HEALTH EFFECTS OF WIRELESS RADIATION – POSSIBLE OR PROBABLE?

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WHO I AM… EDUCATION AND WORK

- Two doctorates and docentship in biochemistry
- Independent expert; actively advising and lecturing
- 22 years (1992-2013) at STUK
  - 2003-2007 as Head of Radiation Biology Laboratory
  - 2000-2013 as Research Professor
- Assistant Professor at Harvard Medical School, USA; 1997-1999
- Guangbiao Prof. at Zhejiang Univ., Hangzhou, China; 2006-2009
- Visiting Prof. at Swinburne Univ. Technology, Melbourne, Australia; 2012-2013

WHO I AM… EXPERT EXPERIENCE

- 20 years of experimental work on EMF and health
- Testified
  - In the Canadian Parliament's House of Commons' hearing in 2015
  - before Minister of Health and Family Welfare of India in 2014
  - In the US Senate Appropriations Committee hearing in 2009
- Member of 2011 IARC Working Group for classification of the carcinogenicity of cell phone radiation
- Advised e.g.: Parliament of Finland; National Academies, USA; World Health Organization; Bundesamt für Strahlenshutz, Germany; International Commission on Non-Ionizing Radiation Protection (ICNIRP); Swiss National Foundation; The Netherlands Organization for Health Research and Development;

Effects: thermal vs. non-thermal

- Terms ‘thermal’ and ‘non-thermal’ cause confusion
- Better term: ‘effects at low level exposures’ = exposures at permitted or below the current safety limits
- Effects at low level exposures = non-thermal effects – do exist
- Epidemiology and EEG studies provide compelling evidence, in humans, for the existence of non-thermal effects (=low level exposure effects)
  - Epidemiology studies show effects for the regular cell phones
  - EEG shows effect, even if it is not harmful it is effect at low level exposure

IARC 2011: Epidemiology

- Interphone & Hardell studies
  - no reliable exposure data based on person's memory
  - risk increase in long-term avid users
- Children – only CEFALO
  - exposures for 2-4 years
  - has no statistical power to detect small risk

...after IARC: Epidemiology (1/2)

- Trend-data - Little et al. 2012: slow rise of brain cancer cases in USA
  - trend is similar to Interphone "prediction" but not Hardell "prediction"
- Danish Cohort update study 2011 – no effect
  - no exposure data but just the length of phone subscription with service provider
- Million Women study 2014 - no effect but exposure data inadequate
  - use of cell phone: 'never', 'less than once a day', 'every day'
- CERENAT study from France 2014 – effect as in Interphone and Hardell
  - no reliable exposure data based on person's memory
- Chapman et al. 2016
  - Misleading claim of 29 years of use and 10 years latency of brain cancer

...after IARC: Epidemiology (2/2)

