Electromagnetic Hypersensitivity
A Summary by Dr Erica Mallery-Blythe

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WORKING DRAFT Version 1

For printing purposes:
The first 1-7 pages are body text, the rest are references. This document consists of 79 pages.

Author's note:

This summary is expanded section of a larger document entitled "Electromagnetic Health for Children". The full document is designed in response to requests for information detailing current health concerns of electromagnetic fields (EMFs) with a focus on radiofrequency (RF) radiation. This is an expanded subsection covering EHS only.

Background:

We are currently witnessing the largest change to the Earth's electromagnetic environment that has ever taken place in human history. This change has taken place in the very short period of a handful of decades and continues to escalate at an exponential rate (Appendix 1). Given that household electricity, which was the first anthropogenic (man-made) electromagnetic field (EMF), only became prolific after the turn of the century, artificial EMF has barely seen one generation from cradle to grave. The use of higher frequency microwave devices such as mobile telephony, Wi-fi and smart meters, have suddenly become commonplace despite almost no safety testing and decades of evidence of potentially lethal effects. This has sparked a political and scientific debate that is gathering momentum on a daily basis, raising concern about the continued use of such devices. One may assume when witnessing the vast implementation of, for example Wi-fi in the home, school, workplace or public domain, that experts have provided sufficient evidence of safety to overwhelm scientific concern. This is not the case.

The World Health Orgnaisation (WHO) / International Agency for Research on Cancer (IARC) Classified RF as a Group 2 B 'Possible Human Carcinogen" (2011). Despite this, there has been no attempt in the UK at disseminating this important information to the public. Conversely, it was not even mentioned in the AGNIR government commissioned report a year later in 2012. The only safety guidelines currently used in the UK are those constructed in 1998 regarding 'thermal (heating) effects' of non-ionising radiation. These are not protective of health given the vastly documented non-thermal effect taking place orders of magnitude below these levels. They are obsolete. Other countries have responded to this information and have safety limits more biologically sensible thousands of times below ours (see Appendix 2). Mechanistic data is available to explain these effects and every bodily system is affected (as one would expect from a radiation induced illness).

The very broad range of RF emitting devices on the market were never pre-market safety tested and many now contain fine print warnings from the manufacturers which warn that one must keep the devices a minimum distance from the body which in some cases is incompatible with use. The public are generally not aware of these warnings or the increased vulnerability of certain groups such as children, foetuses, elderly, pregnant women, infirm and those with EHS.

The full paper gives an overview of facts that should be considered during the policy change that is clearly necessary, and this subsection concerns Electromagnetic Hypersensitivity (EHS) only.

Contents:

Electromagnetic Hypersensitivity (EHS)

A Summary

1. **Definition:**
   Electromagnetic hypersensitivity is characterised by an awareness and/or adverse symptomatology in response to even extremely weak (orders of magnitude below current safety levels[1,2]) electromagnetic fields of multiple types (in terms of frequency/intensity and waveforms). Relevant diagnostic coding that may be used by UK medical doctors include "idiopathic/environmental intolerance (IEI)",[3,4] code Z58.4 (Exposure to radiation) under the International Classification of Diseases (ICD-10),[5] T66 (microwave syndrome)="other unspecified effects of external causes: radiation sickness."[6]

   [Note: All life is electrosensitive to some degree and thresholds for conscience perception will vary depending on age, gender and individual physiology.[7,8,9,10]]

2. **Common symptoms include:**
   Headaches, dizziness, sleep disturbance, sensory up-regulation, palpatations, unusual pain in multiple sites, visual disturbance, auditory disturbance (esp tinnitus), membrane sensitivity, muscle twitching, dermatalogical complaints, hyperactivity /fatigue (depends on adrenal status/ state of EHS), restless leg syndrome, memory/concentration disturbance and anxiety[11,12,13,14,15] (psychiatric symptoms such as anxiety and depression are likely to be secondary to the physiological effects rather than a primary cause[16]). Interestingly, with good avoidance, symptoms tend to disappear in the reverse order that they accumulated.

3. **Characterised by multiple sensory up-regulation:**
   Up-regulation of all senses is commonly noted in persons with EHS, i.e. Photophobia and/or Scotopic sensitivity syndrome (visual sensitivity), Hyperacusis (hearing sensitivity), Hyperosmia (heightened sense of smell), Hypergeusia (heightened taste sensitivity), Hyperesthesia/Photosensitivity (heightened skin sensitivity) and Multiple Chemical Sensitivity (MCS) is associated.[17,18,99,109]

4. **Exposure induced:**
   EHS is a cumulative, exposure-triggered condition, and exposures are rising rapidly (see Appendix 1). Devices which emit RF and know to cause symptoms in those with EHS include:
   mobile phones, DECT cordless landlines, Wi-Fi/bluetooth enabled laptop, desktop computers and laptops, Wi-Fi routers, Smart meters, fluorescent lighting, baby monitors, security systems, RFID systems and wireless gaming consoles. ELF (Extremely Low Frequency) fields (household electrical) will also cause symptoms in some individuals.

5. **Characterised by increasing trigger susceptibility and irreversibility:**
   If EHS is unmanaged and there is general detioration, there will be reaction to an increasingly broad range of frequencies at increasingly low intensities, i.e. the number of devices complained of triggering symptoms will increase and symptomatic distances will decrease.[19] Tendency towards MCS will also increase and irreversibility will become more likely.[20]

6. **Highly prevalent:**
   Estimates for the number of people with EHS vary widely, but several countries report around 4-10%.[21,22,23] **In the UK this corresponds to approximately 2.5 to 6.3 million**[24] (which is more than the number of UK wheelchair users). This is likely to be a gross underestimation (see point 7 below) given that figures are based on the number of people who have made the connection between their symptoms and EMF exposure. The number of people who have mild EHS symptoms, but have not linked them yet to exposure would be far higher. Given the ubiquity of exposure now in all environments, it can be very difficult for people to notice the association.

7. **Rapidly rising:**
   Extrapolated figures suggest that 50% of the population may be affected by 2017 (Appendix 3).

8. **May affect everyone:**
   Interestingly, the signs and symptoms associated with RF exposures from e.g. mobile phone base stations,[25,26,27,28 29,30,31,32,33,34,35,36,37,38,39,40] (also see Appendix 4) Wi-Fi,[41,42] mobile phones,[43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,140,143] radio/TV broadcasting transmitters,[70,71,72,73,74] smart meters,[75] MRI scanners,[76,77,78,79,80,81,82,83,84,85,86] and other RF sources[87,88] **reveal that the general population (not know to be EHS) experience the same constellation of symptoms as are noted in EHS**. This is a dose-response relationship. Thus, it is possible that EHS could manifest in all members of the population with enough exposure. (Please note some of the above studies are demonstrating EHS symptoms in children.)

9. **Proven physiological condition:**
   EHS has been demonstrated in a published, peer-reviewed, double blind research study,[89] as an **'environmentally inducible bona-fide neurological syndrome'**,[90] and other provocation tests corroborate this evidence.[73,76,91,92,93,94,95,101] In addition, multiple papers have demonstrated physiological variations in those with EHS[25,26,28,31,33,37,92,94,96,97,98,99,100,101,102,103,104,105,106,107,108,109,110,111,112,113] and genetic variations.[99] Furthermore, mechanisms are evolving that may explain the symptomatology of EHS.[42,44,52,55,56,62,65,69,78,81,87,88,96,100, 114,115,116,117,118,119,120,121,122,123,124,125,126] Therefore, increasingly, professional bodies are recognising this as a physiological condition.[127,128,129,130,131,132,133,134,135]

10. **Recognised by World Health Organisation (WHO):**
    The WHO states that **'symptoms are certainly real'** and **'in some cases can be disabling'**.[136]
    'Some studies suggest that certain physiological responses of IEI individuals tend to be outside the normal range. In particular, the findings of hyper reactivity in the central nervous system and misbalance in the autonomic nervous system need to be followed up in clinical investigations and the results for the individuals taken as input for possible treatment.' [113]

11. **Nocebo effect invalid:**
    Whilst the nocebo effect (physical symptoms induced by fear) has been suggested,[137] thorough investigation of individual histories renders this concept invalid in the majority of cases. Additionally, psychological therapies are much less effective at reducing symptoms than avoidance of electromagnetic fields[138] (see also point 14 below) and risk perception alone has not been felt adequate to explain the characteristics witnessed.[17] Furthermore, evidence of EHS type symptomatology in studies involving small children, foetuses[139,140,141,142,143] and

animals[144,145,146,147,148,149,150,151,152,153,154,155,156,157,158,159,160,161,162,163] (where media-cultivated perceptions are impossible), also invalidates this theory.

12. Recognised as a functional impairment:

- Under the disability act in Sweden,[164,165] USA[166] and Canada.[167]
- Legal cases are now being won for long term disability pensions/compensation (Australia,[168] France,[169] Spain,[170] UK [171] and United States[172,173]).
- Hospital facilities with low EMF have been constructed.[174]
- Academic bodies urge immediate protection for those with EHS.[175,176]
- The UN[177,178] and the European Parliament[179] have made clear the requirement for equal opportunities for those with EHS.

13. Notable persons with EHS:

Well known, credible individuals such as Dr Gro Harlem Brundtland, Former Director-General of WHO and the first female Prime Minister of Norway[180] and Matti Niemelä, former Nokia Chief Technical Officer[181] have been public regarding their Electromagnetic Hypersensitivity.

14. Medical guidelines for management exist:

Medical guidelines have been drawn up for doctors to diagnose[95,182] and manage[183,184,185] the condition physiologically with advice to urgently reduce exposure, and this advice is echoed by many other organizations.[164,167,183,186,187,188,189,190.191,192,193,194] Additionally, research has shown avoidance can be the only reliable form of management to improve symptoms.[138,195] Currently the most reliable way to diagnose EHS is via history, i.e. it is a clinical diagnosis,[182] but there are other tests currently being used in the private sector and in the research forum believed by their users to be diagnosistic or aid diagnosis.

15. Children have EHS:

Many children are currently affected, but undiagnosed. Children are likely to be more vulnerable to developing EHS since their exposure is higher (as explained above), and outcomes may be worse given their developing systems and greater time for latent effects. Children with EHS must be supported at school under the conditions stated in the 'Supporting pupils at school with medical conditions' Department for Education document (April 2014).[196]

16. Vulnerable groups and white zones:

In addition to those with EHS and children, other vulnerable groups include the elderly, pregnant women, foetuses and those with co-morbidity (concurrent) illnesses. In order to protect vulnerable groups there has been increased call for designated, legally protected white zones (no or low EMF areas).[197,198,199]

17. Socioeconomic impact of EHS and human rights:

It has been demonstrated that EHS is already affecting a very large number of people in the UK (see point 6) and given that a proportion of these people will be unable to work due to their condition, revenue is being lost.[200] Additionally an extra burden is created on NHS resources due to inappropriate diagnosis and management of common symptoms, including in those who may be unaware they have EHS. In more severe cases, individuals are forced to live in extreme isolation, poverty and poor health. These individuals cannot access basic, life sustaining public amenities, such as grocery stores, petrol stations and health care facilities. There is there a clear breach of their human rights. We are aware

that some individuals are living in automobiles and tents which can also prove threatening to health and life, especially in extremes of temperature.

All EHS persons require 'comprehensive health evaluation':

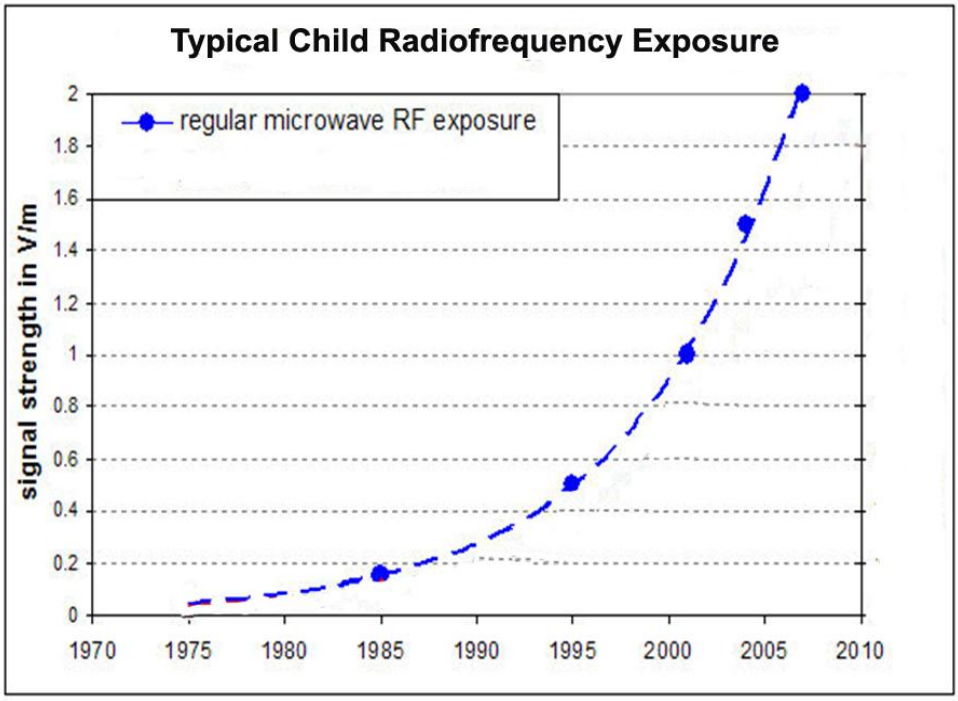
"Because of the huge socioeconomic impact anticipated for EHS worldwide, the World Health Organization has devoted considerable attention to EHS, acknowledging this condition and recommending that people self-reporting sensitivities receive a comprehensive health evaluation".[201]

Author's notes:

I am contacted on a daily basis by a variety of different individuals including, persons with EHS, medical practitioners, school and parent groups, legal representatives, media and political bodies in the UK looking for medical advice on EHS or health effects of EMF in general. This is an increasingly demanding task and therefore I have founded a medical doctors organisation entitled PHIRE (Physicians' Health Initiative for Radiation and Environment) in order to increase the available support for those requesting it. **PHIRE aims to:**

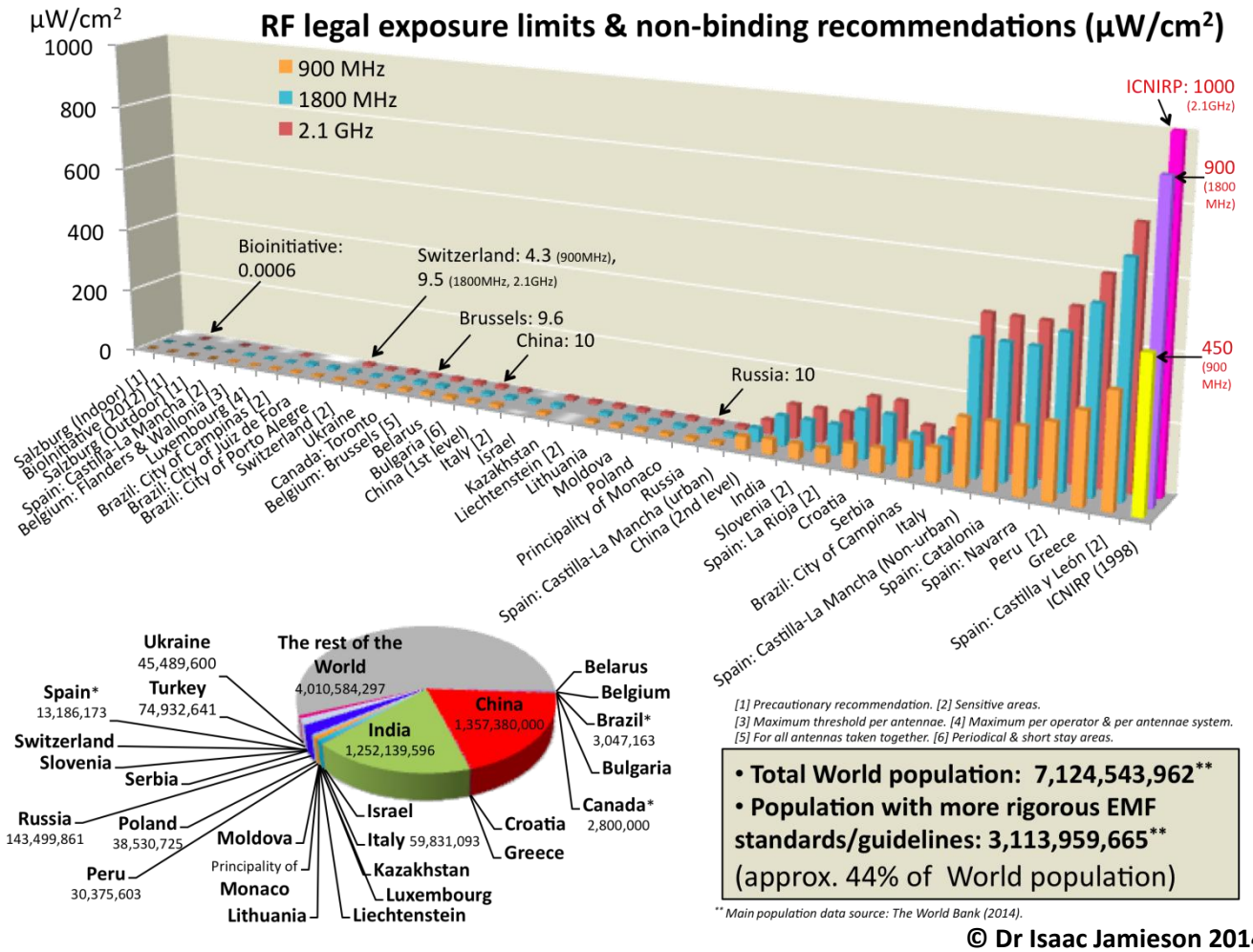
1. Create an academic programme for the education of medical practicioners to improve understanding of EMF related health effects.
2. Construct British medical guidelines for diagnosis and management of EHS.
3. Advise educational groups regarding protection of children from EMF exposure.
4. Increase awareness and support for adults and children with EHS and other vulnerable groups.
5. Expand current British research teams, and use global connections to maintain state-of-the-art education.
6. Open constructive dialogue with DoH (Department of Health)/PHE (Public Health England).
7. Advise on best practice public guidance.

