEE C95.6™-2002 (R2007)**  
  Safety Levels with Respect to Human Exposure to Electromagnetic Fields, 0-3 kHz
- **IEEE C95.7™-2014**  
  Recommended Practice for Radio Frequency Safety Programs, 3 kHz to 300 GHz

Sponsored by the United States Navy, Air Force, and Army.
Regulations
Two approaches of protection

- Established Adverse Health Effects
- Possible Biological Effects
International RF Safety Standards

- **IEEE ICES C95.1-2005**: “The purpose of this standard is to provide exposure limits to protect against established adverse effects to human health induced by exposure to RF electric, magnetic and electromagnetic fields over the frequency range of 3 kHz to 300 GHz.”  
  *C95.1-2345 (2014) for NATO application

- **ICNIRP (1998)**: “this publication is to establish guidelines for limiting EMF exposure that will provide protection against known adverse health effects”.
  *ICNIRP reconfirmed its RF guidelines in 2009.
Other interested organizations

- **International Commission for Electromagnetic Safety (ICEMS)** advocates protection of the public health from electromagnetic fields and develops the scientific basis and strategies for assessment, prevention, management and communication of risk, based on the precautionary principle (web posted 3 resolutions)

- **BiolInitiative Report** promotes low exposure limits to avoid possible biological effects as a precautionary measure (2012 report suggests 0.3 nW/cm² as a precautionary action level)
Example of the two different approaches

- “The general approach to public health protection and setting exposure limits by previous Soviet and current Russian committees is that people should not have to compensate for any effects produced by RF exposure, even though they are not shown to be adverse to health (pathological).”
- “Exposure limits are then set that do not cause any possible biological consequence among the population (regardless of age or gender) that could be detected by modern methods during the RF exposure period or long after it has finished.”


- This is an important difference from the approach used by the IEEE and ICNIRP.
Regulatory Status of Localized “peak“ SAR Standards for Portable Devices

- **ICNIRP mandatory or accepted products (2/10 W/kg over 10 g)**
- **1991 IEEE mandatory: USA, Bolivia, Canada, Cuba, India, Iran, Iraq, Panama, South Korea, Vietnam (1.6/8 W/kg over 1 g)**

Health Canada reissued Safety Code 6 in 2015
Adopted old IEEE in 2009
Adopted ICNIRP in 2007
Changed from FCC to ICNIRP in 2005
Required SAR certificate with ICNIRP limit in 2010
Changed from ICNIRP to FCC in 2012
Changed from FCC to ICNIRP in 2003

San Diego, CA  
October 5, 2017  
Slide 61
Whole body exposure limits for antenna sites

ICNIRP 1998  FCC 1996  other  unknown

Note: Information from public sources except where indicated.

Last updated: 10 November 2016

Whole body exposure limits for antenna sites

- ICNIRP Guidelines (124 countries and territories)
  Albania, Argentina, Armenia, Australia, Austria, Bahrain, Botswana, Brazil, Cambodia, Cameroon, Cape Verde, Central African Republic, Colombia, Costa Rica, Côte d'Ivoire, Croatia, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, El Salvador, Equatorial Guinea, Estonia, Faroe Islands, Falkland Islands (Malvinas), Finland, France, French Guiana, French Polynesia, Germany, Ghana, Greenland, Guadeloupe, Guatemala, Guinea-Bissau, Honduras, Hong Kong SAR, Hungary, Iceland, Iran (Islamic Republic of), Iraq, Ireland, Japan, Jordan, Kenya, Korea, Republic of (South), Kuwait, Latvia, Lebanon, Madagascar, Malaysia, Mali, Malta, Martinique, Mauritania, Mauritius, Mexico, Moldova, Namibia, Nepal, Netherlands, New Caledonia, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Palestinian National Authority, Panama, Paraguay, Peru, Philippines, Portugal, Qatar, Réunion, Romania, Rwanda, Saudi Arabia, Senegal, Singapore, South Africa, Spain, Sri Lanka, St. Helena, St. Pierre and Miquelon, Suriname, Svalbard, Sweden, Taiwan, Thailand, Tunisia, Uganda, United Arab Emirates, United Kingdom, United Republic of Tanzania, Uruguay, Vanuatu, Venezuela, Wallis and Futuna Islands, Zambia, etc.

- IEEE/NCRP standard (11 follow FCC)
  American Samoa, Bolivia, Federated States of Micronesia, Guam, Iraq, Marshall Islands, Northern Mariana Islands, Palau, Puerto Rico, United States of America, United States Virgin Islands

- Below ICNIRP and IEEE
  Belarus, Bulgaria, China, Lithuania, Poland, Russia (Soviet influence)
  Belgium, Chile, Greece, India, Israel, Italy, Liechtenstein, Switzerland (precautionary)
Worldwide Harmonization of RF standards

- One RF exposure standard
  - IEEE C95.1/ICNIRP guidelines
    (Harmonized on major issues and limits)
  - Converge of science based standards

- One portable device SAR measurement standard
  - IEC 62209-1/IEEE 1528 (at ear) (Totally harmonized)
  - IEC 62209-2 (at body, and in front of face)