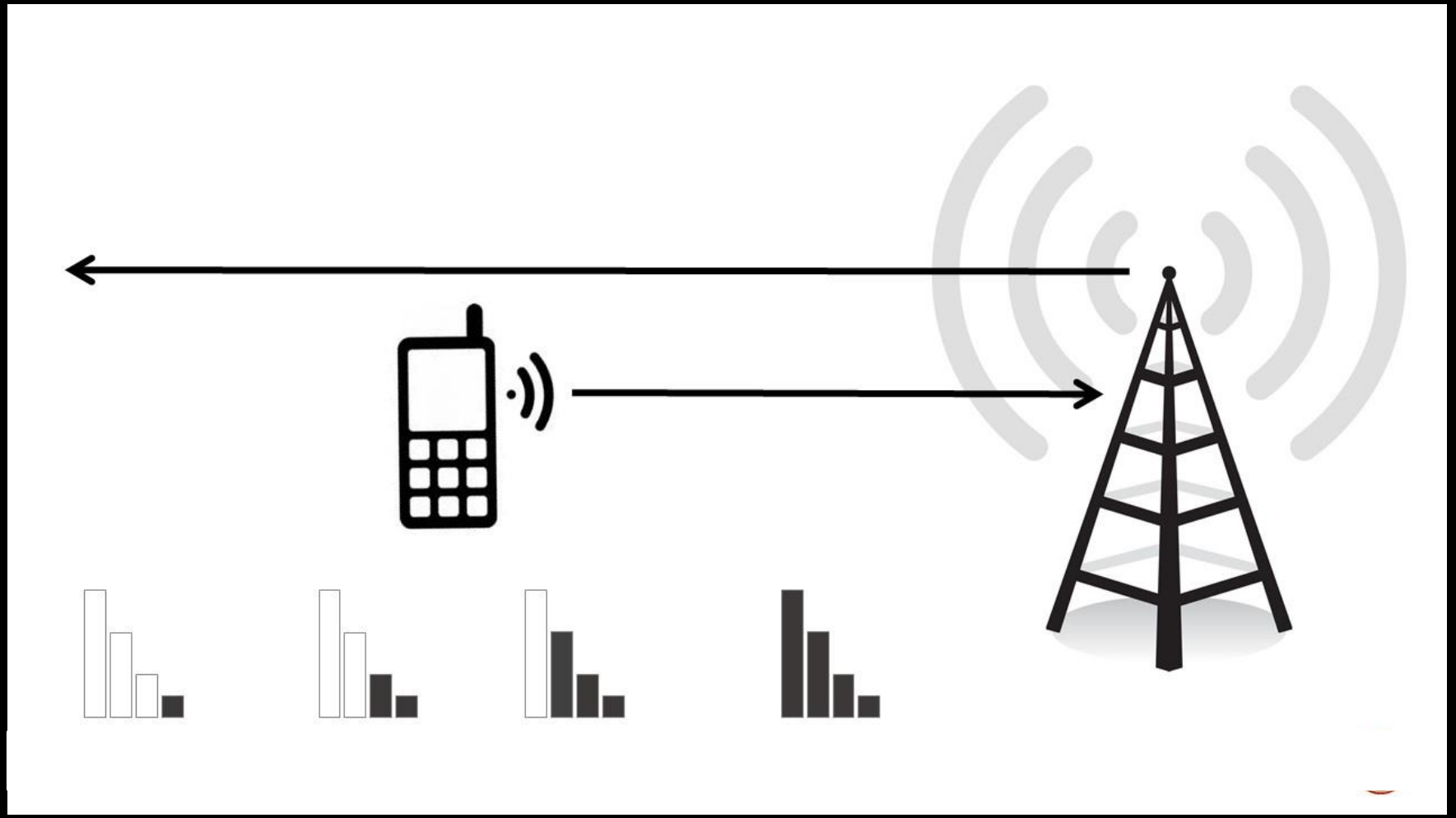
- **Interphone** – 3 articles from a single set of data
  - **Larjavaara** et al. 2011: partial data; *results do not support the hypothesis of gliomas among mobile phone users being preferentially located in the parts of the brain with the highest radio-frequency exposure*
  - **Cardis** et al. 2011: partial data; *there was weak evidence of stronger associations of glioma and meningioma when a comprehensive estimate of RF dose rather than just mobile phone use was used in the case-control analysis*
  - **Grell** et al. 2016: full set of data; *statistically significant association between the intracranial distribution of gliomas and the self-reported (possible bias) location of the phone*

- Epidemiolgy studies use very bad data on radiation exposure
  - When study shows no effect this does not prove lack of effect
  - When study shows effect it does not prove that effect exist but…
    - It indicates that effect is possible/probable because effect is seen even in situation when very poor radiation exposure data is used = such studies underestimate effect

Epidemiological evidence supports cancer risk

- IARC classification was based on the results of Interphone and Hardell studies
- In 2014, a new epidemiological study was published - the French CERENAT
- The French study reached similar conclusions as Interphone and Hardell previously – long term avid use of cell phone increases a risk of developing brain cancer
- Interphone 2016 analysis of full data confirms location of cancer in most exposed part of brain
- Now, there are three replications of the same epidemiological type of study, the case-control study, that all suggest the cell phone radiation might increase risk of developing brain cancer