APPENDIX 1

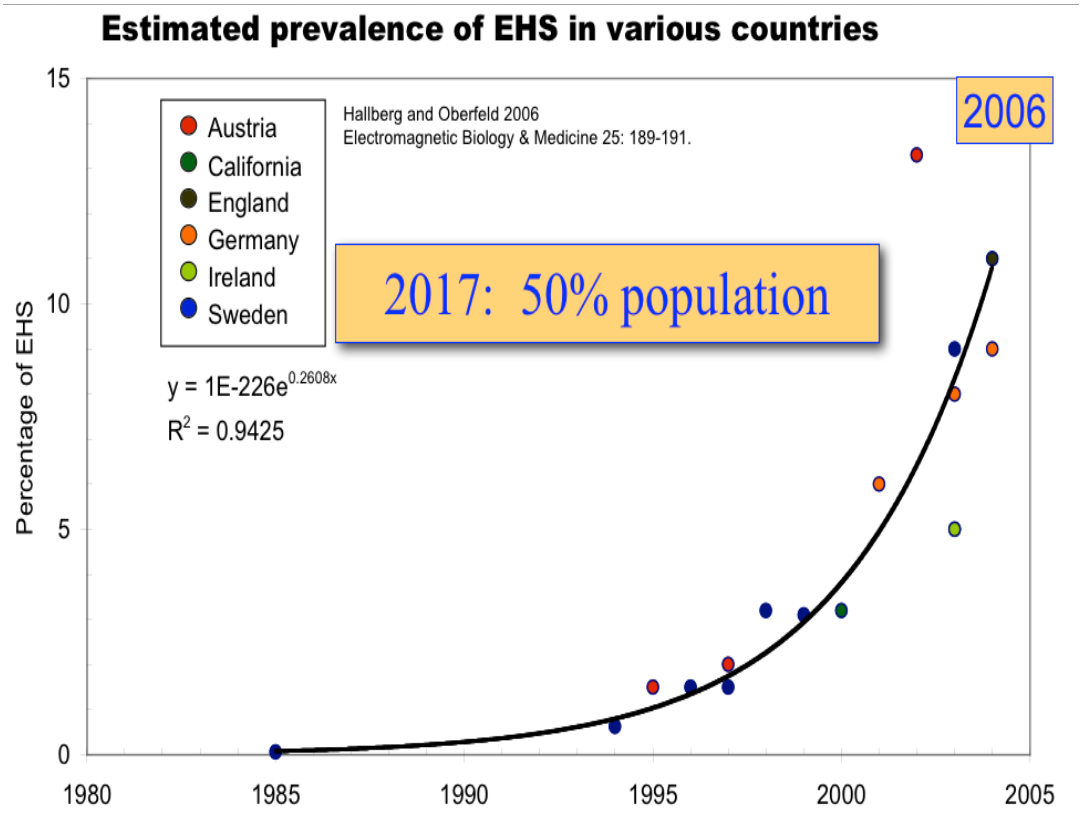


Alasdair Philips, Powerwatch http://www.powerwatch.org.uk/

APPENDIX 2



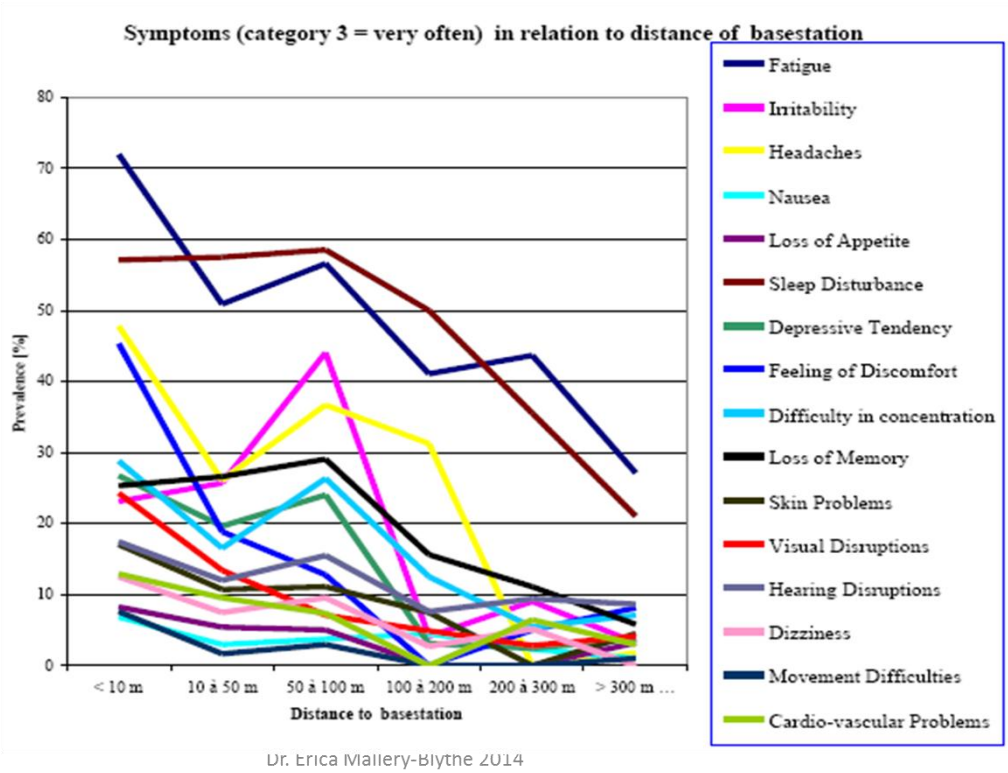
APPENDIX 3



APPENDIX 4

Santini et al 2002 - 2003

- France
- 530 persons
- Selection by media announcement
- Exposure: participants' estimate of distance
- Outcome: list of 18 symptoms



Dr. Erica Mallery-Blythe 2014

DEFINITION:

1 **Canadian Human Rights Commission, May 2007**
The Medical Perspective on Environmental Sensitivities
http://www.chrc-ccdp.gc.ca/sites/default/files/envsensitivity_en.pdf
B. Symptoms (p18)
A single, isolated low-level exposure (e.g. perfume on someone several seats away in the theatre or bus, that is not obviously harming the wearer) may cause significant symptoms such as headache, confusion, breathing difficulties or loss of balance in a person with environmental sensitivities. These symptoms may take minutes, hours or days to resolve. However, regular exposure to something to which one is sensitive may lead to habituation or "masking," and chronic ill-health that may even be accepted as normal.
[Author's note: the above paper refers to MCS but the phenomonen of a miniscule exposure causing potential catastrophic symptoms can also be seen in EHS. This amplification should not be surprising as it is also seen in anaphylaxsis.]

2 Miller, 2001, Ann N Y Acad Sci. 2001 Mar;933:1-23.
The compelling anomaly of chemical intolerance.
http://www.ncbi.nlm.nih.gov/pubmed/12000012
[Author's note: the above paper refers to MCS but the phenomonen of a miniscule exposure causing potential catastrophic symptoms can also be seen in EHS. This amplification should not be surprising as it is also seen in anaphalacsis.]

DEFINITION – DIAGNOSTIC CODING:

3 **The Nordic Adaption of Classification of Occupationally Related Disorders (Diseases and Symptoms) to ICD-10**
Electrohypersensitivity (EHS) symptoms are classified as an **occupationally-related symptom-based diagnosis (code ICD-10) by the Nordic Council of Ministers since 2000.**
http://www.nordclass.se/icd10_e.htm
http://www.nordclass.se/ICD-10_Nordic%20Occupational_2000.pdf
R68.8 Other specified general symptoms and signs (page 33)
(suggested/recommended for multisymptomatic **"idiopathic/environmental intolerance" (IEI)**, including "multiple chemical sensitivity" (MCS); "**electromagnetic intolerance" ("el-allergy")** etc. if the patient has not one major symptom which should preferably be coded)
'Electromagnetic intolerance' "EI-Allergy" (page 50)
Usually general symptoms (**tiredness, nausea, memory- and concentration difficulties etc.) related to use of TV/PC/data-screens, electrical transformers or fluorescent lamps.** Symptoms disappear in "non-electrical environments".

4 **WHO Fact Sheet 296, December 2005**
Electromagnetic fields and public health : Electromagnetic hypersensitivity
http://www.who.int/peh-emf/publications/facts/fs296/en/
A more general term for sensitivity to environmental factors is Idiopathic Environmental Intolerance (IEI).

5 **Austria, 2012**
Guideline of the Austrian Medical Association for diagnosis and treatment of EMF-related health problems and illnesses (EMF Syndrome)
http://www.magdahavas.com/wordpress/wp-content/uploads/2012/06/Austrian-EMF-Guidelines-2012.pdf
5. Diagnosis A diagnosis of EMF syndrome will largely be based on a comprehensive case history, focusing in particular on correlations between health problems and times and places of EMF exposure, as well as the progression of symptoms over time. In addition, measurements of EMF exposure and the results of additional diagnostic tests (laboratory tests, cardiovascular system) serve to support the diagnosis. Moreover, all other potential causes should be excluded as far as possible.
We recommend that the code Z58.4 (Exposure to radiation) under the International Classification of Diseases (ICD-10) be used for EMF syndrome for the time being.

6 **WHO, International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10)-2015-WHO Version for ;2015**
http://apps.who.int/classifications/icd10/browse/2015/en#/T66
Chapter XIX
Injury, poisoning and certain other consequences of external causes (S00-T98)
Other and unspecified effects of external causes (T66-T78)
T66 Unspecified effects of radiation

EMF PERCEPTION:

[Author's note: These studies involve ELF, however, RF perception can be reasonably assumed to follow similar patterns].

7 Blondin et al, 1996, Bioelectromagnetics. 1996;17(3):230-41.
Human perception of electric fields and ion currents associated with high-voltage DC transmission lines.
http://www.ncbi.nlm.nih.gov/pubmed/8809363
The objective of this study was to assess the ability of humans to detect the presence of DC electric field and ion currents. An exposure chamber simulating conditions present in the vicinity of high-voltage DC (HVDC) lines was designed and built for this purpose. In these experiments, the facility was used to expose observers to DC electric fields up to 50 kV/m and ion current densities up to 120 nA/m2. Forty-eight volunteers (25 women and 23 men) between the ages of 18 and 57 years served as observers. Perception of DC fields was examined by using two psychophysical methods: an adaptive staircase procedure and a rating method derived from signal-detection theory. Subjects completed three different series of observations by using each of these methods; one was conducted without ion currents, and the other two involved various combinations of electric fields and ion currents. Overall, subjects were significantly more likely to detect DC fields as the intensity increased. Observers were able to detect the presence of DC fields alone, but only at high intensities; the average threshold was 45 kV/m. Except in the most sensitive individuals, ion current densities up to 60 nA/m2 did not significantly facilitate the detection of DC fields. However, higher ion current densities were associated with a substantial lowering of sensory thresholds in a large majority of observers. **Data analysis also revealed large variations in perceptual thresholds among observers.** Normative data indicating DC field and ion current intensities that can be detected by 50% of all observers are provided. **In addition, for the most sensitive observers, several other detection proportions were derived from the distribution of individual detection capabilities.** These data can form the basis for environmental guidelines relating to the design of HVDC lines.

8 Leitgeb et al, 2006, J Med Eng Technol. 2006 Sep-Oct;30(5):306-9.
Electric current perception of children: the role of age and gender.
http://www.ncbi.nlm.nih.gov/pubmed/16980285
Although it is widely accepted that children merit increased protection, little is known about the quantitative consequences of electric currents when setting safety limits. Measurements were performed on 240 children (117 girls and 123 boys) older than 9 years. **It was found that the electrosensitivity of children was higher than that of adults**, but did not exceed the overall span of adult electrosensitivity. Girls' results depend only weakly on age. Therefore, no major change should be expected below the age of 9. **The electrosensitivity of boys increases with decreasing age**; however, it finally approaches and merges with that of girls. The results imply that the factor by which the allowed touch current should be reduced for children depends on the perception probability level considered. The reduction factor of 2, as chosen in the past, would need revision either in regard to its value or to the related perception probability level. If related to the still existing rationale for safety limits the factor would need to be far higher.

9 Leitgeb & Schroettner, 2002, J Med Eng Technol. 2002 Jul-Aug;26(4):168-72.
Electric current perception study challenges electric safety limits.
http://www.ncbi.nlm.nih.gov/pubmed/12396332
Although a key parameter for safety regulations, the electric current perception threshold is not sufficiently established yet. Present knowledge suffers from a lack of women's data, small numbers of data on investigation of men and investigated samples non-representative for the general population. With measurement at 708 adults aged between 16 and 60 years (349 men and 359 women) these deficiencies could be overcome. The results are important. They show that the **perception variability among the general population is 100-fold higher than estimated so far and that the currently used estimate of the threshold is more than 10-fold too high. Besides this, it could be shown that there are an over-proportion of more sensitive women compared with men indicating the need for revision of the present**

assumptions on gender-specific differences in electrosensibility. The results show that the existing assumptions on safety limits and remaining safety factors need serious review. In any case, relaxation of safety requirements is not justified.

10 McCarty et al, Int J Neurosci. 2011 Dec;121(12):670-6.
Electromagnetic hypersensitivity: evidence for a novel neurological syndrome.
http://www.ncbi.nlm.nih.gov/pubmed/21793784
http://andrewamarino.com/PDFs/171-IntJNeurosci2011.pdf (full paper)
… A possible nonpsychological basis for EMF hypersensitivity was provided by the discovery of the ability of human beings to detect weak EMFs, as evidenced by the occurrence of field-onset and field-offset brain potentials (Carrubba, Frilot, Chesson, & Marino, 2007), and the induction of steady-state changes in brain electrical activity that persisted during the presence of the field (Marino, Carrubba, Frilot, Chesson, & Gonzalez-Toledo, 2010)….

COMMON SYMPTOMS:

11 **American Academy of Environmental Medicine (AAEM), 2012**
Electromagnetic and Radiofrequency Fields Effect on Human Health (Dec 2012)
http://aaemonline.org/emf_rf_position.html
Other neurological and cognitive disorders such as headaches, dizziness, tremors, decreased memory and attention, autonomic nervous system dysfunction, decreased reaction times, sleep disturbances and visual disruption have been reported to be statistically significant in multiple epidemiological studies with RF exposure occurring non-locally.

12 **Austrian Medical Association, 2012**
Guideline of the Austrian Medical Association for diagnosis and treatment of EMF-related health problems and illnesses (EMF Syndrome)
http://www.magdahavas.com/wordpress/wp-content/uploads/2012/06/Austrian-EMF-Guidelines-2012.pdf
Background (page 3)
Among others, the following symptoms were reported as occurring frequently: sleep problems (58%), headaches (41%), nervousness (19%), fatigue (18%) and difficulty concentrating (16%). The respondents listed mobile phone base stations (74%), cell phones (36%), cordless phones (29%) and high-voltage lines (27%) as causes. Two thirds of respondents had taken measures to reduce their symptoms, the most frequent measure being to avoid exposure.
1. History of health problems and EMF exposure (page 6)
Most EMF-related symptoms fall within the scope of so-called stress-related health problems, e.g. sleep problems, fatigue, exhaustion, lack of energy, restlessness, heart palpitations, blood pressure problems, muscle and joint pain, headaches, depression, difficulty concentrating, forgetfulness, anxiety, urinary urgency, anomia, dizziness, tinnitus and sensations of pressure in the head and the ears.

13 Genuis and Lipp , 2012, Sci Total Environ. 2012 Jan 1;414:103-12.
Electromagnetic hypersensitivity: fact or fiction?
http://www.ncbi.nlm.nih.gov/pubmed/22153604
Table 1 (page 105)
Common reported signs and symptoms associated with electromagnetic hypersensitivity (EHS).
Some common signs and symptoms of electromagnetic hypersensitivity (Havas, 2006; Johansson, 2006) Headache, Thought processing difficulties, Memory impairment, Heart palpitations, Sleep disorder, General malaise, Blurred vision, Weakness, Dizziness, Chest discomfort, Muscle pain, Tinnitus, Fatigue, Nausea, Night sweats, Restless legs, Paresthesias.

14 Hagström et al, 2013, Pathophysiology. 2013 Apr;20(2):117-22.
Electromagnetic hypersensitive Finns: Symptoms, perceived sources and treatments, a questionnaire study.
http://www.ncbi.nlm.nih.gov/pubmed/23557856
The aim was to analyze the subjective experiences of Finns who describe themselves as suffering from electromagnetic hypersensitivity (EHS), their symptoms, self-perceived sources of the health complaints and the effectiveness of medical and complementary alternative therapies. A total of 395 questionnaires were mailed to self-diagnosed EHS persons. Of the participants 345 belonged to a Finnish self-help group and 50 came from outside of the group. The return rate of the study was 52.1% (206) and 80.9% of the respondents were women. Before the onset of EHS the most common health complaints were different types of allergies (35.1%, 68). **During the acute phase of EHS the most**

common symptoms were nervous system related: "stress" (60.3%, 117), "sleeping disorders" (59.3%, 115) and "fatigue" (57.2%, 111). The sources that were most often reported to have triggered EHS were: "personal computers" (50.8%, 94) and "mobile phones" (47.0%, 87). The same devices were also claimed to cause the most symptoms during the acute phase. After the acute phase of EHS had passed, the respondents still claimed to react to these same digital and wireless devices while their reactions to basic electrical appliances were reduced.

15 Kato & Johansson, 2012, Pathophysiology. 2012 Apr;19(2):95-100.
Reported functional impairments of electrohypersensitive Japanese: A questionnaire survey.
http://www.ncbi.nlm.nih.gov/pubmed/22458999
An increasing number of people worldwide complain that they have become electromagnetic hypersensitive (EHS). We conducted a questionnaire survey of EHS persons in Japan. The aim was to identify electromagnetic fields (EMF) and plausible EMF sources that caused their symptoms. Postal questionnaires were distributed via a self-help group, and 75 participants (95% women) responded. Reported major complaints were **"fatigue/tiredness" (85%), "headache", "concentration, memory, and thinking" difficulty (81%, respectively).** Seventy-two per cent used some form of complementary/alternative therapy. The most plausible trigger of EHS onset was a mobile phone base station or personal handy-phone system (37%). Sixty-five percent experienced health problems to be due to the radiation from other passengers' mobile phones in trains or buses, and 12% reported that they could not use public transportation at all. Fifty-three percent had a job before the onset, but most had lost their work and/or experienced a decrease in income. Moreover, 85.3% had to take measures to protect themselves from EMF, such as moving to low EMF areas, or buying low EMF electric appliances. EHS persons were suffering not only from their symptoms, but also from economical and social problems.

16 **Canadian Human Rights Commission, May 2007**
The Medical Perspective on Environmental Sensitivities
http://www.chrc-ccdp.gc.ca/sites/default/files/envsensitivity_en.pdf
Physical or psychological origins (page 22)
Recent research with better defined patient populations concluded that **psychiatric symptoms are more likely to stem from, rather than to cause, symptoms of environmental sensitivities.** Development of sensitivities usually pre-dates symptoms of depression and anxiety in people with sensitivities, with 1.4% of patients identifying problems before the onset of sensitivities and 38% reporting the development of depression, anxiety and other symptoms after sensitivities became apparent.

