A review of non-thermal health effects from RF fields

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Scope of the talk

- Laboratory studies on biological and health effects of “low-level” RF exposure
- All data re to whole-body exposure of humans and animals
- All data re to cellular systems
- All sources (mobile telephony, WiFi, etc.)
**Scope: levels of exposure**

- **high level**
  - 1 W/kg
  - 4 W/kg

- **Medium level**
  - 0.1 W/kg
  - 0.08 W/kg
  - 5000 mW/m²

- **low level**
  - 0.01 W/kg
  - 0.01 W/kg
  - 0.001 W/kg
  - 0.0001 W/kg
  - 0.1 mW/m²
Characteristics of exposure

- Low-level
- Long-lasting
- Whole-body
- Intermittent
- Modulated signals (+ time-varying amplitude)
Characteristics of bioeffects

- Biological vs. Health
- Long-term vs. Delayed
- Reversible vs. Irreversible
Mechanisms

- Thermal vs. Nonthermal?
- Threshold vs. Stochastic?
- Window vs. Continuous?
- Multiple windows vs. single window?
Threshold: power vs. energy
“Window” effect

![Graph showing the “Window” effect](image-url)

- Effect on the y-axis
- Power on the x-axis

- Peaks at 1, 10, 100, and 1000 power levels
Old data not re mobile telephony

- i.e. reviewed in published books and review papers
- Across the frequency spectrum
- Mostly in the “high” to “medium” range
Recent data: methodology

- Much-improved exposure systems in terms of SAR uniformity
- 3 to 4 SAR levels + Sham
- ca. half of the investigations are replication experiments: most of them negative
  - ODC,
  - memory of rodents,
  - genotoxicity,
  - etc.
in vivo exposure systems

Loop antenna

Ferris’ wheel

17 housing for rats.
Recent data: humans

- TNO study on well-being
- EEG, cerebral blood flow

Pulse modulation appears crucial for RF-EMF-induced alterations in brain physiology


Summary & Conclusion

- exposure to pulse-modulated RF EMF affects brain physiology (EEG, rCBF)
- effects outlast exposure
- pulse modulation appears crucial for RF EMF-induced effects
- non-thermal biological action
- underlying mechanisms unknown
Recent data: animals

- Cancer (Pim1, DMBA, bioassays)
- Blood-brain-barrier permeability
Recent data: cells

- Genotoxicity

Non-thermal DNA breakage by mobile-phone radiation (1800 MHz) in human fibroblasts and in transformed GFSH-R17 rat granulosa cells in vitro

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- Heat shock proteins
Health risk assessment

- Weight-of-evidence approach
- 95% of research RF projects deal with mobile phones
- No established health effects at “medium level” of exposure
- Few biological effects at “medium level” of exposure
- None below guidelines (0.08 W/kg)
Lab studies on effects of MW at very low level are:
- Not necessary…
- Difficult to perform
- Difficult to extrapolate to human health

All recent expert report have concluded that there are no health effects from exposure to very-low-level exposure.