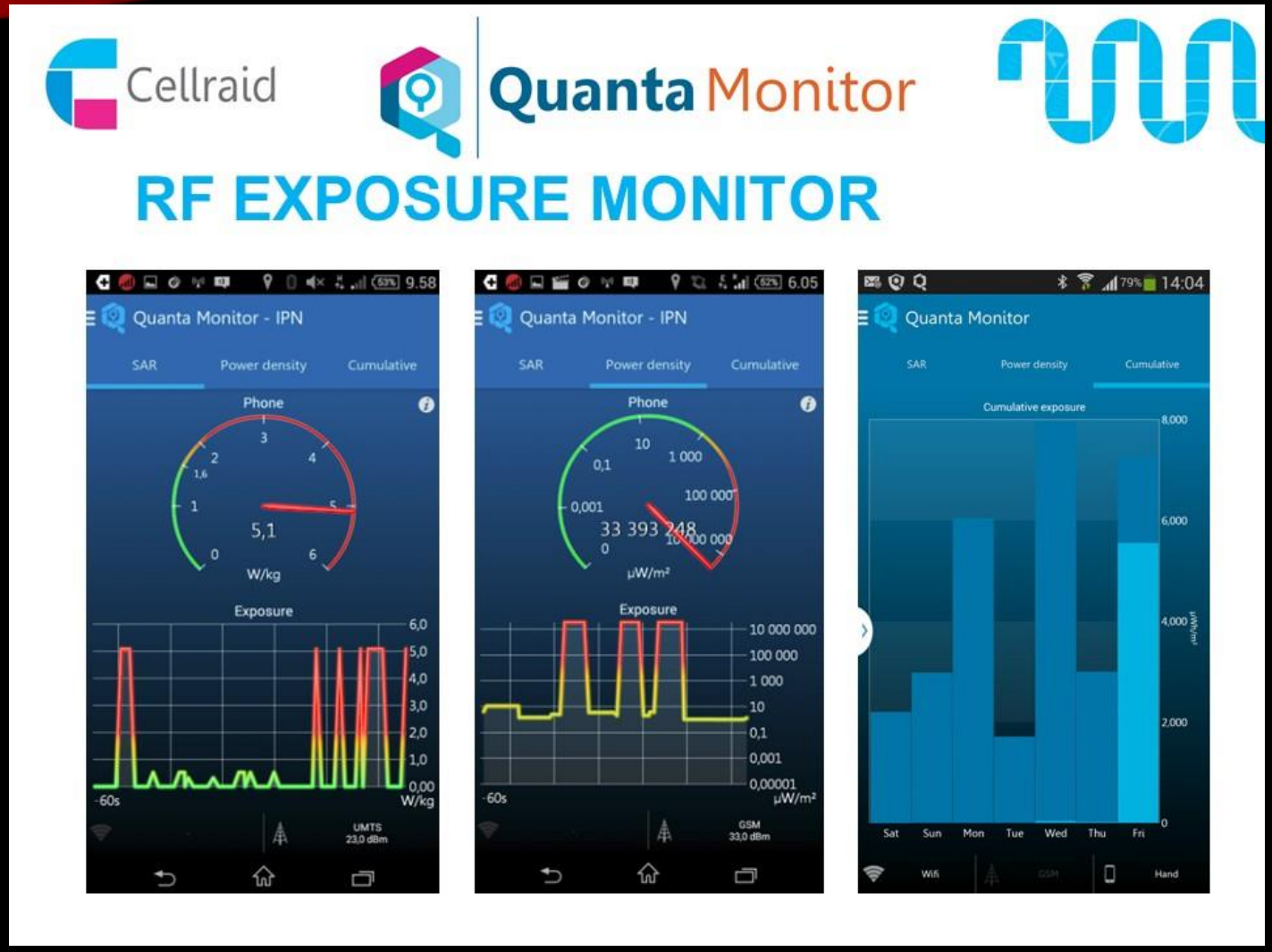
Length of call does not say "much" about radiation exposure



All epidemiology studies have completely unreliable exposure data

- Length of calls or length of phone subscription with service provider or saying whether you ever or never used cell phone, does not inform about the real exposure of the cell phone user.
- Using the above ”exposure data”, persons with very different radiation exposures are placed in the same exposed group for statistical evaluation. This dilutes severity of results!
- Ongoing cohort study COSMOS collects exposure data as length of calls!
- There is a way to collect real exposure data by using apps installed on currently used smart phones

Smart phone app measuring radiation exposure



- App measures cell phone, cell tower and wifi exposures
- For users to follow daily exposures
- For scientists to collect radiation data

There are suggestions, by some scientists that app might overestimate body exposure and SAR. Makers of Quanta disagree with this opinion

Human studies

- The vast majority are "feelings" studies done by psychologists
  - Subjects asked how they feel and do they feel when radiation is on/off
  - EHS must exist – question is only what is radiation cut-off level
  - Otherwise EMF would be the only factor not causing individual sensitivity
  - Problem of EHS – studied by psychologists not physiologists – wrong methods
  - WHO definition of health – how to consider it? IARC classification justifies reasoning for "*mental and social well-being*"
- Lack of studies examining biochemical responses of human tissues (!)
  - Single skin proteomics study
  - Two studies examined glucose metabolism in the brain

IARC 2011: Animal studies

- No classical toxicology possible
  - Not possible to overdose cell phone radiation because of heating effect
  - By classical toxicology standards RF would be judged as harmful to humans
  - Life-time exposures to radiation at doses similar to those emitted by cell phones show no effect – result is useless for human health risk estimation
- Misleading claims that because animal studies, performed with cell phone radiation levels, do not show effects means that people are safe
- Co-carcinogen studies show some effects – cell phone radiation might potentiate effects of carcinogenic chemicals or radiation
  - Published replication of Tillmann et al. 2010 confirmed by Lerchl et al. 2015