Table 7: Environmental sensitivity symptoms/reactions (page 19)

Body system	Symptoms
Nervous system	Heightened sense of smell Difficulty concentrating Difficulty remembering Apparent variability in mental processes Feeling dull or groggy Feeling "spacey" Headaches Restlessness, hyperactivity, agitation, insomnia Depression Lack of coordination or balance Anxiety Seizures Tinnitus
Upper respiratory system	Stuffy nose, itchy nose (the "allergic salute") Blocked ears Sinus stuffiness, pain, infections
Lower respiratory system	Cough Wheezing, shortness of breath, heavy chest Asthma Frequent bronchitis or pneumonia

Eyes	Red, watery eyes Dark circles under eyes Pain in eyes Blurred, disturbed vision
Gastrointestinal system	Heartburn Nausea Bloating Constipation Diarrhea Abdominal pain
Endocrine system	Fatigue, lethargy Blood sugar fluctuations
Musculoskeletal system	Joint and muscle pain in the extremities and/or back Muscle twitching or spasms Muscle weakness
Cardiovascular system	Rapid or irregular heartbeat Cold extremities High or low blood pressure
Skin (dermatological system)	Flushing (whole body, or isolated, such as ears, nose or cheeks) Hives Eczema Other rashes Itching
Genitourinary system	Frequency and urgency to urinate Painful bladder spasms

Summary (page 20)
Environmental sensitivities may affect every system in the body, so multiple symptoms are possible, with variation among individuals.

CHARACTERISED BY MULTIPLE SENSORY UP-REGULATION:

See also: De Luca 2014[99], Nordin 2014[109].

17 Levallois et al, 2002, Environ Health Perspect. 2002 Aug;110 Suppl 4:619-23.
Study of self-reported hypersensitivity to electromagnetic fields in California.
http://www.ncbi.nlm.nih.gov/pubmed/12194896
Cases of alleged hypersensitivity to electromagnetic fields (EMFs) have been reported for more than 20 years, and some authors have suggested some connection with the "multiple chemical sensitivity" illness. We report the results of a telephone survey among a sample of 2,072 Californians. Being "allergic or very sensitive" to being near electrical devices was reported by 68 subjects, resulting in an adjusted prevalence of 3.2% (95% confidence interval = 2.8, 3.7**). Twenty-seven subjects (1.3%) reported sensitivity to electrical devices but no sensitivity to chemicals. Characteristics of the people reporting hypersensitivity to EMFs were generally different from those of people reporting being allergic to everyday chemicals. Alleging environmental illness or multiple chemical sensitivity diagnosed by a doctor was the strongest predictor of reporting being hypersensitive to EMFs in this population.** Other predictive factors apart from self-reporting chemical sensitivity were race/ethnicity other than White, Black, or Hispanic; having low income; and being unable to work. The perception of risk of exposure to EMFs through the use of hair dryers (vs. exposure to power and distribution lines) was the factor the most associated with self-reporting about hypersensitivity to EMFs. **However, risk perception was not sufficient to explain the characteristics of people reporting this disorder.**

18 **WHO Fact Sheet 296, December 2005**
Electromagnetic fields and public health : Electromagnetic hypersensitivity
http://www.who.int/peh-emf/publications/facts/fs296/en/
EHS resembles multiple chemical sensitivities (MCS), another disorder associated with low-level environmental exposures to chemicals.

CHARACTERISED BY INCREASING TRIGGER SUSCEPTIBILITY AND IRREVERSIBILITY:

19 **Canadian Human Rights Commission, May 2007**
The Medical Perspective on Environmental Sensitivities
http://www.chrc-ccdp.gc.ca/sites/default/files/envsensitivity_en.pdf
B Prevalence (page 5)
However, recent studies have revealed genetic links to sensitivities, and biochemical differences between people with sensitivities and "control" populations. Clinical experience shows that increasing chemical exposures are associated with increasing symptoms and reports of **sensitivity spreading to more incitants**.
[Author's note: this observation in MCS is also noted in EHS, i.e. increasing EMF exposures are associated with increasing symptoms and reports of sensitivity spreading to more EMF incitants.]
A Agents initiating the condition of environmental sensitivities and triggering Reactions (page 16)
Once people are initially sensitized to low levels of environmental factors, they may experience reactions triggered by a broader range of exposures if the condition is not recognized and addressed. In this two-stage process, environmental sensitivities may develop gradually with chronic exposure to relatively low levels of chemicals as seen in "sick buildings," or suddenly after a major exposure to an environmental disaster or a chemical spill.

20 **Canadian Human Rights Commission, May 2007**
The Medical Perspective on Environmental Sensitivities
http://www.chrc-ccdp.gc.ca/sites/default/files/envsensitivity_en.pdf
Summary (page 26)
The balance of scientific evidence and experience indicates that environmental sensitivities generally arise from physiological causes, although there are many neurological and psychological consequences.

HIGHLY PREVALENT:

21 Schröttner and Leitgeb, 2008, BMC Public Health. 2008 Sep 12;8:310.
Sensitivity to electricity--temporal changes in Austria.
http://www.ncbi.nlm.nih.gov/pubmed/18789137
"This study showed an actual EHS prevalence of **3.5%** compared with 2% estimated in 1994".

22 Schreier, Huss and Röösli, 2006, Sozial- und Präventivmedizin, July 2006, Volume 51, Issue 4, pp 202-209
The prevalence of symptoms attributed to electromagnetic field exposure: a cross-sectional representative survey in Switzerland
http://www.ncbi.nlm.nih.gov/pubmed/17193782
"We found a prevalence of 5% (95% CI 4–6%) for electromagnetic hypersensitivity (EHS) in our study sample. The most common health complaints among EHS individuals were sleep disorders (43%) and headaches (34%), which were mostly attributed to power lines and mobile phone handsets."

23 O. Johansson, Pathophysiology 16 (2009) 157–177
Disturbance of the immune system by electromagnetic fields—A potentially underlying cause for cellular damage and tissue repair reduction which could lead to disease and impairment
http://www.pathophysiologyjournal.com/article/S0928-4680(09)00035-2/fulltext
The functional impairment electrohypersensitivity is reported by individuals in the United States, Sweden, Switzerland, Germany, Belgium, Italy, The Netherlands, Norway, Denmark and many other countries of the world. Estimates range from 3% to perhaps 10% of populations, and appear to be a growing condition of ill-health leading to lost work and productivity.

24 **UK 2011 Population Census**
http://en.wikipedia.org/wiki/Demography_of_the_United_Kingdom
The estimated population of the United Kingdom in the 2011 census was 63.182 million.

EHS GENERAL POPULATION SIGNS & SYMPTOMS - MAY AFFECT EVERYONE

EHS GENERAL POPULATION SIGNS & SYMPTOMS – BASE STATIONS:

25 Abdel-Rassoul et al, 2007, Neurotoxicology. 2007 Mar;28(2):434-40.
Neurobehavioral effects among inhabitants around mobile phone base stations.
http://www.ncbi.nlm.nih.gov/pubmed/16962663
Results: The prevalence of neuropsychiatric complaints **as headache (23.5%), memory changes (28.2%), dizziness (18.8%), tremors (9.4%), depressive symptoms (21.7%), and sleep disturbance (23.5%)** were significantly higher among exposed inhabitants than controls: (10%), (5%), (5%), (0%), (8.8%) and (10%), respectively (P<0.05). The NBTB indicated that the exposed inhabitants exhibited a significantly lower performance than controls in one of the tests of attention and short-term auditory memory [Paced Auditory Serial Addition Test (PASAT)]. Also, the inhabitants opposite the station exhibited a lower performance in the problem solving test (block design) than those under the station. All inhabitants exhibited a better performance in the two tests of visuomotor speed (Digit symbol and Trailmaking B) and one test of attention (Trailmaking A) than controls. The last available measures of RFR emitted from the first mobile phone base station antennas in Menoufiya governorate were less than the allowable standard level. **Conclusions: Inhabitants living nearby mobile phone base stations are at risk for developing neuropsychiatric problems and some changes in the performance of neurobehavioral functions either by facilitation or inhibition. So, revision of standard guidelines for public exposure to RER from mobile phone base station antennas and using of NBTB for regular assessment and early detection of biological effects among inhabitants around the stations are recommended.**

26 Augner et al, 2010, Biomed Environ Sci. 2010 Jun;23(3):199-207.
http://www.ncbi.nlm.nih.gov/pubmed/20708499?dopt=Abstract
Effects of exposure to GSM mobile phone base station signals on salivary cortisol, alpha-amylase, and immunoglobulin A.
OBJECTIVE:
The present study aimed to test whether exposure to radiofrequency electromagnetic fields (RF-EMF) emitted by mobile phone base stations may have effects on salivary alpha-amylase, immunoglobulin A (IgA), and cortisol levels.
METHODS:
Fifty seven participants were randomly allocated to one of three different experimental scenarios (22 participants to scenario 1, 26 to scenario 2, and 9 to scenario 3). Each participant went through five 50-minute exposure sessions. The main RF-EMF source was a GSM-900-MHz antenna located at the outer wall of the building. In scenarios 1 and 2, the first, third, and fifth sessions were "low" (median power flux density 5.2 microW/m(2)) exposure. The second session was "high" (2126.8 microW/m(2)), and the fourth session was "medium" (153.6 microW/m(2)) in scenario 1, and vice versa in scenario 2. Scenario 3 had four "low" exposure conditions, followed by a "high" exposure condition. Biomedical parameters were collected by saliva samples three times a session. Exposure levels were created by shielding curtains.
RESULTS:
In scenario 3 from session 4 to session 5 (from "low" to "high" exposure), an increase of cortisol was detected, while in scenarios 1 and 2, a higher concentration of alpha-amylase related to the baseline was identified as compared to that in scenario 3. IgA concentration was not significantly related to the exposure.
CONCLUSIONS:
RF-EMF in considerably lower field densities than ICNIRP-guidelines may influence certain psychobiological stress markers.
[Exposure: 900 MHz; 5 x 50 mins; power flux density 5.2, 153.6 and 2126.8 µW/m², SAR unspecified]

27 Bortkiewicz et al,2004, Med Pr. 2004;55(4):345-51.
Subjective symptoms reported by people living in the vicinity of cellular phone base stations: review.
http://www.ncbi.nlm.nih.gov/pubmed/15620045 (article in Polish).
A questionnaire was used as a study tool. The results of the questionnaire survey reveal that people living in the vicinity of base stations report various complaints **mostly of the circulatory system, but also of sleep disturbances, irritability, depression, blurred vision, concentration difficulties, nausea, lack of appetite, headache and vertigo**. The performed studies showed the relationship between the incidence of individual symptoms, the level of exposure, and the distance between a residential area and a base station. **This association was observed in both groups of persons, those who linked their complaints with the presence of the base station and those who did not notice such a relation.**

28 Buchner and Eger, 2011, Umwelt - Medizin - Gesellschaft 2011; 24 (1): 44 - 57

Modification of clinically important neurotransmitters under the influence of modulated high-frequency fields - A long-term study under true-to-life conditions
http://www.umg-verlag.de/umwelt-medizin-gesellschaft/111_be_z.pdf
This long-term study over one and a half years shows a significant activation of the 60 participants´ adrenergic systems after the installation of a regional mobile telephone transmitting station in the village of Rimbach (Bavaria). The values of the stress hormones adrenaline and noradrenaline grow significantly during the first six months after starting the GSM transmitter; the values of the precursor substance dopamine decreases substantially after the beginning of the radiation (Wilcoxon test, p<0,0002). **The initial condition is not restored even after one and a half years.** Due to the not regulable chronic difficulties of the stress balance, **the phenylethylamine (PEA) values drop until the end of the research period (Wilcoxon test, p<0,0001).The effects show a dose effect relation and are situated far under the valid limits for technical high-frequency stress. Chronic dysregulations of the catecholamine system have a substantial health relevance and cause health damages in the long run.**

29 Eger, H. & Jahn, M., 2010, Umwelt - Medizin - Gesellschaft 2010; 23 (2): 130 – 139
Specific symptoms and radiation from mobile basis stations in Selbitz, Bavaria, Germany: evidence for a dose-effect relationship.
http://www.emf-portal.de/viewer.php?l=e&aid=18762(original article in German)
http://ebookbrowsee.net/eger-jahn-selbitz-study-2010-english-pdf-d404387440 (full article in English)
In January 2009 the administration of the Bavarian Municipality of Selbitz gathered relevant data from 251 residents as part of a health survey. Subsequently, the data were assessed based on the exposure levels of cell phone radiation. In a next step, the exposure levels based on residential location and available RF measurements of local cell phone radiation levels were used to classify participants into exposure groups. The mean radiation exposure level of the highest exposure group in Selbitz (1.2V/m) was substantially higher than that of the study population inn the QUEBEB study of the German Mobile Phone Programme (mean value 0.07V/m). For such symptoms **as sleep problems, depressions, cerebral symptoms, joint problems, infections, skin problems, cardiovascular problems as well as disorders of the visual and auditory systems and the gastrointenstinal tract, a significan dose-response relationship was observed** in relation to objectively determined exposure levels. The impact of microwave radiation on the human nervous system serves as an explanation.
Carried out without outside funds, the study presented here provides a protocol concept that allows physicians and municipalities to cooperate and assess the potential human health impact of cell phone base statins located within residential areas.

30 Gómez-Perretta et al, 2013, BMJ Open. 2013 Dec 30;3(12)
Subjective symptoms related to GSM radiation from mobile phone base stations: a cross-sectional study.
http://www.ncbi.nlm.nih.gov/pubmed/24381254
OBJECTIVES:
We performed a re-analysis of the data from Navarro et al (2003) in which health symptoms related to microwave exposure from mobile phone base stations (BSs) were explored, including data obtained in a retrospective inquiry about fear of exposure from BSs.
DESIGN: Cross-sectional study.
SETTING: La Ñora (Murcia), Spain.
PARTICIPANTS:
Participants with known illness in 2003 were subsequently disregarded: 88 participants instead of 101 (in 2003) were analysed. Since weather circumstances can influence exposure, we restricted data to measurements made under similar weather conditions.
OUTCOMES AND METHODS:
A statistical method indifferent to the assumption of normality was employed: namely, binary logistic regression for modelling a binary response (eg, suffering fatigue (1) or not (0)), and so exposure was introduced as a predictor variable. This analysis was carried out on a regular basis and bootstrapping (95% percentile method) was used to provide more accurate CIs.
RESULTS:
The symptoms most related to exposure were lack of appetite (OR=1.58, 95% CI 1.23 to 2.03); lack of concentration (OR=1.54, 95% CI 1.25 to 1.89); irritability (OR=1.51, 95% CI 1.23 to 1.85); and trouble sleeping (OR=1.49, 95% CI 1.20 to 1.84). Changes in -2 log likelihood showed similar results. Concerns about the BSs were strongly related with trouble sleeping (OR =3.12, 95% CI 1.10 to 8.86). The exposure variable remained statistically significant in the multivariate analysis. The bootstrapped values were similar to asymptotic CIs.

CONCLUSIONS:
This study confirms our preliminary results. We observed that the incidence of most of the symptoms was related to exposure levels-independently of the demographic variables and some possible risk factors. Concerns about adverse effects from exposure, despite being strongly related with sleep disturbances, do not influence the direct association between exposure and sleep.

31 Hocking & Westerman, 2001, Occup Med (Lond). 2001 Sep;51(6):410-3.
Neurological abnormalities associated with CDMA exposure.
http://www.ncbi.nlm.nih.gov/pubmed/11584121
Dysaesthesiae of the scalp and neurological abnormality after mobile phone use have been reported previously, but the roles of the phone per se or the radiations in causing these findings have been questioned. We report finding a neurological abnormality in a patient after accidental exposure of the left side of the face to mobile phone radiation [code division multiple access (CDMA)] from a down-powered mobile phone base station antenna. **He had headaches, unilateral left blurred vision and pupil constriction, unilateral altered sensation on the forehead, and abnormalities of current perception thresholds on testing the left trigeminal ophthalmic nerve.** His nerve function recovered during 6 months follow-up. His exposure was 0.015-0.06 mW/cm(2) over 1-2 h. The implications regarding health effects of radiofrequency radiation are discussed.

32 Hutter et al, 2006, Occup Environ Med. 2006 May;63(5):307-13.
Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations
http://www.ncbi.nlm.nih.gov/pubmed/16621850
METHODS:
In a cross-sectional study of randomly selected inhabitants living in urban and rural areas for more than one year near to 10 selected base stations, 365 subjects were investigated. Several cognitive tests were performed, and wellbeing and sleep quality were assessed.
RESULTS:
Total HF-EMF and exposure related to mobile telecommunication were far below recommended levels (max. 4.1 mW/m2). Distance from antennae was 24-600 m in the rural area and 20-250 m in the urban area. Average power density was slightly higher in the rural area (0.05 mW/m2) than in the urban area (0.02 mW/m2).
Despite the influence of confounding variables, including fear of adverse effects from exposure to HF-EMF from the base station, there was a significant relation of some symptoms to measured power density; this was highest for headaches. Perceptual speed increased, while accuracy decreased insignificantly with increasing exposure levels. There was no significant effect on sleep quality.
CONCLUSION:
Despite very low exposure to HF-EMF, effects on wellbeing and performance cannot be ruled out, as shown by recently obtained experimental results; however, mechanisms of action at these low levels are unknown.

33 Khurana et al, 2010, Int J Occup Environ Health. 2010 Jul-Sep;16(3):263-7.
Epidemiological evidence for a health risk from mobile phone base stations.
http://www.ncbi.nlm.nih.gov/pubmed/20662418
By searching PubMed, we identified a total of 10 epidemiological studies that assessed for putative health effects of mobile phone base stations. Seven of these studies explored the association between base station proximity and neurobehavioral effects and three investigated cancer. **We found that eight of the 10 studies reported increased prevalence of adverse neurobehavioral symptoms or cancer in populations living at distances < 500 meters from base stations. None of the studies reported exposure above accepted international guidelines, suggesting that current guidelines may be inadequate in protecting the health of human populations. We believe that comprehensive epidemiological studies of long-term mobile phone base station exposure are urgently required to more definitively understand its health impact.**

34 Kundi & Hutter, 2009, Pathophysiology. 2009 Aug;16(2-3):123-35.
Mobile phone base stations-Effects on wellbeing and health.
http://www.ncbi.nlm.nih.gov/pubmed/19261451
Studying effects of mobile phone base station signals on health have been discouraged by authoritative bodies like WHO International EMF Project and COST 281. WHO recommended studies around base stations in 2003 but again stated in 2006 that studies on cancer in relation to base station exposure are of low priority. As a result only few investigations of effects of base station exposure on health and wellbeing exist. **Cross-sectional investigations of**

subjective health as a function of distance or measured field strength, despite differences in methods and robustness of study design, found indications for an effect of exposure that is likely independent of concerns and attributions. Experimental studies applying short-term exposure to base station signals gave various results, but there is weak evidence that **UMTS and to a lesser degree GSM signals reduce wellbeing in persons that report to be sensitive to such exposures. Two ecological studies of cancer in the vicinity of base stations report both a strong increase of incidence within a radius of 350 and 400m respectively**. Due to the limitations inherent in this design no firm conclusions can be drawn, but the results underline the urgent need for a comprehensive investigation of this issue.