- Other portable and mobile devices SAR computational standards
  - IEC and IEEE close collaboration, Dual logo

- One base station measurement standard
  - IEC 62232

“One sun in the sky”

“A world-wide harmonized exposure standard would be desirable.”
### Differences between Science and Media

<table>
<thead>
<tr>
<th>Science</th>
<th>Media</th>
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</thead>
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<td>Consensus</td>
<td>Conflicts</td>
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<tr>
<td>Truth</td>
<td>“News“</td>
</tr>
<tr>
<td>General Laws</td>
<td>Stories</td>
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</tbody>
</table>

*to be continued*
Problems in Media Communication

- Media reports on EME issues often are not verified and reviewed
- Statements from so called “Experts”
- “Spot light” reporting, not “weight of evidence”
- Sensationalism, need to have a “hook” in each story
- Misinformation propagates fast and continuously
- Corrections do not make the news
- General public acquire knowledge from media and NOT from scientific journals

Scientists have an overall responsibility to ensure their findings are robust before publication, and not to mislead the media.
Mobile Telephony RF Exposures
Actual handset transmitted power


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**Adaptive Power control**

Max power 125 mW

Mostly 0.1 mW

Fig. 3. Distribution of mobile phone transmitted power in different areas.
Mobile levels similar to other radio sources

Based on Valberg et al., 2007
Exposure similar for all countries

Global average more than 5,500 times below limit values.

Based on Rowley and Joyner, 2012
Residential and office building RF exposures are in general lower than 1% of ICNIRP or IEEE limits, similar to radio and TV broadcast exposure level.

Rooftop antenna installation is safe.
Example: antennas on a pole

Compliance range

Outside the green regions, exposure is below ICNIRP limits.

20 watts
3G, 2100 MHz
EU policy and public concern

- Stricter legal safety standards (limits, exclusion zones)
- Strong precautionary advice by governments
- ICNIRP, Compliance, Communications

Data source: Special Eurobarometer 347, 2010, p. 66. Presentation by GSMA Europe

Question: QC3. How concerned are you about the potential health risks of electromagnetic fields?
Answers: Very concerned + Fairly concerned
American Council on Science and Health – Risk Rings, Exposures

Death rate 1/771

Death rate 1/2681
American Cancer Society (2017)

- Cancer occurrence in life, male 1/2, female 1/3

Estimated Cancer Deaths in the US in 2017

<table>
<thead>
<tr>
<th>Site</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung &amp; bronchus</td>
<td>318,420</td>
<td>282,500</td>
</tr>
<tr>
<td>Colon &amp; rectum</td>
<td>9%</td>
<td>10%</td>
</tr>
<tr>
<td>Prostate</td>
<td>8%</td>
<td>8%</td>
</tr>
<tr>
<td>Pancreas</td>
<td>7%</td>
<td>5%</td>
</tr>
<tr>
<td>Liver &amp; intrahepatic bile duct</td>
<td>6%</td>
<td>5%</td>
</tr>
<tr>
<td>Leukemia</td>
<td>4%</td>
<td>3%</td>
</tr>
<tr>
<td>Esophagus</td>
<td>4%</td>
<td>3%</td>
</tr>
<tr>
<td>Urinary bladder</td>
<td>4%</td>
<td>3%</td>
</tr>
<tr>
<td>Non-Hodgkin lymphoma</td>
<td>4%</td>
<td>3%</td>
</tr>
<tr>
<td>Brain &amp; other nervous system</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>All other sites</td>
<td>24%</td>
<td>24%</td>
</tr>
</tbody>
</table>

Trends in Cancer Death Rates* Among Males, US, 1930-2014

- Lung & bronchus
- Colon & rectum
- Prostate
- Pancreas
- Liver & intrahepatic bile duct
- Leukemia
- Non-Hodgkin lymphoma
- Brain & other nervous system
- All other sites
Proven Deadly Risk
Definitely, there are big effects!

1.6 million accidents per year in US are related to mobile phone use

Not RF effects
It’s improper use of the device!
Established Scientific Understanding (in green)

- Microwave radiation is dangerous
  ✓ Only when at high intensity
- We don’t have enough understanding of its effects
  ✓ 70 years of research
- Many reports show non-thermal effects
  ✓ Either not repeatable or no proven health effects
- It can cause cancer, and many other diseases
  ✓ No proof and no mechanism other than heating
- The standards are not protective
  ✓ Worldwide expert groups and health authorities agree they are
- Need precautionary measure to be safe than sorry
  ✓ Safety standards already have large safety margins
Electrophobia induced products
Conclusions

- Radiofrequency electromagnetic exposure is very different from nuclear radiation.
- 70 years of research shows the only established adverse health effect of RF energy (above 100 kHz) is thermal effect.
- International exposure (with large safety margins) and assessment standards are available to provide protection.
- A large number of expert scientific reviews have concluded that no adverse health effects have been confirmed below the current international RF safety guidelines or exposure standards (ICNIRP, IEEE).
- Ordinary exposures are very low. Unnecessary worry can cause nocebo effects.
Kurosawa 1950 movie “Rashomon”

Less opinions
More facts
Built on Solid Rocks (Established Effects)

Thank You

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