Unrealistic exposures in mechanistic studies

The Discrepancy Between Maximum In Vitro Exposure Levels and Realistic Conservative Exposure Levels of Mobile Phones Operating at 900/1800 MHz

Gernot Schmid[1]* and Niels Kuster[2,3]

[1]Seibersdorf Laboratories, Seibersdorf, Austria
[2]Foundation for Research on Information Technologies in Society (IT'IS), Zurich, Switzerland
[3]Swiss Federal Institute of Technology (ETH), Zurich, Switzerland

The analysis demonstrated that exposure of skin, blood, and muscle tissues may well exceed 40 W/kg at the cell level. Consequently, in vitro studies reporting minimal or no effects in response to maximum exposure of 2 W/kg or less averaged over the cell media, which includes the cells, may be of only limited value for analyzing risk from realistic mobile phone exposure. We, therefore, recommend future in vitro experiments use specific absorption rate levels that reflect maximum exposures and that additional temperature control groups be included to account for sample heating.

- Exposures of cells in laboratory in vitro studies were performed at radiation levels significantly lower than exposures cells received in epidemiological studies

- Unrealistic exposures used in laboratory in vitro studies are the reason why mechanism of the effects is still ”unclear”

- Mechanistic studies should be repeated at higher radiation exposure levels

Mechanism of some of the biological effects: Cellular stress response

Leszczynski et al. 2002

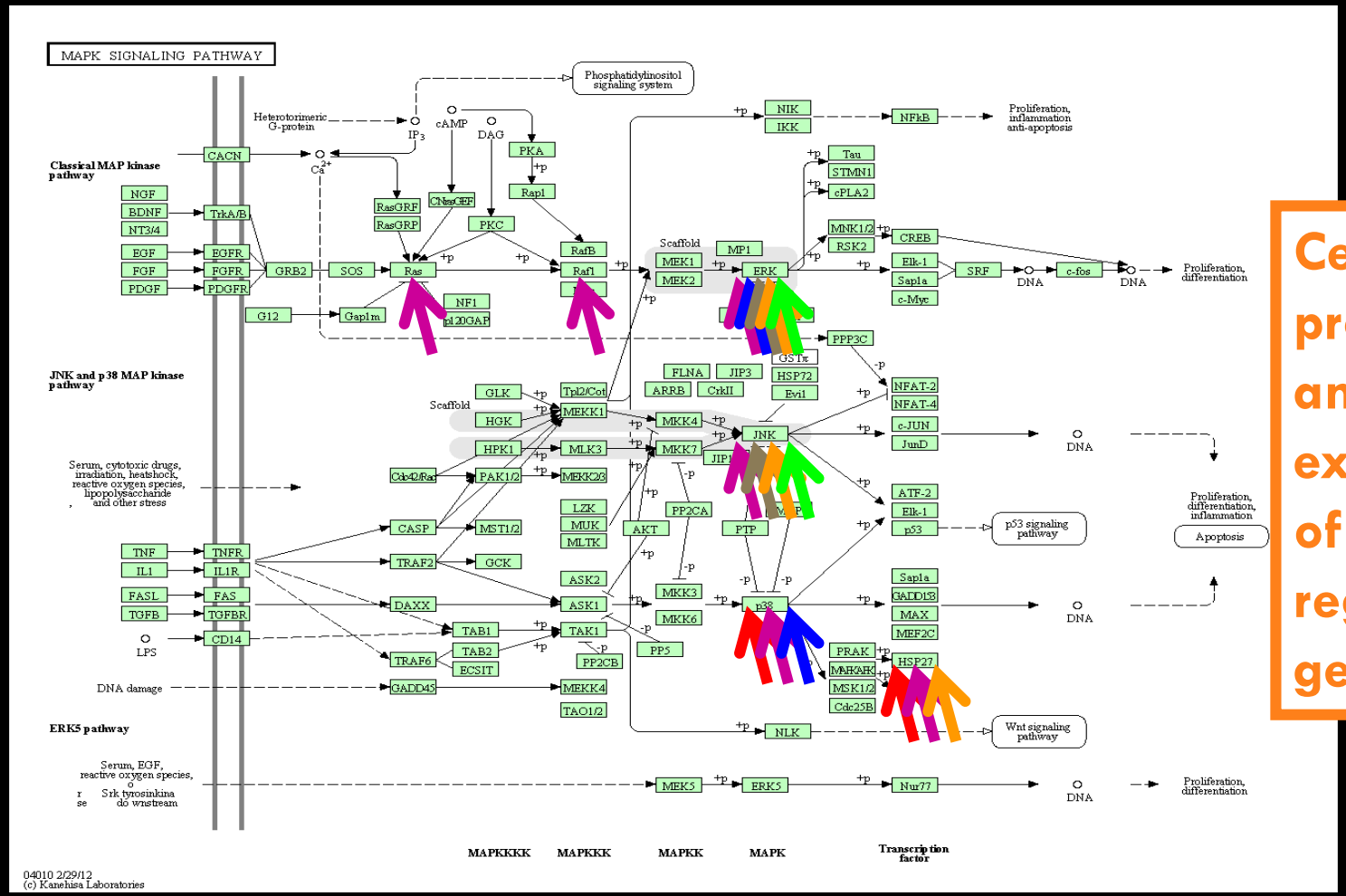
Caraglia et al. 2005

Friedman et al. 2007

Buttiglione et al. 2007

Yu et al. 2008

Lee et al. 2008



Cell proliferation and expression of cancer regularory genes

Game changers after 2011 IARC

strengthening the evidence for carcinogenicity of cell phone radiation

- Epidemiology
  - Coureau G, et al. Mobile phone use and brain tumours in the CERENAT case-control study. Occup Environ Med. 2014; 71: 514-522
  - Grell et al. The Intracranial Distribution of Gliomas in Relation to Exposure From Mobile Phones: Analyses From the INTERPHONE Study. Am J Epi. Nov. 2016; DOI: 10.1093/aje/kww082
- Animal studies – Lerchl's group replication of Tillman et al study
  - Lerchl A, et al. Tumor promotion by exposure to radiofrequency electromagnetic fields below exposure limits for humans. BBRC 2015; 459: 585-590
- Dosimetry – reevaluation of in vitro dosimetry by Schmid & Kuster
  - Schmid G & Kuster N. The discrepancy between maximum in vitro exposure levels and realistic conservative exposure levels of mobile phones operating at 900/1800 MHz. Bioelectromagnetics. 2015; 36:133-148

In my opinion, the currently available scientific evidence from epidemiology and animal studies is sufficient to upgrade the carcinogenicity of cell phone radiation from the possible carcinogen (Group 2B) to the probable carcinogen (Group 2A)