35 Navarro et al, 2003, Electromagn Biol Med 2003; 22 (2-3): 161 – 169
The Microwave Syndrome: A Preliminary Study in Spain.
http://informahealthcare.com/doi/abs/10.1081/JBC-120024625
A health survey was carried out in Murcia, Spain, in the vicinity of a Cellular Phone Base Station working in DCS-1800 MHz. This survey contained health items related to "microwave sickness" or "RF syndrome." The microwave power density was measured at the respondents' homes. **Statistical analysis showed significant correlation between the declared severity of the symptoms and the measured power density. The separation of respondents into two different exposure groups also showed an increase of the declared severity in the group with the higher exposure.**

36 Oberfeld et al, 2004, Presented at Conference in Kos
The Microwave Syndrome – Further Aspects of a Spanish Study
http://www.powerwatch.org.uk/pdfs/20040809_kos.pdf
Questionnaire study of health effects with proximity to GSM base stations.
The strongest five associations found are depressive tendency, fatigue, sleeping disorder, difficulty in concentration and cardiovascular problems. The symptoms associated are in line with the symptoms reported in the literature as "Microwave Syndrome". The odds ratios are quite high having small p values. Some kind of selection bias cannot be ruled out, because of the way the questionnaires were distributed, but that would affect more or less all cases and therefore affect the odds ratios not substantially.
Based on the data of this study the advice would be to strive for levels not higher than 0.02 V/m for the sum total, which is equal to a power density of 0.0001 µW/cm² or 1 µW/m², which is the indoor exposure value for GSM base stations proposed on empirical evidence by the Public Health Office of the Government of Salzburg in 2002.

37 Santini et al, 2003, Electromagn Biol Med 2003; 22 (1): 41 – 49
Survey study of people living in the vicinity of cellular phone base stations.
http://informahealthcare.com/doi/abs/10.1081/JBC-120020353
A survey study was conducted, using a questionnaire, on 530 people (270 men, 260 women) living or not in proximity to cellular phone base stations. Eighteen different symptoms (Non Specific Health Symptoms–NSHS), described as radiofrequency sickness, were studied by means of the chi-square test with Yates correction. The results that were obtained underline that certain complaints are experienced only in the immediate vicinity of base stations (up to 10 m for **nausea, loss of appetite, visual disturbances**), and others at greater distances from base stations (up to 100 m for irritability, depressive tendencies, lowering of libido, and up to 200 m for **headaches, sleep disturbances, feeling of discomfort**). In the 200 m to 300 m zone, only the complaint of **fatigue** is experienced significantly more often when compared with subjects residing at more than 300 m or not exposed (reference group). For seven of the studied symptoms and for the distance up to 300 m, **the frequency of reported complaints is significantly higher ($P < 0.05$) for women in comparison with men**. Significant differences are also observed in relation to the ages of subjects, and for the location of subjects in relation to the antennas and other electromagnetic factors.

38 Santini et al., 2002, Pathol Biol (Paris). 2002 Jul;50(6):369-73
Investigation on the health of people living near mobile telephone relay stations: I/Incidence according to distance and sex
http://www.ncbi.nlm.nih.gov/pubmed/12168254
A survey study using questionnaire was conducted in 530 people (270 men, 260 women) living or not in vicinity of cellular phone base stations, on 18 Non Specific Health Symptoms. Comparisons of complaints frequencies (CHI-SQUARE test with Yates correction) in relation with distance from base station and sex, **show significant ($p < 0.05$) increase as compared to people living > 300 m or not exposed to base station, till 300 m for tiredness, 200 m for headache, sleep disturbance, discomfort, etc. 100 m for irritability, depression, loss of memory, dizziness, libido sleep disturbance, depression, discomfort and visual perturbations. This first study on symptoms experienced by**

people living in vicinity of base stations shows that, in view of radioprotection, minimal distance of people from cellular phone base stations should not be < 300 m.

39 Shahbazi-Gahrouei et al, 2013, Electromagn Biol Med. 2013 Jun 19.
Health effects of living near mobile phone base transceiver station (BTS) antennae: a report from Isfahan, Iran.
http://www.ncbi.nlm.nih.gov/pubmed/23781985
Background: In recent years, by tremendous use of mobile phone telecommunication, a growing concern about the possible health hazards has increased greatly among public and scientists. **The mobile phone exposure has been shown to have many effects upon the immune functions, stimulating hormones, mammalian brain, sperm motility and morphology, and neurological pathologies syndrome.** The aim of this study was to find out the psychological and psychobiological reactions of the people who are living near mobile phone base transceiver stations (BTS) antenna, in Isfahan, Iran. Materials and methods: A cross-sectional study on 250 randomly selected inhabitants (133 women and 117 men) was performed in October 2012 till November 2012. The inhabitants were requested to complete a standardized questionnaire that focused on the relevant psychological and psychobiological reactions parameters. A computer program (SPSS version16.0, Chicago, IL) was used for statistical analysis using the Chi-square test with Yates correction. All the data were tested using a criterion level of p=0.05. **Results: The results showed that most of the symptoms such as nausea, headache, dizziness, irritability, discomfort, nervousness, depression, sleep disturbance, memory loss and lowering of libido were statistically significant in the inhabitants living near the BTS antenna (<300 m distances) compared to those living far from the BTS antenna (>300 m). Conclusion: It is suggested that cellular phone BTS antenna should not be sited closer than 300 m to populations to minimize exposure of neighbors.**

40 Suleiman et al, 2014, GEP 2014; 2 : 77 – 83
Electromagnetic Radiation Health Effects in Exposed and Non-Exposed Residents in Penang. epidemiol.
http://www.emf-portal.de/viewer.php?aid=25434&l=e
A comparative study was conducted between residents exposed and not exposed to electromagnetic radiation (EMR) from TELCO towers in Penang Island with the objective of determining the possible health effects using 14 non-specific health symptoms (NSHS). Interviews on 201 respondents were conducted using structured questionnaire for demographic details, health related problems and the public concern**. Comparison of symptoms frequencies and its significance (Chi-square test) between the exposed and not exposed residents from the TELCO tower showed statistical significance (p < 0.05) for headache, giddiness, insomnia, loss of memory, diarrhea, mental slowness, reduced reaction time and mood swing.** The odds ratio for the development of the NSHS scored > 1 for all that gave a conclusion that respondents who were exposed were more likely to suffer symptoms as compared to the respondents who were not exposed to EMR. **This outcome showed that the existence of TELCO tower in these communities has detrimental health effects towards the residents who were exposed to the electromagnetic fields radiation that was emitted. Measures to be taken to minimize adverse health effects on residents should include imposing more stringent guidelines in terms of safety distance and radiation intensity, practicing of WHO precautionary approach, encouraging electromagnetic fields radiation related conference, researches and public awareness, sharing of transceivers by TELCO companies and using protective barriers. These steps will ultimately promote a healthier, harmonious and sustainable living environment.**

EHS GENERAL POPULATION SIGNS & SYMPTOMS – WI-FI:

41 Maganioti et al, 2010,
Wi-Fi electromagnetic fields exert gender related alterations on EEG.
6th International Workshop on Biological Effects of Electromagnetic fields.
The present data support the idea that Wi-Fi signal may influence normal physiology through changes in gender related cortical excitability, as reflected by alpha and beta EEG frequencies.
(The study found that Wi-Fi signals significantly decreased EEG electrical activity (alpha and beta frequencies) in cortical brain areas of young women whilst they were performing a short memory task.)

42 Papageorgiou et al, 2011, Journal of Integrative Neuroscience 10(2):189–202.
Effects of Wi-Fi signals on the p300 component of event-related potentials during an auditory hayling task.
http://www.ncbi.nlm.nih.gov/pubmed/21714138
The P300 component of event-related potentials (ERPs) is believed to index attention and working memory (WM) operation of the brain. The present study focused on the possible gender-related effects of Wi-Fi (Wireless Fidelity)

electromagnetic fields (EMF) on these processes. Fifteen male and fifteen female subjects, matched for age and education level, were investigated while performing a modified version of the Hayling Sentence Completion test adjusted to induce WM. ERPs were recorded at 30 scalp electrodes, both without and with the exposure to a Wi-Fi signal. P300 amplitude values at 18 electrodes were found to be significantly lower in the response inhibition condition than in the response initiation and baseline conditions. Independent of the above effect, within the response inhibition condition there was also a significant gender X radiation interaction effect manifested at 15 leads by decreased P300 amplitudes of males in comparison to female subjects only at the presence of EMF. In conclusion, **the present findings suggest that Wi-Fi exposure may exert gender-related alterations on neural activity associated with the amount of attentional resources engaged during a linguistic test adjusted to induce WM (Working Memory).**
[Exposure: 2.45 GHz; unspecified times; power 100mW, electric field strength 0.49 V/m (at subject's head)]

EHS GENERAL POPULATION SIGNS & SYMPTOMS - MOBILE PHONE EFFECTS:

See also Divan 2012[140], Sudan 2012[143].

43 Al-Khlaiwi & Meo, 2004, Saudi Med J. 2004 Jun;25(6):732-6.
Association of mobile phone radiation with fatigue, headache, dizziness, tension and sleep disturbance in Saudi population.
http://www.ncbi.nlm.nih.gov/pubmed/15195201
OBJECTIVE:
The widespread use of mobile phones has been increased over the past decade; they are now an essential part of business, commerce and society. The use of mobile phones can cause health problems. Therefore, the aim of the present study is to investigate the association of using mobile phones with fatigue, headache, dizziness, tension and sleep disturbance in the Saudi population and provide health and social awareness in using these devices.
METHODS:
This study was conducted in the Department of Physiology, College of Medicine, King Saud University, Riyadh, Kingdom of Saudi Arabia during the year 2002 to 2003. In the present study, a total of 437 subjects (55.1% male and 39.9% female) were invited, they have and had been using mobile phones. A questionnaire was distributed regarding detailed history and association of mobile phones with health hazards.
RESULTS:
The results of the present study showed an association between the use of mobile phones and health hazards. The overall mean percentage for these clinical findings in all groups were headache (21.6%), sleep disturbance (4.%), tension (3.9%), fatigue (3%) and dizziness (2.4%).
CONCLUSION:
Based on the results of the present study, we conclude that the use of mobile phones is a risk factor for health hazards and suggest that long term or excessive use of mobile phones should be avoided by health promotion activities such as group discussions, public presentations and through electronic and print media sources.
[Exposure: mobile phone (frequency unspecified); duration of calls 5-10, 10-30, 30-60, 60-120 and >120 min and duration of exposure to mobile phone <1, 1-5 and 5-10 years; SAR unspecified]

44 Andrzejak R et al, 2008, Ind Health, 2008 Aug;46(4):409-17.
The influence of the call with a mobile phone on heart rate variability parameters in healthy volunteers.
http://www.ncbi.nlm.nih.gov/pubmed/18716391
It is possible that electromagnetic field (EMF) generated by mobile phones (MP) may have an influence on the autonomic nervous system (ANS) and modulates the function of circulatory system. The aim of the study was to estimate the influence of the call with a mobile phone on heart rate variability (HRV) in young healthy people. The time and frequency domain HRV analyses were performed to assess the changes in sympathovagal balance in a group of 32 healthy students with normal electrocardiogram (ECG) and echocardiogram at rest. The frequency domain variables were computed: ultra low frequency (ULF) power, very low frequency (VLF) power, low frequency (LF) power, high frequency (HF) power and LF/HF ratio was determined. ECG Holter monitoring was recorded in standardized conditions: from 08:00 to 09:00 in the morning in a sitting position, within 20 min periods: before the telephone call (period I), during the call with use of mobile phone (period II), and after the telephone call (period III). During 20 min call with a mobile phone time domain parameters such as standard deviation of all normal sinus RR intervals (SDNN [ms]--period I: 73.94+/-25.02, period II: 91.63+/-35.99, period III: 75.06+/-27.62; I-II: $p<0.05$, II-III: $p<0.05$) and standard deviation of the averaged normal sinus RR intervals for all 5-mm segments (SDANN [ms]--period I: 47.78+/-22.69, period II: 60.72+/-27.55, period III: 47.12+/-23.21; I-II: $p<0.05$, II-III: $p<0.05$) were significantly increased. As well as very

low frequency (VLF [ms2]--period I: 456.62+/-214.13, period II: 566.84+/-216.99, period III: 477.43+/-203.94; I-II: p<0.05), low frequency (LF [ms(2)]--period I: 607.97+/-201.33, period II: 758.28+/-307.90, period III: 627.09+/-220.33; I-II: p<0.01, II-III: p<0.05) and high frequency (HF [ms(2)]--period I: 538.44+/-290.63, period II: 730.31+/-445.78, period III: 590.94+/-301.64; I-II: p<0.05) components were the highest and the LF/HF ratio (period I: 1.48+/-0.38, period II: 1.16+/-0.35, period III: 1.46+/-0.40; I-II: p<0.05, II-III: p<0.05) was the lowest during a call with a mobile phone. The tone of the parasympathetic system measured indirectly by analysis of heart rate variability was increased while sympathetic tone was lowered during the call with use of a mobile phone. **It was shown that the call with a mobile phone may change the autonomic balance in healthy subjects. Changes in heart rate variability during the call with a mobile phone could be affected by electromagnetic field but the influence of speaking cannot be excluded.**
[Exposure: 1800 MHz (pulsed); continuous for 20 min; SAR 0.48 W/kg (tested by manufacturer)]

45 Chia et al, 2000, Environ Health Perspect. 2000 Nov;108(11):1059-62.
Prevalence of headache among handheld cellular telephone users in Singapore: a community study.
http://www.ncbi.nlm.nih.gov/pubmed/11102297
We carried out a cross-sectional community study in Singapore to determine the prevalence of specific central nervous system (CNS) symptoms among hand-held cellular telephone (HP) users compared to nonusers and to study the association of risk factors and CNS symptoms among HP users. A total of 808 men and women between 12 and 70 years of age, who lived in one community, were selected using one-stage cluster random sampling and responses to a structured questionnaire. The prevalence of HP users was 44.8%. **Headache was the most prevalent symptom among HP users compared to non-HP users**, with an adjusted prevalence rate ratio of 1.31 [95% confidence interval, 1.00-1.70]**. There is a significant increase in the prevalence of headache with increasing duration of usage (in minutes per day). Prevalence of headache was reduced by more than 20% among those who used hand-free equipment for their cellular telephones as compared to those who never use the equipment.** The use of HPs is not associated with a significant increase of CNS symptoms other than headache.

46 Chiu et al, 2014, J Formos Med Assoc. 2014 Aug 9. pii: S0929-6646(14)00207-1.
Mobile phone use and health symptoms in children.
http://www.ncbi.nlm.nih.gov/pubmed/25115529
BACKGROUND/PURPOSE:
To investigate the mobile phone (MP) use for talking in relation to health symptoms among 2042 children aged 11-15 years in Taiwan.
METHODS:
A nationwide, cross-sectional study, using the computer assisted telephone interview (CATI) technique, was conducted in 2009 to collect information on children's utilization of MPs and the perceived health symptoms reported by their parents.
RESULTS:
The overall prevalence of MP use in the past month was estimated at 63.2% [95% confidence interval (CI) = 61.1-65.3%]. **MP use was associated with a significantly increased adjusted odds ratio (AOR) for headaches and migraine (1.42, 95% CI = 1.12-1.81) and skin itches (1.84, 95% CI = 1.47-2.29). Children who regularly used MPs were also considered to have a health status worse than it was 1 year ago (β = 0.27, 95% CI = 0.17-0.37).**
CONCLUSION:
Although the cross-sectional design precludes the causal inference for the observed association, **our study tended to suggest a need for more cautious use of MPs in children,** because children are expected to experience a longer lifetime exposure to radiofrequency electromagnetic fields (RF-EMF) from MPs.

47 Hillert et al, 2008, Bioelectromagnetics. 2008 Apr;29(3):185-96.
The effects of 884 MHz GSM wireless communication signals on headache and other symptoms: an experimental provocation study.
http://www.ncbi.nlm.nih.gov/pubmed/18044740
Findings from prior studies of possible health and physiological effects from mobile phone use have been inconsistent. Exposure periods in provocation studies have been rather short and personal characteristics of the participants poorly defined. We studied the effect of radiofrequency field (RF) on self-reported symptoms and detection of fields after a prolonged exposure time and with a well defined study group including subjects reporting symptoms attributed to mobile phone use. The design was a double blind, cross-over provocation study testing a 3-h long GSM handset exposure versus sham. The study group was 71 subjects age 18-45, including 38 subjects reporting headache or vertigo in relation to mobile phone use (symptom group) and 33 non-symptomatic subjects. Symptoms were scored on a 7-

point Likert scale before, after 1(1/2) and 2(3/4) h of exposure. Subjects reported their belief of actual exposure status. **The results showed that headache was more commonly reported after RF exposure than sham, mainly due to an increase in the non-symptom group.** Neither group could detect RF exposure better than by chance. A belief that the RF exposure had been active was associated with skin symptoms. **The higher prevalence of headache in the non-symptom group towards the end of RF exposure justifies further investigation of possible physiological correlates.** The current study indicates a need to better characterize study participants in mobile phone exposure studies and differences between symptom and non-symptom groups.

48 Hocking, 1998, Occup Med (Lond). 1998 Sep;48(6):357-60.
Preliminary report: symptoms associated with mobile phone use.
http://www.ncbi.nlm.nih.gov/pubmed/10024730
Mobile phone use is ubiquitous, although the alleged health effects of low level radio-frequency radiation (RFR) used in transmission are contentious. Following isolated reports of headache-like symptoms arising in some users, a survey has been conducted to characterize the symptoms sometimes associated with mobile phone usage. A notice of interest in cases was placed in a major medical journal and this was publicized by the media. Respondents were interviewed by telephone using a structured questionnaire. **Forty respondents from diverse occupations described unpleasant sensations such as a burning feeling or a dull ache mainly occurring in the temporal, occipital or auricular areas. The symptoms often began minutes after beginning a call, but could come on later during the day. The symptoms usually ceased within an hour after the call, but could last until evening. Symptoms did not occur when using an ordinary handset, and were different from ordinary headaches. There were several reports suggestive of intra-cranial effects. Three respondents reported local symptoms associated with wearing their mobile phone on their belts.** There was one cluster of cases in a workplace. Seventy-five per cent of cases were associated with digital mobile phones. Most of the respondents obtained relief by altering their patterns of telephone usage or type of phone. **Cranial and other diverse symptoms may arise associated with mobile phone usage**. **Physicians and users alike should be alert to this.** Further work is needed to determine the range of effects, their mechanism and the possible implications for safety limits of RFR.

