MOBILE PHONE RADIATION & BLOOD-BRAIN BARRIER
EFFECTS OF MOBILE PHONE RADIATION ON HUMAN ENDOTHELIUM

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Dec. 11, 2015
WHO I AM... EDUCATION AND WORK

- Two doctorates and docentship in biochemistry
- Independent expert; actively advising and lecturing
  - 2014 – e.g. Norway, South Africa, USA, India, Australia
  - 2015 – e.g. Switzerland, USA, Serbia, Turkey, Australia
- 22 years (1992-2013) at STUK – Radiation and Nuclear Safety Authority
  - 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

• 18 years of experimental work on EMF and health
• Testified
  - In the Canadian Parliament’s House of Commons’ hearing on cell phones and health in 2015
  - before Minister of Health and Family Welfare of India in 2014
  - In the US Senate Appropriations Committee hearing on cell phones and health, 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 Strahlenschutz, Germany; International Commission on Non-Ionizing Radiation Protection (ICNIRP); Swiss National Foundation; The Netherlands Organization for Health Research and Development;
WHY STUDY HEALTH EFFECTS OF CELL PHONE RADIATION?
NO PRE-MARKET TESTING OF HEALTH EFFECTS OF CELL PHONE RADIATION

• Commercialization of cell phone technology, developed for the US Department of Defense

• US Food and Drug Administration

• Permitted sales of cell phones without pre-market safety testing

• Rationale: “low power exclusion” when compared with microwave ovens

• Only thermal effects known at that time and considered
RESEARCHING HEALTH IMPACT OF CELL PHONE RADIATION

• Acute effects
  – Immediate health effect – not known
  – Safety standards based on lack of acute effects

• Delayed effects
  – Change in physiology that may later affect health
    • Health effect (brain cancer?; individual sensitivity?)
    • Physiology adapts and develops resilience
  – Safety standards do not take into account possible delayed effects
RESEARCH OF LESZCZYNSKI’S BioNIR/FunProt GROUP IN FINLAND (selected examples)

Stress response, proteome & transcriptome

- Nylund et al. Proteome Sci 2010, 8:52
- Karinen et al. BMC Genomics 9, 2008, 77-
- Nylund & Leszczynski Proteomics 6, 2006, 4769-4780
- Nylund & Leszczynski Proteomics, 4, 2004, 1359-1365
- Leszczynski et al. Differentiation 70, 2002, 120-129
FINDINGS OF LESZCZYNSKI’S BioNIR/FunProt RESEARCH GROUP IN FINLAND

• Is cell phone radiation inducing physiological effects in human endothelial cell line in vitro?
  • Yes – stress response – activated Hsp27/p38MAP kinase pathway (2002)
• Is activation of Hsp27/p38MAPK causing cellular responses?
  • Yes – stabilization of F-actin stress fibers, shrinkage of cells, changes in gene expression, changes in protein expression (2002-2008)
• Are cell phone radiation effects occurring in humans?
  • Yes – changes in expression of proteins in human skin in vivo (2008)
cells with high expression of hsp27 (red color) have prominent stress fibers-network (green color) and stress fiber components are present also in the ruffles of the cells...
Active hsp27 regulates stability of stress fibers in EA.hy926

SB203580 - inhibitor of p38MAP kinase

1h 2.4SAR without SB203580

1h 2.4SAR with SB203580
hamster cell line CCL39
over-expressing human wild-hsp27

sham

1h 2.4SAR
hamster cell line CCL39 over-expressing human mutant-hsp27

sham

1h 2.4SAR
CELLULAR STRESS RESPONSE IS ACTIVATED BY THE MOBILE PHONE RADIATION

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 regulatory genes
BLOOD-BRAIN BARRIER
Non-thermal activation of the hsp27/p38MAPK stress pathway by mobile phone radiation in human endothelial cells: Molecular mechanism for cancer- and blood-brain barrier-related effects


Nerve Cell Damage in Mammalian Brain after Exposure to Microwaves from GSM Mobile Phones

Leif G. Salford,1 Arne E. Brun,2 Jacob L. Eberhardt,3 Lars Malmgren,4 and Bertil R. R. Persson3

1Department of Neurosurgery, 2Department of Neuropathology, 3Department of Medical Radiation Physics, and 4Department of Applied Electronics, Lund University, The Rausing Laboratory and Lund University Hospital, Lund, Sweden

Figure 1. Cross-section of central parts of the brain of (A) an unexposed control rat and (B) an RF EMF-exposed rat, both stained for albumin, which appears brown. In (A), albumin is visible in the central inferior parts of the brain (the hypothalamus), which is a normal feature. In (B), albumin is visible in multiple small foci representing leakage from many vessels. Magnification, about ×3.
In a study published in 2009, Patrick Mason and his co-workers from the Air Force Research Laboratory at the Brooks City-Base, TX, USA, have failed to replicate observations from Salford’s group.


This year, well recognized and established journal - Brain Research - published in March 2015 issue an article from the scientists at the Department of Neurosurgery, Southwest Hospital, Third Military Medical University, Chongqing, 400038, China:

STRESS RESPONSE ACTIVATION... AGAIN

Gang Zhu et al. have shown that activation of stress response pathway is involved in the effect on blood-brain barrier. Quote from the abstract:

"Taken together, these results demonstrated that exposure to 900 MHz EMF radiation for 28 days can significantly impair spatial memory and damage BBB permeability in rat by activating the *mkp-1/ERK pathway.*"
POTENTIAL MECHANISM: 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
Zhu et al. 2015

Cell proliferation and expression of cancer regulatory genes
FUTURE RESEARCH NEEDS
Unlike the genome, the transcriptome and the proteome are highly dynamic and change rapidly and dramatically in response to perturbations or even during normal cellular events.

Strong stimulus \[\downarrow\] robust response

Weak stimulus \[\downarrow\] response will very much depend on the transcriptome and proteome expressed by the cells at the time of exposure.

Nylund R. & Leszczynski D. Mobile phone radiation causes broad changes in gene and protein expression in human endothelial cell lines and the response appears to be genome- and proteome-dependent. 
Proteomics 6, 2006
The Proteome is the operating system for nearly all biological functions. It is the link between the genome and phenotypes.

It undergoes dynamic changes in different cells and organs, during development, in response to environmental stimuli, and in disease processes.

Understanding the dynamics of protein interactions with other proteins, nucleic acids, and metabolites is the key to delineating biological mechanisms and understanding disease.
Exposure of skin, blood, and muscle tissues may well exceed 40 W/kg at the cell level.

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.

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.
CONCLUSIONS

• Mobile phone radiation activates cellular stress response in vitro and in vivo

• Stress response pathways, activated by mobile phone radiation, appear to be cell-type specific

• Activation of stress response indicates that cells recognize mobile phone radiation as a potentially damaging agent and launch protective response

• Activation of stress response in endothelial cells forming blood-brain barrier may potentially impair functioning of the barrier

• Further research, including this with omics techniques, should continue to determine potential effects of mobile phone radiation on human blood-brain barrier

• New exposure protocols need to be considered in the context of the “game changer” observation by Schmid & Kuster