Reasons for invoking the Precautionary Principle

Scientific information is insufficient, inconclusive, or uncertain

- IARC classification as possible carcinogen (Group 2B)

There are indications that the possible effects on human health may be potentially dangerous

- epidemiological studies from Interphone, Hardell and CERENAT show an increased risk of brain cancer in long-term avid users

Inconsistent with the chosen level of protection

- epidemiological studies, showing increased risk in long-term avid users, were generated in populations using regular cell phones, meeting current safety standards = current safety standards are insufficient to protect users
- epidemiological studies provide compelling evidence for non-thermal effects (=effects at low level exposures)

The impact of implementing the Precautionary Principle

- **Precaution** does not equal **Prevention**
- Strong opposition from telecom industry
  - Technology providers can be made responsible to prove their product is safe
  - Requirement of making more efficient (less radiation emissions) technology
  - Limiting current rampant and uncontrolled deployment of wireless networks
- Will create new knowledge through research
- Will create new jobs in research and technology

Gaps in research

- Some examples
  - Epidemiology with realistic radiation exposure data
  - Search for sensitive sub-population using biochemistry methods
  - Finding out if DNA damage happens in people
  - Examining whether human blood-brain barrier is affected

- Lack of clear vision from funders what is needed for health risk estimate
- Scientists responsible for “creating and maintaining” gaps in research
- Poor supervision from funding agencies over “activity” of scientists

Conclusions (1/2)

- IARC classification of cell phone radiation as a possible carcinogen is a sufficient reason for invoking Precautionary Principle
- Claims that the current safety standards protect all users are not supported by the scientific evidence
- Users should be better informed about the current scientific uncertainty and strongly advised to limit exposures whenever possible and feasible and strongly discouraged from keeping cell phones close to body (in pockets)
- Real radiation exposure data should be used in epidemiological studies

Conclusions (2/2)

- How possible or probable are health effects of wireless radiation?
  - IARC 2011– possible cancer
  - Current evidence in 2016 on cancer – rather probable than possible
  - Cancer will remain rare disease
  - Wireless radiation might be acting solely as co-carcinogen
    - hence very slow increase in spite of huge number of users;
    - impact of latency difficult to estimate
  - Other diseases – too limited evidence to draw any reliable conclusions
  - Need for comprehensive overhaul of all research efforts to focus on supporting studies providing data useful for health risk estimate