49 Ikeda et al, 2014, Environ Health Prev Med. 2014 May;19(3):187-93.
Association between mobile phone use and depressed mood in Japanese adolescents: a cross-sectional study.
http://www.ncbi.nlm.nih.gov/pubmed/24347468
OBJECTIVES:
Mobile phones are commonly used by adolescents. The aim of this study was to clarify associations between duration of mobile phone use and psychological mood in high school students.
METHODS:
This cross-sectional study included 2,785 high school students in Niigata, Japan. A self-administered questionnaire was used to elicit information on sex, school year, hours of mobile phone use, psychological mood status, and possible confounders. Psychological mood outcomes were evaluated with the Mood Inventory, developed and validated in 1994, which includes five subcomponents with total scores ranging from 8 to 32 (higher score indicates stronger feeling): "Tension and excitement," "Refreshing mood," "Fatigue," "Depressed mood," and "Anxious mood." Analysis of covariance with Bonferroni's multiple comparison was used to compare mean values among quartiles of hours of mobile phone use.
RESULTS:
Among the respondents, mean mobile phone use per week was 24 (median 18) h. Long-duration mobile phone use was associated with female students, no participation in sports club activities, early mobile phone use, and fewer hours spent sleeping (all $P < 0.001$). Overall associations between hours of mobile phone use and total scores were significant for "Depressed mood" (P for trend = 0.005), "Tension and excitement" (P for trend <0.001), and "Fatigue" (P for trend < 0.001). Total scores for "Depressed mood," "Tension and excitement," and "Fatigue" of the fourth quartile (≥33 h/week) of mobile phone use were significantly higher than for other quartiles (all $P < 0.05$).
CONCLUSIONS:
Increased duration of mobile phone use is associated with unfavorable psychological mood, in particular, a depressed mood. Decreasing mobile phone use may help maintain appropriate mental health in very long-duration users.

50 Khan, 2008, Int J Occup Med Environ Health. 2008;21(4):289-93.
Adverse effects of excessive mobile phone use.
http://www.ncbi.nlm.nih.gov/pubmed/19228576
INTRODUCTION:

Research findings indicate that the use of mobile phones may lead to a number of symptoms such as headache, impaired concentration and memory, and also fatigue.
MATERIALS AND METHODS:
The present study was designed to investigate whether the symptoms of ill health reported by young people may be associated with the use of mobile phone (MP) and to analyze its influence on health and development of medical students. The questionnaire was designed specifically for this study and contained items regarding health condition and health complaints as well as the frequency of MP use. The response rate was 86.6% (286 of 330 forms, completed by 73.77% males and 26.22% females).
RESULTS:
Most of the subjects (83.57%) had some knowledge about the adverse effects of MP use. 76.92% of the students carried one mobile, and 23.08% more than one. 55.94%, of the subjects reported the average daily MP use of less than 30 min, 27.97%, of 30-60 min, 11.53%, of 60-90 min and 4.54% of more than 90 min. 16.08% of the subjects complained of headache and 24.48% of fatigue. **Impaired concentration was reported by 34.27% of respondents, memory disturbances by 40.56%, sleeplessness by 38.8%, hearing problems by 23.07%, and facial dermatitis by 16.78%. The sensation of warmth within the auricle and behind/around the ear was reported by 28.32%. Out of 286 subjects who participated in this study, 44.4% related their symptoms to mobile phone use.**
CONCLUSIONS:
The findings of the present study indicate that mobile phones play a large part in the daily life of medical students. Therefore, its impact on psychology and health should be discussed among the students to prevent the harmful effects of mobile phone use.
[Exposure: mobile phone (frequency unspecified); daily mobile phone use <30, 30-60, 60-90 and >90 min/day; SAR unspecified]

51 Khorseva et al, 2011, Radiats Biol Radioecol. 2011 Sep-Oct;51(5):617-23.
Psychophysiological indicators for children using mobile phones. Communication 2. Results of four-year monitoring
http://www.ncbi.nlm.nih.gov/pubmed/22279774
This study submits the results of a four-year monitoring of a complex diagnostics of the psychophysiological indicators for 196 children aged 7 to 12 years old: 147 of them are child users of mobile communication (test group) and 49 are in the control group. **We have identified the following major trends of the psychophysiological indicators for child users of mobile communication: an increased number of phonemic perception disorders, abatement of efficiency, reduced indicators for the arbitrary and semantic memory, an increased fatigue. A steady decline of the parameters from high values to bottom standards has been found.**

52 Khullar et al, 2013, Indian J Otolaryngol Head Neck Surg. 2013 Dec;65(Suppl 3):645-9
Auditory Brainstem Responses and EMFs Generated by Mobile Phones.
http://www.ncbi.nlm.nih.gov/pubmed/24427730?dopt=Abstract
There has been a manifold increase in the number of mobile phone users throughout the world with the current number of users exceeding 2 billion. However this advancement in technology like many others is accompanied by a progressive increase in the frequency and intensity of electromagnetic waves without consideration of the health consequences. The aim of our study was to advance our understanding of the potential adverse effects of GSM mobile phones on auditory brainstem responses (ABRs). 60 subjects were selected for the study and divided into three groups of 20 each based on their usage of mobile phones. Their ABRs were recorded and analysed for latency of waves I-V as well as interpeak latencies I-III, I-V and III-V (in ms). Results revealed no significant difference in the ABR parameters between group A (control group) and group B (subjects using mobile phones for maximum 30 min/day for 5 years). **However the latency of waves was significantly prolonged in group C (subjects using mobile phones for 10 years for a maximum of 30 min/day)** as compared to the control group. **Based on our findings we concluded that long term exposure to mobile phones may affect conduction in the peripheral portion of the auditory pathway.** However more research needs to be done to study the long term effects of mobile phones particularly of newer technologies like smart phones and 3G.
[Exposure: mobile phone RF (unspecified frequency)]

53 Küçer & Pamukçu, 2014, Electromagn Biol Med. 2014 Jan;33(1):15-7.
Self-reported symptoms associated with exposure to electromagnetic fields: a questionnaire study.
http://www.ncbi.nlm.nih.gov/pubmed/23730819
In the last years, it has been discussed frequently whether there are any harmful effects of electromagnetic fields on human health. Electromagnetic fields are generated by several natural and man-made sources. Part of the electromagnetic spectrum called Radiofrequency is used in communication systems such as mobile (cellular) phone and

computer. The aim of our study was to explore different self-reported symptoms that may be associated with exposure to electromagnetic fields. This survey study was conducted, using a questionnaire, on 350 people aged +9 years in Turkey. The chi-square test was used for data analysis. **Self-reported symptoms were headache, vertigo/dizziness, fatigue, forgetfulness, sleep disturbance-insomnia, tension-anxiety, joint and bone pain, lacrimation of the eyes, hearing loss and tinnitus.** As a result of the survey, the study has shown that **users of mobile phone and computer more often complained of headache, joint and bone pain, hearing loss, vertigo/dizziness, tension-anxiety symptoms according to time of daily usage ($p < 0.05$). In users of mobile phone and computer, women significantly ($p < 0.05$) complained more often of headache, vertigo/dizziness, fatigue, forgetfulness and tension-anxiety than men.**

54 Lowden et al, 2011, Bioelectromagnetics. 2011 Jan;32(1):4-14.
Sleep after mobile phone exposure in subjects with mobile phone-related symptoms.
http://www.ncbi.nlm.nih.gov/pubmed/20857453
http://www.emf-portal.de/viewer.php?aid=18633&l=e
Several studies show increases in activity for certain frequency bands (10-14 Hz) and visually scored parameters during sleep after exposure to radiofrequency electromagnetic fields. A shortened REM latency has also been reported. We investigated the effects of a double-blind radiofrequency exposure (884 MHz, GSM signaling standard including non-DTX and DTX mode, time-averaged 10 g psSAR of 1.4 W/kg) on self-evaluated sleepiness and objective EEG measures during sleep. Forty-eight subjects (mean age 28 years) underwent 3 h of controlled exposure (7:30-10:30 PM; active or sham) prior to sleep, followed by a full-night polysomnographic recording in a sleep laboratory. The results demonstrated that following exposure, time **in Stages 3 and 4 sleep (SWS, slow-wave sleep) decreased by 9.5 min (12%) out of a total of 78.6 min, and time in Stage 2 sleep increased by 8.3 min (4%) out of a total of 196.3 min compared to sham. The latency to Stage 3 sleep was also prolonged by 4.8 min after exposure. Power density analysis indicated an enhanced activation in the frequency ranges 0.5-1.5 and 5.75-10.5 Hz during the first 30 min of Stage 2 sleep, with 7.5-11.75 Hz being elevated within the first hour of Stage 2 sleep, and bands 4.75-8.25 Hz elevated during the second hour of Stage 2 sleep**. No pronounced power changes were observed in SWS or for the third hour of scored Stage 2 sleep. No differences were found between controls and subjects with prior complaints of mobile phone-related symptoms. The results confirm previous findings that **RF exposure increased the EEG alpha range in the sleep EEG, and indicated moderate impairment of SWS (slow-wave sleep).** Furthermore, reported differences in sensitivity to mobile phone use were not reflected in sleep parameters.
[Exposure: 884 MHz (amplitude modulation pulsed); continuous for 3 hr; SAR 1.4 W/kg average over time (10g), 1.95 W/kg peak value (10g) during non-GSM-DTX mode, 1.8 W/kg peak value (1g) gray matter, 0.2 W/kg spatial average (1g) gray matter, 0.18 W/kg spatial average (1g) thalamus]

55 Maby E et al, 2006, Conf Proc IEEE Eng Med Biol Soc. 2006;1:3751-4.
Short-term effects of GSM mobile phones on spectral components of the human electroencephalogram
http://www.ncbi.nlm.nih.gov/pubmed/17946579
The aim of the study was to investigate whether the GSM (global system for mobile) signals affect the electrical activity of the human brain. Nine healthy subjects and six temporal epileptic patients were exposed to radiofrequencies emitted by a GSM mobile phone signals. Electroencephalographic (EEG) signals were recorded using surface electrodes with and without radiofrequency. In order to obtain a reference, a control session was also carried out. The spectral attributes of the EEG signals recorded by surface electrodes were analyzed. The significant decrease of spectral correlation coefficients under radiofrequency influence **showed that the GSM signal altered the spectral arrangement of the EEG activity for healthy subjects as well as epileptic patients**. For the healthy subjects, the EEG spectral energy decreased on the studied frequency band [0-40 Hz] and more precisely on occipital electrodes for the alpha-band. For the epileptic patients, these modifications were demonstrated by an increase of the power spectral density of the EEG signal. Nevertheless, these biological effects on the EEG are not sufficient to put forward some electrophysiological hypothesis.
[Exposure: mobile phone 900 MHz (pulsed)]

56 Maier et al, 2004, Acta Neurol Scand. 2004 Jul;110(1):46-52.
Effects of pulsed electromagnetic fields on cognitive processes - a pilot study on pulsed field interference with cognitive regeneration.
http://www.ncbi.nlm.nih.gov/pubmed/15180806
BACKGROUND:
Due to the ubiquitous use of cellular phones much has been speculated on secondary effects of electromagnetic irradiation emitted by those. Additionally, several studies have reported vegetative alterations as well as effects on the

neuronal and molecular levels in humans. Here, using a psycho-physiological test paradigm, we examined effects of exposure to pulsed electromagnetic fields on cognitive performance.
MATERIALS AND METHODS:
In 11 volunteers, we tested cognitive processing under field exposure (GSM standard) and under field-free conditions. To examine the hypothesized effect of pulsed fields, we applied an auditory discrimination task and determined the participant's current 'Order Threshold' value. Following a first test cycle, the volunteers had to relax for 50 min while being, or not, exposed to pulsed electromagnetic fields. Subsequently, the test was repeated. Data acquired before and after the resting phase were compared from both experimental conditions.
RESULTS:
We found that nine of the 11 test participants (81.8%) showed worse results in their auditory discrimination performance upon field exposure as compared with control conditions. Group data comparison revealed a statistical significance of P = 0.0105.
CONCLUSION:
We could show that the participants' cognitive performance was impaired after exposure to pulsed electromagnetic fields. With regard to this finding, we recommend that the use of cellular phones should be restricted generally and in particular in respect of physical hazard of high-risk groups, e.g. elderly, children and ill people.
[Exposure: mobile phone 902 MHz (pulsed); continuous for 50 min; power flux density 1 mW/m² (manufacturer's information, distance unspecified)]

57 Mortazavi et al, 2011, Iran J Med Sci. 2011 Jun;36(2):96-103.
The pattern of mobile phone use and prevalence of self-reported symptoms in elementary and junior high school students in Shiraz, Iran.
http://www.ncbi.nlm.nih.gov/pubmed/23358105
BACKGROUND:
The use of mobile phone by children is increasing drastically. Children are likely to accumulate many years of exposure during their lives. Furthermore, as nervous systems in children are developing, children may be at a greater risk compared to adults. In this light, some scientists have suggested that the use of mobile phones should be restricted in high-risk groups such as children. This study is an attempt to explore the pattern of mobile phone use and its health effects among students from the city of Shiraz, Iran.
METHODS:
A total of 469 (235 males and 234 females; 250 elementary and 219 junior high school) healthy students participated in this study. The students were randomly selected from three different educational districts of the city. For each student, a questionnaire regarding the possible sources of exposure to electromagnetic fields or microwave radiation, specially the pattern of mobile phone use, medical history and life style was filled out by interviewers.
RESULTS:
Only 31.42% of the students used to use mobile phones. The average daily time of using mobile phones in talk mode was 7.08±21.42 minutes. Not only the relative frequency of mobile phone ownership in boys was significantly more than the girls, but also the boys used their mobile phones more frequently. **Statistically significant associations were found between the time mobile phones were used in talk mode and some symptoms. Furthermore, a statistically significant association was found between the time mobile phones were used in talk mode and the number of headaches per month, number of vertigo per month, or number of sleeping problem per month.**
CONCLUSION:
Results obtained in this study show that a large proportion of children in the city of Shiraz use mobile phones. **A significant increase was found in some self-reported symptoms among users of mobile phones. These findings are in line with what is widely believed regarding the higher vulnerability of children to exhibit symptoms from using mobile phones.** The findings and conclusion of the present study should be viewed in the light the nature of symptoms measurement (self-report) and the knowledge and understandings of the participants about the symptoms.

58 Munezawa et al, 2011, Sleep. 2011 Aug 1;34(8):1013-20.
The association between use of mobile phones after lights out and sleep disturbances among Japanese adolescents: a nationwide cross-sectional survey.
http://www.ncbi.nlm.nih.gov/pubmed/21804663
STUDY OBJECTIVE:
The objective of this study was to examine the association between the use of mobile phones after lights out and sleep disturbances among Japanese adolescents.
DESIGN AND SETTING:

This study was designed as a cross-sectional survey. The targets were students attending junior and senior high schools throughout Japan. Sample schools were selected by cluster sampling. Self-reported anonymous questionnaires were sent to schools for all students to fill out.
PARTICIPANTS:
A total of 95,680 adolescents responded. The overall response rate was 62.9%, and 94,777 questionnaires were subjected to analysis.
INTERVENTION:
N/A.
MEASUREMENTS AND RESULTS:
Daily mobile phone use, even if only for a brief moment every day, was reported by 84.4%. Moreover, as for use of mobile phones after lights out, 8.3% reported using their mobile phone for calling every day and 17.6% reported using it for sending text messages every day. **Multiple logistic regression analysis showed that mobile phone use for calling and for sending text messages after lights out was associated with sleep disturbances (short sleep duration, subjective poor sleep quality, excessive daytime sleepiness, and insomnia symptoms) independent of covariates and independent of each other.**
CONCLUSION:
This study showed that the use of mobile phones for calling and for sending text messages after lights out is associated with sleep disturbances among Japanese adolescents. However, there were some limitations, such as small effect sizes, in this study. More studies that examine the details of this association are necessary to establish strategies for sleep hygiene in the future.

59 Oftedal et al, 2000, Occup Med (Lond). 2000 May;50(4):237-45.
Symptoms experienced in connection with mobile phone use.
http://www.ncbi.nlm.nih.gov/pubmed/10912374
Many people in Norway and Sweden reported headaches, fatigue, and other symptoms experienced in connection with the use of a mobile phone (MP). Therefore, we initiated a cross-sectional epidemiological study among 17,000 people, all using an MP in their job. Thirty-one percent of the respondents in Norway and 13% of those in Sweden had experienced at least one symptom in connection with MP use. **Next to the sensations of warmth on the ear and behind/around the ear, burning sensations in the facial skin and headaches were most commonly reported. Most symptoms usually began during or within half an hour after the call and lasted for up to 2 h.** Relatively few had consulted a physician or been on sick leave because of the symptoms, **but about 45% among those with an MP attributed symptom had taken steps to reduce the symptom.** These results suggest an awareness of the symptoms, but not necessarily a serious health problem.

60 Oktay & Dasdag, 2006, Electromagn Biol Med. 2006;25(1):13-21.
Effects of intensive and moderate cellular phone use on hearing function.
http://www.ncbi.nlm.nih.gov/pubmed/16595330
The purpose of this study is to investigate the effects of radiation emitted by mobile phones on the hearing of users. The study was carried out on three groups: 1) 20 men who have used a cellular phone frequently and spoken approximately 2 h per day for four years; 2) 20 men who have used a cellular phone for 10-20 min per day for four years; and 3) 20 healthy men who have never used a cellular phone (the control group). Brainstem evoked response audiometric (BERA) and pure tone audiometric (PTA) methods were used to measure the effects of exposure on hearing function of the subjects. In BERA measurements, I-III, III-V, and I-V interpeak latencies were evaluated. Interpeak latency of subjects in two experimental groups was compared to that of subjects in the control group. The BERA results showed no differences among the groups ($p > 0.05$). In PTA measurements, detection thresholds at 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, and 8000 Hz frequencies were measured in all three groups. No differences were observed between moderate mobile phone users (10-20 min. per day) and control subjects. However, **detection thresholds in those who talked approximately 2 h per day were found to be higher than those in either moderate users or control subjects.** Differences at 4000 Hz for both bone and air conduction for right ears, and 500 Hz, and 4000 Hz bone and air conduction for left ears were significant for mean hearing threshold. **This study shows that a higher degree of hearing loss is associated with long-term exposure to electromagnetic (EM) field generated by cellular phones.**

61 Redmayne et al, 2013, Environ Health. 2013 Oct 22;12(1):90.
The relationship between adolescents' well-being and their wireless phone use: a cross-sectional study.
http://www.ncbi.nlm.nih.gov/pubmed/24148357

The exposure of young people to radiofrequency electromagnetic fields (RF-EMFs) has increased rapidly in recent years with their increased use of cellphones and use of cordless phones and WiFi. We sought to ascertain associations between New Zealand early-adolescents' subjective well-being and self-reported use of, or exposure to, wireless telephone and internet technology.
METHODS:
In this cross-sectional survey, participants completed questionnaires in class about their cellphone and cordless phone use, their self-reported well-being, and possible confounding information such as whether they had had influenza recently or had a television in the bedroom. Parental questionnaires provided data on whether they had WiFi at home and cordless phone ownership and model. Data were analysed with Ordinal Logistic Regression adjusting for common confounders. Odds ratios (OR) and 95% confidence intervals were calculated.
RESULTS:
The number and duration of cellphone and cordless phone calls were associated with **increased risk of headaches** (>6 cellphone calls over 10 minutes weekly, adjusted OR 2.4, CI 1.2-4.8; >15 minutes cordless use daily adjusted OR 1.74, CI 1.1-2.9)). Texting and extended use of wireless phones was related to having a **painful 'texting' thumb**). Using a wired cellphone headset was associated with **tinnitus** (adjusted OR 1.8, CI 1.0-3.3), while wireless headsets were associated with **headache** (adjusted OR 2.2, CI 1.1-4.5), **feeling down/depressed** (adjusted OR 2.0, CI 1.1-3.8), and **waking in the night** (adjusted OR 2.4, CI 1.2-4.8). Several cordless phone frequencies bands were related to **tinnitus, feeling down/depressed and sleepiness** at school, while the last of these was also related to modulation. Waking nightly was less likely for those with WiFi at home (adjusted OR 0.7, CI 0.4-0.99). Being woken at night by a cellphone was strongly related to tiredness at school (OR 4.1, CI 2.2-7.7).
CONCLUSIONS:
There were more statistically significant associations (36%) than could be expected by chance (5%). Several were dose-dependent relationships. To safeguard young people's well-being, we suggest limiting their use of cellphones and cordless phones to less than 15 minutes daily, and employing a speaker-phone device for longer daily use. We recommend parental measures are taken to prevent young people being woken by their cellphones.

62 Regel et al, 2007, J Sleep Res. 2007 Sep;16(3):253-8.
Pulsed radio-frequency electromagnetic fields: dose-dependent effects on sleep, the sleep EEG and cognitive performance.
http://www.ncbi.nlm.nih.gov/pubmed/17716273
To establish a dose-response relationship between the strength of electromagnetic fields (EMF) and previously reported effects on the brain, we investigated the influence of EMF exposure by varying the signal intensity in three experimental sessions. The head of 15 healthy male subjects was unilaterally exposed for 30 min prior to sleep to a pulse-modulated EMF (GSM handset like signal) with a 10 g-averaged peak spatial specific absorption rate of (1) 0.2 W kg(-1), (2) 5 W kg(-1), or (3) sham exposed in a double-blind, crossover design. During exposure, subjects performed two series of three computerized cognitive tasks, each presented in a fixed order [simple reaction time task, two-choice reaction time task (CRT), 1-, 2-, 3-back task]. Immediately after exposure, night-time sleep was polysomnographically recorded for 8 h. Sleep architecture was not affected by EMF exposure. **Analysis of the sleep electroencephalogram (EEG) revealed a dose-dependent increase of power in the spindle frequency range in non-REM sleep. Reaction speed decelerated with increasing field intensity in the 1-back task, while accuracy in the CRT and N-back task were not affected in a dose-dependent manner. In summary, this study reveals first indications of a dose-response relationship between EMF field intensity and its effects on brain physiology as demonstrated by changes in the sleep EEG and in cognitive performance.**
[Exposure: 900 MHz (pulsed); continuous for 30 min; SAR 0.2 and 5 W/kg average over mass (10g)]

63 Salama et al, 2004, J Egypt Public Health Assoc. 2004;79(3-4):197-223.
Cellular phones: are they detrimental?
http://www.ncbi.nlm.nih.gov/pubmed/16918147
The issue of possible health effects of cellular phones is very much alive in the public's mind where the rapid increase in the number of the users of cell phones in the last decade has increased the exposure of people to the electromagnetic fields (EMFs). Health consequences of long term use of mobile phones are not known in detail but available data indicates the development of non specific annoying symptoms on acute exposure to mobile phone radiations. In an attempt to determine the prevalence of such cell phones associated health manifestations and the factors affecting their occurrence, a cross sectional study was conducted in five randomly selected faculties of Alexandria University. Where, 300 individuals including teaching staff, students and literate employee were equally allocated and randomly selected among the five faculties. Data about mobile phone's users and their medical history, their pattern of mobile usage and the possible deleterious health manifestations associated with cellular phone use was collected. **The results**

revealed 68% prevalence of mobile phone usage, nearly three quarters of them (72.5%) were complainers of the health manifestations. They suffered from headache (43%), earache (38.3%), sense of fatigue (31.6%), sleep disturbance (29.5%), concentration difficulty (28.5%) and face burning sensation (19.2%). Both univariate and multivariate analysis were consistent in their findings. Symptomatic users were found to have significantly higher frequency of calls/day, longer call duration and longer total duration of mobile phone usage/day than non symptomatic users. **For headache both call duration and frequency of calls/day were the significant predicting factors for its occurrence (chi2 = 18.208, p = 0.0001). For earache, in addition to call duration, the longer period of owning the mobile phone were significant predictors** (chi2 = 16.996, p = 0.0002). Sense of fatigue was significantly affected by both call duration and age of the user (chi2 = 24.214, p = 0.0000), while burning sensation was only affected by frequency of calls/day (chi2 = 5.360, p = 0.020). According to the 95% confidence interval of frequency and duration of calls, **the study recommended not to increase the call duration more than four minutes and limit their frequency to less than seven calls/day with total duration of exposure less than 22 min./day.**

64 Santini et al,2001, Pathol Biol (Paris). 2001 Apr;49(3):222-6.
Symptoms reported by mobile cellular telephone users. [Article in French]
http://www.ncbi.nlm.nih.gov/pubmed/11367556
A survey study, using questionnaire, was conducted in 161 students and workers in a French engineering school on symptoms experienced during use of digital cellular phones. **A significant increase in concentration difficulty ($p < 0.05$) was reported by users of 1800-MHz (DCS) cellular phones compared to 900-MHz (GSM) phone users. In users of cellular phones, women significantly ($p < 0.05$) complained more often of sleep disturbance than men. This sex difference for sleep complaint is not observed between women and men non-users of cellular phone. The use of both cellular phones and VDT significantly ($p < 0.05$) increased concentration difficulty. Digital cellular phone users also significantly ($p < 0.05$) more often complained of discomfort, warmth, and picking on the ear during phone conversation in relation with calling duration per day and number of calls per day. The complaint of warmth on the ear might be a signal to users for stopping the call.**

65 Schmid et al, 2012, J Sleep Res. 2012 Feb;21(1):50-8.
Sleep EEG alterations: effects of different pulse-modulated radio frequency electromagnetic fields.
http://www.ncbi.nlm.nih.gov/pubmed/21489004
http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2869.2011.00918.x/pdf (full paper)
Previous studies have observed increases in electroencephalographic power during sleep in the spindle frequency range (approximately 11-15 Hz) after exposure to mobile phone-like radio frequency electromagnetic fields (RF EMF). Results also suggest that pulse modulation of the signal is crucial to induce these effects. Nevertheless, it remains unclear which specific elements of the field are responsible for the observed changes. We investigated whether pulse-modulation frequency components in the range of sleep spindles may be involved in mediating these effects. Thirty young healthy men were exposed, at weekly intervals, to three different conditions for 30 min directly prior to an 8-h sleep period. Exposure consisted of a 900-MHz RF EMF, pulse modulated at 14Hz, and a sham control condition. Both active conditions had a peak spatial specific absorption rate of 2 W kg(-1) . During exposure subjects performed three different cognitive tasks (measuring attention, reaction speed and working memory), which were presented in a fixed order. **Electroencephalographic power in the spindle frequency range was increased during non-rapid eye movement sleep (2nd episode) following the 14-Hz pulse-modulated condition. A similar but non-significant increase was also observed following the 217-Hz pulse-modulated condition. Importantly, this exposure-induced effect showed considerable individual variability.** Regarding cognitive performance, no clear exposure-related effects were seen**. Consistent with previous findings, our results provide further evidence that pulse-modulated RF EMF alter brain physiology**, although the time-course of the effect remains variable across studies. **Additionally, we demonstrated that modulation frequency components within a physiological range may be sufficient to induce these effects.**
[Exposure: 900 MHz (pulsed); continuous for 30 min; SAR 2 W/kg peak value (10g)]

66 Söderqvist et al, 2008, Environ Health. 2008 May 21;7:18. doi: 10.1186/1476-069X-7-18.
Use of wireless telephones and self-reported health symptoms: a population-based study among Swedish adolescents aged 15-19 years.
http://www.ncbi.nlm.nih.gov/pubmed/18495003
RESULTS:
The questionnaire was answered by 63.5% of the study subjects. Most participants reported access to a mobile phone (99.6%) and use increased with age; 55.6% of the 15-year-olds and 82.2% of the 19-year-olds were regular users. Girls generally reported more frequent use than boys. Use of wired hands-free equipment 'anytime' was reported by 17.4%.

Cordless phones were used by 81.9%, and 67.3% were regular users. Watching TV increased the odds ratio for use of wireless phones, adjusted for age and gender. Some of the most frequently reported health complaints were **tiredness, stress, headache, anxiety, concentration difficulties and sleep disturbances. Regular users of wireless phones had health symptoms more often and reported poorer perceived health than less frequent users.**
CONCLUSION:
Almost all adolescence in this study used a wireless phone, girls more than boys. The most frequent use was seen among the older adolescents, and those who watched TV extensively. The study further showed that perceived health and **certain health symptoms seemed to be related to the use of wireless phones**. However, this part of the investigation was explorative and should therefore be interpreted with caution since bias and chance findings due to multiple testing might have influenced the results. Potentially this study will stimulate more sophisticated studies that may also investigate directions of associations and whether, or to what degree, any mediation factors are involved.

67 Szyjkowska et al, 2014, Int J Occup Med Environ Health. 2014 Apr;27(2):293-303.
The risk of subjective symptoms in mobile phone users in Poland--an epidemiological study.
http://www.ncbi.nlm.nih.gov/pubmed/24692074
OBJECTIVES:
To assess the type and incidence of subjective symptoms related to the use of mobile phones in Polish users.
MATERIAL AND METHODS:
The study was conducted in 2005 using a questionnaire survey. Although it has been quite a long time, up to now, no such data have been published for Poland. The questionnaire consisted of 53 questions concerning sex, age, education, general health, characteristics of a mobile phone (hand-held, loud-speaking unit) as well as the habits associated with its use (frequency and duration of calls, text messages, etc.) and complaints associated with using a mobile phone.
RESULTS:
As many as 1800 questionnaires were sent. The response was obtained from 587 subjects aged 32.6 ± 11.3 (48.9% women, 51.1% men); the age did not differ significantly between men and women. The subjects owned a cell phone for an average of 3 years. Majority of the respondents used the phone intensively, i.e. daily (74%) or almost daily (20%). **Headaches were reported significantly more often by the people who talked frequently and long in comparison with other users (63.2% of the subjects, p = 0.0029), just like the symptoms of fatigue (45%, p = 0.013). Also, the feeling of warmth around the ear and directly to the auricle was reported significantly more frequently by the intensive mobile phone users, compared with other mobile phone users (47.3%, p = 0.00004 vs. 44.6%, p = 0.00063, respectively). Most symptoms appeared during or immediately after a call and disappeared within 2 h after the call. Continuous headache, persisting for longer than 6 h since the end of a call, was reported by 26% of the subjects.**
CONCLUSIONS:
Our results show that the mobile phone users may experience subjective symptoms, the intensity of which depends on the intensity of use of mobile phones.

68 Szyjkowska et al, 2005, Pol Merkur Lekarski. 2005 Oct;19(112):529-32.
Subjective symptoms related to mobile phone use--a pilot study. [Article in Polish]
http://www.ncbi.nlm.nih.gov/pubmed/16379318
Research findings indicate that the use of mobile phones may lead to a number of symptoms such as headache, impaired concentration and memory, fatigue. In Poland this problem has not as yet been addressed by scientific studies.
THE AIM:
The present project was undertaken to investigate whether the symptoms of ill health reported by young people may be associated with the use of mobile phone.
MATERIAL AND METHODS:
A survey using a self-reported questionnaire was conducted among randomly selected university students in Lodz, Central Poland. The questionnaire was designed specifically for this study and contained items on health condition and complaints as well as on frequency of mobile phone use. The number of questionnaires necessary for the study was assessed using the simple random sample method. Out of the 160 copies distributed among the students, 140 (87.5%) were completed. Eventually, 117 questionnaires were subject to analysis; the data from respondents who reported health problems (neck trauma in a car accident, chronic sinusitis and arterial hypertension) were excluded. The following statistical methods were used to analyse questionnaire data: t-Student test for equal and unequal variances or F-Snedecor test for comparing parameters in two study groups, Fisher exact test for comparing frequency, and single and multiple logistic regression models for quantitative risk assessment of negative health outcomes in relation to exposure level and with control for confounders. The subjects were 61 (52.1%) males and 56 females (47.9%).
RESULTS:

Most of the subjects (62%) assessed their health condition as good, 31% as very good and 7% as fair. 70% complained of headache and 20% of dizziness. Impaired concentration occurred in 56% of respondents. Facial dermatitis was reported by 11%. The most prevalent symptom related to mobile phone use was the thermal sensation within the auricle and behind/around the ear. This was reported by 33 subjects (28.2%). Out of 82 subjects who complained of headache, only 8 (6.8%) related this symptom to mobile phone use. **Only 10 subjects of 65 reporting impaired concentration thought it could be associated with their using a mobile phone.** The symptoms and health complaints reported by the respondents in no case were the reason for a medical check-up or taking any medication.
CONCLUSIONS:
The large number of young people complaining of headache and impaired concentration calls for further research to investigate the underlying reasons. It cannot be excluded that one of them may be exposure to EMF emitted by mobile phone. The explanation should be sought through further experimental and epidemiologic studies.

69 Vecchio et al, 2010, Clin Neurophysiol. 2010 Feb;121(2):163-71.
Mobile phone emission modulates inter-hemispheric functional coupling of EEG alpha rhythms in elderly compared to young subjects.
http://www.ncbi.nlm.nih.gov/pubmed/20005167
OBJECTIVE:
It has been reported that GSM electromagnetic fields (GSM-EMFs) of mobile phones modulate--after a prolonged exposure--inter-hemispheric synchronization of temporal and frontal resting electroencephalographic (EEG) rhythms in normal young subjects [Vecchio et al., 2007]. Here we tested the hypothesis that this effect can vary on physiological aging as a sign of changes in the functional organization of cortical neural synchronization.
METHODS:
Eyes-closed resting EEG data were recorded in 16 healthy elderly subjects and 5 young subjects in the two conditions of the previous reference study. The GSM device was turned on (45 min) in one condition and was turned off (45 min) in the other condition. Spectral coherence evaluated the inter-hemispheric synchronization of EEG rhythms at the following bands: delta (about 2-4 Hz), theta (about 4-6 Hz), alpha 1 (about 6-8 Hz), alpha 2 (about 8-10 Hz), and alpha 3 (about 10-12 Hz). The aging effects were investigated comparing the inter-hemispheric EEG coherence in the elderly subjects vs. a young group formed by 15 young subjects (10 young subjects of the reference study; Vecchio et al., 2007).
RESULTS:
Compared with the young subjects, the elderly subjects showed a statistically significant ($p<0.001$) increment of the inter-hemispheric coherence of frontal and temporal alpha rhythms (about 8-12 Hz) during the GSM condition.
CONCLUSIONS:
These results suggest that GSM-EMFs of a mobile phone affect inter-hemispheric synchronization of the dominant (alpha) EEG rhythms as a function of the physiological aging.
SIGNIFICANCE:
This study provides further evidence that physiological aging is related to changes in the functional organization of cortical neural synchronization.
[Exposure: mobile phone 902.4 MHz (pulsed); continuous for 45 min; SAR 0.5 W/kg max value (brain)]

EHS GENERAL POPULATION SIGNS & SYMPTOMS – RADIO/TV BROADCASTING TRANSMITTER EFFECTS:

70 Abelin et al, 2005, Somnologie (Somnology) 2005; 9 (4): 203 - 209
Sleep Disturbances in the Vicinity of the Short-Wave Broadcast Transmitter Schwarzenburg.
http://www.emf-portal.de/viewer.php?aid=13159&l=e
Results/conclusion (according to author)
The prevalence of difficulties of falling asleep and maintaining sleep increased with increasing radiofrequency electromagnetic field exposure in both cross-sectional studies. **Sleep quality improved aftertransmitter shut-down.** No chronic change of melatonin excretion was observed.
The authors concluded that the results of the studies give strong evidence of a causal relationship between the operation of a short-wave broadcast transmitter and sleep disturbances in the surrounding population, but there is insufficient evidence to distinguish between a biological and psychological effect.

71 Altpeter et al, 2006, Bioelectromagnetics. 2006 Feb;27(2):142-50.

Effect of short-wave (6-22 MHz) magnetic fields on sleep quality and melatonin cycle in humans: the Schwarzenburg shut-down study.
http://www.ncbi.nlm.nih.gov/pubmed/16342198
This paper describes the results of a unique "natural experiment" of the operation and cessation of a broadcast transmitter with its short-wave electromagnetic fields (6-22 MHz) on sleep quality and melatonin cycle in a general human population sample. In 1998, 54 volunteers (21 men, 33 women) were followed for 1 week each before and after shut-down of the short-wave radio transmitter at Schwarzenburg (Switzerland). Salivary melatonin was sampled five times a day and total daily excretion and acrophase were estimated using complex cosinor analysis. Sleep quality was recorded daily using a visual analogue scale. **Before shut down, self-rated sleep quality was reduced by 3.9 units (95% CI: 1.7-6.0) per mA/m increase in magnetic field exposure. The corresponding decrease in melatonin excretion was 10% (95% CI: -32 to 20%). After shutdown, sleep quality improved by 1.7 units (95% CI: 0.1-3.4) per mA/m decrease in magnetic field exposure. Melatonin excretion increased by 15% (95% CI: -3 to 36%) compared to baseline values suggesting a rebound effect.** Stratified analyses showed an exposure effect on melatonin excretion in poor sleepers (26% increase; 95% CI: 8-47%) but not in good sleepers. **Change in sleep quality and melatonin excretion was related to the extent of magnetic field reduction after the transmitter's shut down in poor but not good sleepers.** However, blinding of exposure was not possible in this observational study and this may have affected the outcome measurements in a direct or indirect (psychological) way.
[Exposure: 6.1-21.8 MHz amplitude modulation; continuous, studied for 4 days before shut-down; 0.4 and 2.6 mA/m mean value]

72 Kolodynski et al, 1996**,** Sci Total Environ. 1996 Feb 2;180(1):87-93.
Motor and psychological functions of school children living in the area of the Skrunda Radio Location Station in Latvia.
http://www.ncbi.nlm.nih.gov/pubmed/8717320
This paper presents the results of experiments on school children living in the area of the Skrunda Radio Location Station (RLS) in Latvia. **Motor function, memory and attention significantly differed between the exposed and control groups. Children living in front of the RLS had less developed memory and attention, their reaction time was slower and their neuromuscular apparatus endurance was decreased.**

73 Nieto-Hernandez et al, 2011, Occup Environ Med. 2011 May;68(5):339-44
Can exposure to a terrestrial trunked radio (TETRA)-like signal cause symptoms? A randomised double-blind provocation study.
http://www.ncbi.nlm.nih.gov/pubmed/20864469
OBJECTIVES:
Concerns have been raised about possible health effects from radiofrequency fields pulsing at around 16 Hz. A radio system used by UK police (TETRA) employs signals which pulse at 17.6 Hz. We tested whether exposure to a continuous wave signal at 385.25 MHz or a TETRA-like signal resulted in symptoms among users reporting sensitivity to TETRA compared to users not reporting sensitivity to TETRA.
METHODS:
60 sensitive and 60 non-sensitive users were exposed to three 50 min conditions: a signal with a 16 Hz component, a continuous wave condition and a sham condition. The mean radiated power for the 16 Hz and continuous wave conditions was 250 mW. The order of conditions was randomised and testing was conducted double-blind. Participants reported the severity of eight symptoms during and after each exposure, their mood state at the end of each exposure, and whether they could tell which sessions involved active signals. The study was registered in advance with the ISRCTN register.
RESULTS:
Exposure to the continuous wave signal increased ratings of headache in all participants, fatigue in non-sensitive participants and difficulty concentrating in sensitive participants. Paradoxically, it reduced sensations of itching in sensitive participants. These effects were not observed in the condition with 16 Hz pulsing, except for those relating to concentration. Adjusting for multiple comparisons removed most significant effects, but not those relating to itch.
CONCLUSIONS:
The results suggested that exposure to TETRA signals is not responsible for symptoms reported by some users, although exposure to a continuous wave signal may affect symptoms. Clinical trial number ISRCTN 73321766.
[Exposure: 385.25 MHz; continuous for 50 min; SAR 1.3 W/kg max valu (10g) (close to antenna), 0.3 W/kg average over mass (10g) (from the handset]

74 Vangelova K et al, 2006, Int J Hyg Environ Health. 209(2):133-138, 2006

Cardiovascular risk in operators under radiofrequency electromagnetic radiation.
http://www.ncbi.nlm.nih.gov/pubmed/16503299
The aim of the study was to assess the long-term effects of radiofrequency electromagnetic radiation (EMR) on the cardiovascular system. Two groups of exposed operators (49 broadcasting (BC) station and 61 TV station operators) and a control group of 110 radiorelay station operators, matched by sex and age, with similar job characteristics except for the radiofrequency EMR were studied. The EMR exposure was assessed and the time-weighted average (TWA) was calculated. The cardiovascular risk factors arterial pressure, lipid profile, body mass index, waist/hip ratio, smoking, and family history of cardiovascular disease were followed. **The systolic and diastolic blood pressure (SBP and DBP), total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C) were significantly higher in the two exposed groups. It was found that the radiofrequency EMR exposure was associated with greater chance of becoming hypertensive and dyslipidemic. The stepwise multiple regression equations showed that the SBP and TWA predicted the high TC and high LDL-C, while the TC, age and abdominal obesity were predictors for high SBP and DBP. In conclusion, our data show that the radiofrequency EMR contributes to adverse effects on the cardiovascular system**.
[Exposure: 6-25 MHz (broadcasting station) and 66-900 MHz (TV station); 20.7 ± 5.5 years and 18.6 ± 8.9 years (average length of service) respectively]

EHS GENERAL POPULATION SIGNS & SYMPTOMS – SMART METER EFFECTS:

75 Quebec Huffington Post, October 2013
A first clinical study documents the harmful effects of smart meters
http://quebec.huffingtonpost.ca/2013/11/25/etude-clinique-sur-les-effets-nocifs-des-compteurs-intelligents_n_4309494.html?utm_hp_ref=canada-quebec&just_reloaded=1
[Author's note: translated using Google Translate].
An Australian family physician has carefully documented 92 cases of patients with symptoms of EHS occurred after the installation of an electricity meter emits radio frequency (RF) pulse.

World first, the case study of Dr. Federica Lamech has not been published by a scientific journal peer-reviewed. According to the American Academy of Environmental Medicine (AAEM), it is nonetheless "scientifically valid" and "clearly shows the harmful effects of smart meters emissions on the health of the human population." International Association founded in 1965, the AAEM includes doctors and other health professionals who are interested in the impact of the environment on health.

The symptoms observed in patients of Dr. Lamech such as fatigue, headaches, heart palpitations or dizziness are correlated with the guidelines of the Austrian Medical Association for the diagnosis and treatment of the fields related health problems electromagnetic (EMC), emphasizes the AAEM. They also could be triggered in the laboratory by EMF exposure under controlled conditions (double-blind, placebo-exposure): neither the patients nor the researchers knew who was exposed or not to EMF.

"The scientific peer-reviewed literature demonstrating the correlation between exposure to EMF / RF and neurological, cardiac and pulmonary diseases and reproductive disorders, immune dysfunction, cancer and other health problems, adds the EMEA. The evidence is irrefutable. "

The organization insists that it is "extremely important" to note that the vast majority of 92 Australian patients were not electrohypersensitive before installing the new generation meter. Dr. Lamech concludes that smart meters "may have unique characteristics that lower development threshold symptoms of people."…

….Often called smart meters, new generation meters transmit utilities information about amounts of electricity, gas or water consumed in buildings. Transmission of this information is wireless, using microwave type of radio frequency (typically at frequencies 900 MHz and 2.4 GHz).

EHS GENERAL POPULATION SIGNS & SYMPTOMS– MRI SCANNERS:

76 Friebe et al, 2014, J Magn Reson Imaging. 2014 Sep 19.
Sensory perceptions of individuals exposed to the static field of a 7T MRI: A controlled blinded study.
http://www.ncbi.nlm.nih.gov/pubmed/25236353

PURPOSE:
To determine the subjective experience of subjects undergoing 7T magnetic resonance imaging (MRI) compared to a mock scanner with no magnetic field.
METHODS AND MATERIALS:
In all, 44 healthy subjects were exposed to both the B0 field of a 7T whole-body MRI and a realistic mock scanner with no magnetic field. Subjects were blinded to the actual field strength and no scanning was performed. After exposure, subjects rated their experience of potential sensory perceptions.
RESULTS:
The most frequently observed side effect was vertigo while entering the gantry, which was reported by 38.6% (n = 17). Other frequent side effects were the appearance of phosphenes (18.2%, n = 8), thermal heat sensation (15.9%), unsteady gait after exposure (13.6%, n = 6), and dizziness (13.6%). All side effects were reported significantly more often after 7T exposure. Nine subjects (20.5%) did not report any sensory perceptions at all, ie, neither in the 7T scanner nor in the mock scanner.
CONCLUSION:
Light, acute, and transient sensory perceptions can occur in subjects undergoing ultrahighfield MRI, of which vertigo seems to be the most frequently reported. Possible psychological effects might contribute to the emergence of such sensory perceptions, as some subjects also reported them to appear in a realistic mock scanner with no magnetic field.

77 Heilmaier et al, 2011, Bioelectromagnetics. 2011 Dec;32(8):610-9
A large-scale study on subjective perception of discomfort during 7 and 1.5T MRI examinations.
http://www.ncbi.nlm.nih.gov/pubmed/21598286
A study on subjective perception has been carried out in order to gain further insight into subjective discomfort and sensations experienced during 7T magnetic resonance imaging (MRI). This study provides information about subjective acceptance, which is essential if 7T MRI is to become a clinical diagnostic tool. Of 573 subjects who underwent T MRI, 166 were also examined at 1.5T, providing a means of discriminating field-dependent discomfort. All subjects judged sources of discomfort and physiological sensations on an 11-point scale (0=no side effects, 10=intolerable side effects) and scores were analyzed separately for exam phases, with and without table movement at each field strength. **Results revealed that 7T MRI was, in general, judged more uncomfortable than 1.5T;** however, most subjects rated the effects as being non-critical (mean scores between 0.5 and 3.5). **Significant differences were detected regarding vertigo and sweating between subjects positioned "head-first" and "feet-first" at 7T (worse in "head-first") and between 7 and 1.5T (worse at 7T), with the effects being more pronounced in the moving compared to the stationary table position. The most unpleasant factor at 7T was the extensive examination duration, while potentially field-dependent sensations were rated less bothersome.** In summary, our study indicates that although certain sensations increase at 7T compared to 1.5T, they are unlikely to hinder the use of 7T MRI as a clinical diagnostic tool.

78 Heinrich et al, 2013, Radiology. 2013 Jan;266(1):236-45.
Cognition and sensation in very high static magnetic fields: a randomized case-crossover study with different field strengths.
http://www.ncbi.nlm.nih.gov/pubmed/23091174
PURPOSE:
To establish the extent to which representative cognitive functions in subjects undergoing magnetic resonance (MR) imaging are acutely impaired by static magnetic fields of varying field strengths.
MATERIALS AND METHODS:
This study was approved by the local ethics committee, and informed consent was obtained from all subjects. In this single-blind case-crossover study, 41 healthy subjects underwent an extensive neuropsychologic examination while in MR units of differing field strengths (1.5, 3.0, and 7.0 T), including a mock imager with no magnetic field as a control condition. Subjects were blinded to field strength. Tests were performed while subjects were lying still in the MR unit and while the examination table was moved. The tests covered a representative set of cognitive functions, such as memory, eye-hand coordination, attention, reaction time, and visual discrimination. Subjective sensory perceptions were also assessed. Effects were analyzed with a repeated-measures analysis of variance; the within-subject factors were field strength (0, 1.5, 3.0, and 7.0 T) and state (static, dynamic).
RESULTS:
Static magnetic fields were not found to have a significant effect on cognitive function at any field strength. **However, sensory perceptions did vary according to field strength. Dizziness, nystagmus, phosphenes, and head ringing were related to the strength of the static magnetic field.**
CONCLUSION:

Static magnetic fields as high as 7.0 T did not have a significant effect on cognition.

79 Heinrich et al, 2011, J Magn Reson Imaging. 2011 Oct;34(4):758-63.
Effects of static magnetic fields on cognition, vital signs, and sensory perception: a meta-analysis.
http://www.ncbi.nlm.nih.gov/pubmed/21751291
To evaluate whether cognitive processes, sensory perception, and vital signs might be influenced by static magnetic fields in magnetic resonance imaging (MRI), which could pose a risk for health personnel and patients, we conducted a meta-analysis of studies that examined effects of static magnetic fields. Studies covering the time from 1992 to 2007 were selected. Cohen's d effects sizes were used and combined in different categories of neuropsychology (reaction time, visual processing, eye-hand coordination, and working memory). Additionally, effects of static magnetic fields on sensory perception and vital signs were analyzed. In the category "neuropsychology," only **effects on the visual system were homogeneous, showing a statistically significant impairment as a result of exposure to static magnetic fields (d = -0.415).** Vital signs were not affected and **effects on sensory perceptions included an increase of dizziness and vertigo, primarily caused by movement during static magnetic field gradient exposures.** The number of studies dealing with this topic is very small and the experimental set-up of some of the analyzed studies makes it difficult to accurately determine the effects of static magnetic fields by themselves, excluding nonspecific factors. The implications of these results for MRI lead to suggestions for improvement in research designs.

80 Mian et al, 2013, PLoS One. 2013 Oct 30;8(10):e78748.
On the vertigo due to static magnetic fields.
http://www.ncbi.nlm.nih.gov/pubmed/24205304
Vertigo is sometimes experienced in and around MRI scanners. Mechanisms involving stimulation of the vestibular system by movement in magnetic fields or magnetic field spatial gradients have been proposed. However, it was recently shown that vestibular-dependent ocular nystagmus is evoked when stationary in homogenous static magnetic fields. **The proposed mechanism involves Lorentz forces acting on endolymph to deflect semicircular canal (SCC) cupulae.** To investigate whether vertigo arises from a similar mechanism we recorded qualitative and quantitative aspects of vertigo and 2D eye movements from supine healthy adults (n=25) deprived of vision while pushed into the 7T static field of an MRI scanner. Exposures were variable and included up to 135s stationary at 7T. Nystagmus was mainly horizontal, persisted during long-exposures with partial decline, and reversed upon withdrawal. The dominant vertiginous perception with the head facing up was rotation in the horizontal plane (85% incidence) with a consistent direction across participants. With the head turned 90 degrees in yaw the perception did not transform into equivalent vertical plane rotation, indicating a context-dependency of the perception. During long exposures, illusory rotation lasted on average 50 s, including 42 s whilst stationary at 7T. Upon withdrawal, perception re-emerged and reversed, lasting on average 30 s. Onset fields for nystagmus and perception were significantly correlated ($p<.05$). Although perception did not persist as long as nystagmus, this is a known feature of continuous SSC stimulation. **These observations, and others in the paper, are compatible with magnetic-field evoked-vertigo and nystagmus sharing a common mechanism. With this interpretation, response decay and reversal upon withdrawal from the field, are due to adaptation to continuous vestibular input. Although the study does not entirely exclude the possibility of mechanisms involving transient vestibular stimulation during movement in and out of the bore, we argue these are less likely.**

81 Patel et al, 2008, J Occup Environ Med. 2008 May;50(5):576-83.
Pilot study investigating the effect of the static magnetic field from a 9.4-T MRI on the vestibular system.
http://www.ncbi.nlm.nih.gov/pubmed/18469627
OBJECTIVE:
To objectively evaluate workers' sensory symptoms and vestibular function after exposure to a strong, new generation 9.4-T Magnetic Resonance Imaging (MRI) scanner.
METHOD:
Six MRI employees underwent standardized electronystagmographic evaluation, postural testing, and caloric function at baseline evaluation, 30 minutes postexposure to 9.4 T static field and at a 3-month follow-up.
RESULTS:
All participants noted sensory symptoms after exposure. No overall deterioration in vestibular function was noted following 30-minute exposure or at a 3-month follow-up. **A higher occurrence of tonic vestibular asymmetry, hyperreactive caloric responses, and spontaneous nystagmus was noted compared with that of the normal population.**
CONCLUSION:

Workers exposed to the new, stronger MRIs experience sensory symptoms but it is unclear as yet whether long-term vestibular damage occurs. The higher rates of vestibular changes noted could argue for improved worker surveillance and exposure control.

82 Schlamann et al, 2010, Acad Radiol. 2010 Mar;17(3):277-81.
Short term effects of magnetic resonance imaging on excitability of the motor cortex at 1.5T and 7T.
http://www.ncbi.nlm.nih.gov/pubmed/20036585
RATIONALE AND OBJECTIVES:
The increasing spread of high-field and ultra-high-field magnetic resonance imaging (MRI) scanners has encouraged new discussion of the safety aspects of MRI. Few studies have been published on possible cognitive effects of MRI examinations. The aim of this study was to examine whether changes are measurable after MRI examinations at 1.5 and 7 T by means of transcranial magnetic stimulation (TMS).
MATERIALS AND METHODS:
TMS was performed in 12 healthy, right-handed male volunteers. First the individual motor threshold was specified, and then the cortical silent period (SP) was measured. Subsequently, the volunteers were exposed to the 1.5-T MRI scanner for 63 minutes using standard sequences. The MRI examination was immediately followed by another TMS session. Fifteen minutes later, TMS was repeated. Four weeks later, the complete setting was repeated using a 7-T scanner. Control conditions included lying in the 1.5-T scanner for 63 minutes without scanning and lying in a separate room for 63 minutes. TMS was performed in the same way in each case. For statistical analysis, Wilcoxon's rank test was performed.
RESULTS:
Immediately after MRI exposure, the SP was highly significantly prolonged in all 12 subjects at 1.5 and 7 T. The motor threshold was significantly increased. Fifteen minutes after the examination, the measured value tended toward normal again. Control conditions revealed no significant differences.
CONCLUSION:
MRI examinations lead to a transient and highly significant alteration in cortical excitability. This effect does not seem to depend on the strength of the static magnetic field.

83 Schlamann et al, 2009, Rofo. 2009 Mar;181(3):215-9.
Effects of MRI on the electrophysiology of the motor cortex: a TMS study [Article in German]
http://www.ncbi.nlm.nih.gov/pubmed/19229786
PURPOSE:
The increasing spread of high-field and ultra-high-field MRI scanners encouraged a new discussion on safety aspects of MRI examinations. Earlier studies report altered acoustically evoked potentials. This finding was not able to be confirmed in later studies. In the present study transcranial magnetic stimulation (TMS) was used to evaluate whether motor cortical excitability may be altered following MRI examination even at field strength of 1.5 T.
MATERIALS AND METHODS:
In 12 right-handed male volunteers individual thresholds for motor responses and then the length of the post-excitatory inhibition (silent period) were determined. Subsequently the volunteers were examined in the MRI scanner (Siemens Avanto, 1.5 T) for 63 minutes using gradient and spin echo sequences. MRI examination was immediately followed by another TMS session and a third 10 minutes later. As a control condition, the 12 subjects spent one hour in the scanner without examination and one hour on a couch without the presence of a scanner.
RESULTS:
After MRI examination, the silent period was significantly lengthened in all 12 subjects and then tended to the initial value after 10 min. Motor thresholds were significantly elevated and then normalized after 10 minutes. No significant effects were found in the control conditions.
CONCLUSION:
MRI examination leads to a transient effect on motor cortical excitability indicated by elongation of the post-excitatory inhibition and to an increase in motor thresholds in some subjects. These effects do not seem to be associated with a static magnetic field.

84 Straumann & Bockisch, 2011, Curr Biol. 2011 Oct 11;21(19):R806-7.
Neurophysiology: vertigo in MRI machines.
http://www.ncbi.nlm.nih.gov/pubmed/21996500
Subjects of brain-imaging studies often report experiencing vertigo while in MRI machines; a new study shows that the magnetic field stimulates the vestibular sensors in the inner ear by a Lorentz force.

85 van Nierop et al, 2013, Magn Reson Med. 2013 Jul;70(1):232-40.
MRI-related static magnetic stray fields and postural body sway: a double-blind randomized crossover study.
http://www.ncbi.nlm.nih.gov/pubmed/22886724
We assessed postural body sway performance after exposure to movement induced time-varying magnetic fields in the static magnetic stray field in front of a 7 Tesla (T) magnetic resonance imaging scanner. Using a double blind randomized crossover design, 30 healthy volunteers performed two balance tasks (i.e., standing with eyes closed and feet in parallel and then in tandem position) after standardized head movements in a sham, low exposure (on average 0.24 T static magnetic stray field and 0.49 T·s(-1) time-varying magnetic field) and high exposure condition (0.37 T and 0.70 T·s(-1)). Personal exposure to static magnetic stray fields and time-varying magnetic fields was measured with a personal dosimeter. Postural body sway was expressed in sway path, area, and velocity. **Mixed-effects model regression analysis showed that postural body sway in the parallel task was negatively affected (P < 0.05) by exposure on all three measures. The tandem task revealed the same trend, but did not reach statistical significance.** Further studies are needed to investigate the possibility of independent or synergetic effects of static magnetic stray field and time-varying magnetic field exposure. In addition, **practical safety implications of these findings, e.g., for surgeons and others working near magnetic resonance imaging scanners need to be investigated.**

86 van Nierop et al, 2012, Occup Environ Med. 2012 Oct;69(10):759-66.
Effects of magnetic stray fields from a 7 tesla MRI scanner on neurocognition: a double-blind randomised crossover study.
http://www.ncbi.nlm.nih.gov/pubmed/22930737
OBJECTIVE:
This study characterises neurocognitive domains that are affected by movement-induced time-varying magnetic fields (TVMF) within a static magnetic stray field (SMF) of a 7 Tesla (T) MRI scanner.
METHODS:
Using a double-blind randomised crossover design, 31 healthy volunteers were tested in a sham (0 T), low (0.5 T) and high (1.0 T) SMF exposure condition. Standardised head movements were made before every neurocognitive task to induce TVMF.
RESULTS:
Of the six tested neurocognitive domains, **we demonstrated that attention and concentration were negatively affected when exposed to TVMF within an SMF (varying from 5.0% to 21.1% per Tesla exposure, p<0.05), particular in situations were high working memory performance was required. In addition, visuospatial orientation was affected after exposure (46.7% per Tesla exposure, p=0.05).**
CONCLUSION:
Neurocognitive functioning is modulated when exposed to movement-induced TVMF within an SMF of a 7 T MRI scanner. Domains that were affected include attention/concentration and visuospatial orientation. Further studies are needed to better understand the mechanisms and possible practical safety and health implications of these acute neurocognitive effects.

EHS GENERAL POPULATION SIGNS & SYMPTOMS – OTHER RF SOURCES:

87 Lustenberger et al, 2013, Brain Stimul. 2013 Sep;6(5):805-11
Stimulation of the brain with radiofrequency electromagnetic field pulses affects sleep-dependent performance improvement.
http://www.ncbi.nlm.nih.gov/pubmed/23482083
http://www.emf-portal.de/viewer.php?aid=21895&sid=6548580b3eb1e6c4cb4444b33ea2ca2b&sform=8&pag_idx=0&l=e
Abstract:
BACKGROUND:
Sleep-dependent performance improvements seem to be closely related to sleep spindles (12-15 Hz) and sleep slow-wave activity (SWA, 0.75-4.5 Hz). Pulse-modulated radiofrequency electromagnetic fields (RF EMF, carrier frequency 900 MHz) are capable to modulate these electroencephalographic (EEG) characteristics of sleep.
OBJECTIVE:
The aim of our study was to explore possible mechanisms how RF EMF affect cortical activity during sleep and to test whether such effects on cortical activity during sleep interact with sleep-dependent performance changes.

METHODS:
Sixteen male subjects underwent 2 experimental nights, one of them with all-night 0.25-0.8 Hz pulsed RF EMF exposure. All-night EEG was recorded. To investigate RF EMF induced changes in overnight performance improvement, subjects were trained for both nights on a motor task in the evening and the morning.
RESULTS:
We obtained good sleep quality in all subjects under both conditions (mean sleep efficiency > 90%). After pulsed RF EMF **we found increased SWA during exposure to pulse-modulated RF EMF** compared to sham exposure (P < 0.05) toward the end of the sleep period. Spindle activity was not affected. Moreover, subjects showed an increased RF EMF burst-related response in the SWA range, indicated by an increase in event-related EEG spectral power and phase changes in the SWA range. **Notably, during exposure, sleep-dependent performance improvement in the motor sequence task was reduced compared to the sham condition** (-20.1%, P = 0.03).
CONCLUSION:
The changes in the time course of SWA during the exposure night may **reflect an interaction of RF EMF with the renormalization of cortical excitability during sleep, with a negative impact on sleep-dependent performance improvement**.
[Exposure: 900 MHz pulsed; intermittent during 8h (during the sleep, exposure of 5 min 'intermittent 1' was followed by 1 min with no exposure (OFF phase), then 5 min 'intermittent 2' was followed by a 7 min OFF phase; this 18 min sequence was repeated throughout the whole night; SAR 0.15 W/kg spatial average (10g) peak spatial SAR during the whole night, 10 W/kg spatial average (10g) peak spatial SAR during the 7.1 ms pulses, 1 W/kg (500 ms burst average), 0.125 W/kg ('intermittent 1' average), 0.4 W/kg ('intermittent 2' average)]

88 Perentos et al, 2013, IEEE Trans Biomed Eng. 2013 Jun;60(6):1702-10.
The alpha band of the resting electroencephalogram under pulsed and continuous radio frequency exposures.
http://www.ncbi.nlm.nih.gov/pubmed/23358937
The effect of GSM-like electromagnetic fields with the resting electroencephalogram (EEG) alpha band activity was investigated in a double-blind cross-over experimental paradigm, testing the hypothesis that pulsed but not continuous radio frequency (RF) exposure would affect alpha activity, and the hypothesis that GSM-like pulsed low frequency fields would affect alpha. Seventy-two healthy volunteers attended a single recording session where the eyes open resting EEG activity was recorded. Four exposure intervals were presented (sham, pulsed modulated RF, continuous RF, and pulsed low frequency) in a counterbalanced order where each exposure lasted for 20 min. Compared to sham, a suppression of the global alpha band activity was observed under the pulsed modulated RF exposure, and this did not differ from the continuous RF exposure. No effect was seen in the extremely low frequency condition. That there was an effect of pulsed RF that did not differ significantly from continuous RF exposure does not support the hypothesis that "pulsed" RF is required to produce EEG effects. **The results support the view that alpha is altered by RF electromagnetic fields**, but suggest that the pulsing nature of the fields is not essential for this effect to occur.
[Exposure: specially designed handset, unspecified frequency (condition 1 continous wave, condition 2 pulsed); continuous for 3 x 20 min; condition 1. SAR 1.95 W/kg spatial average (10g), condition 2. SAR 0.06 W/kg, 1.95 W/kg peak value]

PROVEN PHYSIOLOGICAL CONDITION:

89 Johansson O, "Elöverkänslighet samt överkänslighet mot mobiltelefoner: Resultat från en dubbel-blind provokationsstudie av metodstudiekaraktär" (="Electrohyper-sensitivity and sensitivity to mobile telephones: Results from a double-blind provocation study of pilot character", in Swedish),Enheten för Experimentell Dermatologi, Karolinska Institutet, Stockholm, Rapport nr. 2, 1995, ISSN 1400-6111

90 McCarty et al, Int J Neurosci. 2011 Dec;121(12):670-6.
Electromagnetic hypersensitivity: evidence for a novel neurological syndrome.
http://www.ncbi.nlm.nih.gov/pubmed/21793784
http://andrewamarino.com/PDFs/171-IntJNeurosci2011.pdf (full paper)
Objective: We sought direct evidence that acute exposure to environmental-strength electromagnetic fields (EMFs) could induce somatic reactions (EMF hypersensitivity). Methods: The subject, a female physician selfdiagnosed with EMF hypersensitivity, was exposed to an average (over the head) 60-Hz electric field of 300 V/m (comparable with typical environmental-strength EMFs) during controlled provocation and behavioral studies. Results: In a double-blinded EMF provocation procedure specifically designed to minimize unintentional sensory cues, **the subject developed temporal pain, headache, muscle twitching, and skipped heartbeats within 1 00 s after initiation of EMF exposure (p < .05). The symptoms were caused primarily by field transitions (off-on, on-off) rather than the presence**

of the field, as assessed by comparing the frequency and severity of the effects of pulsed and continuous fields in relation to sham exposure. The subject had no conscious perception of the field as judged by her inability to report its presence more often than in the sham control. **Discussion: The subject demonstrated statistically reliable somatic reactions in response to exposure to subliminal EMFs under conditions that reasonably excluded a causative role for psychological processes. Conclusion: EMF hypersensitivity can occur as a bona fide environmentally inducible neurological syndrome.**

TABLE 3.

Evaluation of the relation between presentation of a pulsed electric field and the development of symptoms.
(b) Summary table

	Symptoms		
Field condition	None	Mild	>=Mild
Sham	5	5	0
Pulsed field *	0	0	10

*p <.05

TABLE 4.

Evaluation of the comparative effect of continuous and pulsed fields relative to a sham field on the development of symptoms. (b) Summary table

	Symptoms		
Field condition	None	Mild	>=Mild
Sham	4	1	0
Continuous	2	0	3
Pulsed field *	0	2	3

*p <.05

Discussion

…. The subject developed symptoms in association with the presentation of a pulsed electric field significantly ($p < .05$) more often than could reasonably be explained on the basis of chance (see Table 3). Several considerations suggested that the statistical link was a true causal association with a subliminal EMF. First, the subject's environment was carefully controlled to avoid putative confounding factors. The testing took place in an acoustically quiet environment, and the presence of uncontrolled environmental EMFs was nil. The environmental conditions during the field-exposure and sham-exposure intervals were identical except that during the sham-exposure intervals, at a point far removed from the subject's field of view, the wires carrying the plate voltage were disconnected. A key aspect of our laboratory procedure was the elimination of sensory cues that could serve as conscious markers of the electric field leading to a somatization reaction. All appropriate precautions were taken to eliminate potential confounders. Second, the occurrence of symptoms was significantly associated with the type of EMF (see Table 4). The symptomatic response was associated with the pulsed EMF, which maximized occurrence of the number of transient changes in the EMF (off - on and on-off), not with the presence of the field, as expected on the basis of prior animal studies where the issue of somatization was irrelevant (Frilot et al., 2011)…..

PROVOCATION STUDIES:

See also: Griesz-Brisson 2013[101], Heilmaier 2011[76], Nieto-Hernandez 2011[73].

91 Havas, 2013, Rev Environ Health. 2013;28(2-3):75-84.

Radiation from wireless technology affects the blood, the heart, and the autonomic nervous system.

http://www.ncbi.nlm.nih.gov/pubmed/24192494

Exposure to electrosmog generated by electric, electronic, and wireless technology is accelerating to the point that a portion of the population is experiencing adverse reactions when they are exposed. The symptoms of electrohypersensitivity (EHS), best described as rapid aging syndrome, experienced by adults and children resemble symptoms experienced by radar operators in the 1940s to the 1960s and are well described in the literature. An increasingly common response includes clumping (rouleau formation) of the red blood cells, heart palpitations, pain or pressure in the chest accompanied by anxiety, and an upregulation of the sympathetic nervous system coincident with a downregulation of the parasympathetic nervous system typical of the "fight-or-flight" response. **Provocation studies presented in this article demonstrate that the response to electrosmog is physiologic and not psychosomatic.** Those who experience prolonged and severe EHS may develop psychologic problems as a consequence of their inability to work, their limited ability to travel in our highly technologic environment, and the social stigma that their symptoms are imagined rather than real.

92 Leitgeb & Schröttner, 2003, Bioelectromagnetics. 2003 Sep;24(6):387-94.
Electrosensibility and electromagnetic hypersensitivity.
http://www.ncbi.nlm.nih.gov/pubmed/12929157/
Electromagnetic sensibility, the ability to perceive electric and electromagnetic exposure, and electromagnetic hypersensitivity (EHS), developing health symptoms due to exposure to environmental electromagnetic fields, need to be distinguished. Increased electrosensibility is a necessary, however, not a sufficient condition for electromagnetic hypersensitivity. At an extended sample of the general population of 708 adults, including 349 men and 359 women aged between 17 and 60 years, electrosensibility was investigated and characterized by perception threshold and its standard deviation. By analyzing the probability distributions of the perception threshold of electric 50 Hz currents, **evidence could be found for the existence of a subgroup of people with significantly increased electrosensibility (hypersensibility) who as a group could be differentiated from the general population. The presented data show that the variation of the electrosensibility among the general population is significantly larger than has yet been estimated by nonionizing radiation protection bodies,** but much smaller than claimed by hypersensitivity self-aid groups. These quantitative results should contribute to a less emotional discussion of this problem. The investigation method presented, is capable of exclusion diagnostics for persons suffering from the hypersensitivity syndrome. **[Author's note: this investigation method alone is not capable of exclusion diagnostics as EHS symptoms are likely produced via several mechanistic pathways not one.]**

93 Rea et al. (1991), Journal of Bioelectricity, 10(1&2), 241-256.
Electromagnetic Field Sensitivity.
http://informahealthcare.com/doi/abs/10.3109/15368379109031410
A multiphase study was performed to find an effective method to evaluate electromagnetic field (EMF) sensitivity of patients. The first phase developed criteria for controlled testing using an environment low in chemical, particulate, and EMF pollution. Monitoring devices were used in an effort to ensure that extraneous EMF would not interfere with the tests. A second phase involved a single-blind challenge of 100 patients who complained of EMF sensitivity to a series of fields ranging from 0 to 5 MHz in frequency, plus 5 blank challenges. **Twenty-five patients were found who were sensitive to the fields, but did not react to the blanks.** These were compared in the third phase to 25 healthy naive volunteer controls. None of the volunteers reacted to any challenge, active or blank, but **16 of the EMF-sensitive patients (64%) had positive signs and symptoms scores, plus autonomic nervous system changes. In the fourth phase, the 16 EMF-sensitive patients were rechallenged twice to the frequencies to which they were most sensitive during the previous challenge. The active frequency was found to be positive in 100% of the challenges, while all of the placebo tests were negative. we concluded that this study gives strong evidence that electromagnetic field sensitivity exists, and can be elicited under environmentally controlled conditions.**

94 Sandström et al, 1997, J Occup Environ Med. 1997 Jan;39(1):15-22.
Neurophysiological effects of flickering light in patients with perceived electrical hypersensitivity.
http://www.ncbi.nlm.nih.gov/pubmed/9029427
An increasing number of people in Sweden are claiming that they are hypersensitive to electricity. These patients suffer from skin as well as neurological symptoms when they are near computer monitors, fluorescent tubes, or other electrical appliances. Provocation studies with electromagnetic fields emitted from these appliances have, with only one exception, all been negative, indicating that there are other factors in the office environment that can effect the autonomic and/or central nervous system, resulting in the symptoms reported. Flickering light is one such factor and was therefore chosen as the exposure parameter in this study. Ten patients complaining of electrical hypersensitivity and the same number of healthy voluntary control subjects were exposed to amplitude-modulated light. The sensitivity of the brain to this type of visual stimulation was tested by means of objective electrophysiological methods such as electroretinography and visual evoked potential. **A higher amplitude of brain cortical responses at all frequencies of stimulation was found when comparing patients with the control subjects,** whereas no differences in retinal responses were revealed.

95 Tuengler & von Klitzing, 2013, Electromagn Biol Med. 2013 Sep;32(3):281-90.
Hypothesis on how to measure electromagnetic hypersensitivity.
http://www.ncbi.nlm.nih.gov/pubmed/23301924
Electromagnetic hypersensitivity (EHS) is an ill-defined term to describe the fact that people who experience health symptoms in the vicinity of electromagnetic fields (EMFs) regard them as causal for their complaints. Up to now most scientists assume a psychological cause for the suffering of electromagnetic hypersensitive individuals. This paper addresses reasons why most provocation studies could not find any association between EMF exposure and EHS and

presents a hypothesis on diagnosis and differentiation of this condition. Simultaneous recordings of **heart rate variability, microcirculation and electric skin potentials are used for classification of EHS. Thus, it could be possible to distinguish "genuine" electromagnetic hypersensitive individuals from those who suffer from other conditions.**

PAPERS DEMONSTRATING PHYSIOLOGICAL VARIATIONS IN EHS:

See also: Abdel-Rassoul 2007[25], Bortkiewica 2004[26], Eger 2010[28], Hutter 2006[31], Khurana 2010[33], Leitgeb & Schröttner 2003[92], Sandström 1997[94], Santini 2002[37].

96 Interview with Dr Belpomme, President of the Association for Research on Treatment Against Cancer (ARTAC) and Founder of the European Cancer and Environment Research Institute (ECERI), 2014
Electrosensitivity is a Pre-Alzheimer's state
http://electromagnetichealth.org/electromagnetic-health-blog/electrosensitivity-a-pre-alzheimers-state/
Dr. Belpomme has questioned and clinically examined more than 1,000 electrohypersensitivity (EHS) self-reported persons. He says, **"These are real sick people who are in a Pre-Alzheimer's state." He says the most conclusive scientific proof of biological effect are animal studies and biological tests in EHS persons which indicate a Pre-Alzheimer's state.**
The lab tests that show the irregularities (also found in animals exposed to EMF), he says, include:
1. **Brain imagery showing vascular hypoperfusion** in the area of the brain (the limbic system) where Alzheimer's starts
2. 2-10 times **higher levels of histamine** in the blood.
3. Detection of other markers of the **opening of the blood brain barrier**.
4. Higher levels of **auto-antibodies against O- myelin and/or stress proteins**
5. **Decrease in the production of melatonin** in 24h urine.

97 Belyaev et al, 2009, Bioelectromagnetics. 2009 Feb;30(2):129-41.
Microwaves from UMTS/GSM mobile phones induce long-lasting inhibition of 53BP1/gamma-H2AX DNA repair foci in human lymphocytes.
http://www.ncbi.nlm.nih.gov/pubmed/18839414
We have recently described frequency-dependent effects of mobile phone microwaves (MWs) of global system for mobile communication (GSM) on human lymphocytes from persons reporting hypersensitivity to electromagnetic fields and healthy persons. Contrary to GSM, universal global telecommunications system (UMTS) mobile phones emit wide-band MW signals. Hypothetically, UMTS MWs may result in higher biological effects compared to GSM signal because of eventual "effective" frequencies within the wideband. **Here, we report for the first time that UMTS MWs affect chromatin and inhibit formation of DNA double-strand breaks co-localizing 53BP1/gamma-H2AX DNA repair foci in human lymphocytes from hypersensitive and healthy persons and confirm that effects of GSM MWs depend on carrier frequency. Remarkably, the effects of MWs on 53BP1/gamma-H2AX foci persisted up to 72 h following exposure of cells, even longer than the stress response following heat shock.** The data are in line with the hypothesis that the type of signal, UMTS MWs, may have higher biological efficiency and possibly larger health risk effects compared to GSM radiation emissions. No significant differences in effects between groups of healthy and hypersensitive subjects were observed, except for the **effects of UMTS MWs and GSM-915 MHz MWs on the formation of the DNA repair foci, which were different for hypersensitive ($P < 0.02$[53BP1]//0.01[gamma-H2AX]) but not for control subjects ($P > 0.05$).** The non-parametric statistics used here did not indicate specificity of the differences revealed between the effects of GSM and UMTS MWs on cells from hypersensitive subjects and more data are needed to study the nature of these differences.

98 Dahmen et al, 2009, Bioelectromagnetics. 2009 May;30(4):299-306.
Blood laboratory findings in patients suffering from self-perceived electromagnetic hypersensitivity (EHS).
http://www.ncbi.nlm.nih.gov/pubmed/19259984
Risks from electromagnetic devices are of considerable concern. Electrohypersensitive (EHS) persons attribute a variety of rather unspecific symptoms to exposure to electromagnetic fields. The pathophysiology of EHS is unknown and therapy remains a challenge. We hypothesized that some electrosensitive individuals are suffering from common somatic health problems. Toward this end we analysed clinical laboratory parameters including thyroid-stimulating hormone (TSH), alanine transaminase (ALT), aspartate transaminase (AST), creatinine, hemoglobine, hematocrit and c-reactive protein (CRP) in subjects suffering from EHS and in controls that are routinely used in clinical medicine to identify or screen for common somatic disorders. One hundred thirty-two patients (n = 42 males and n = 90 females) and 101 controls (n = 34 males and n = 67 females) were recruited. **Our results identified laboratory signs of thyroid dysfunction, liver dysfunction and chronic inflammatory processes in small but remarkable fractions of EHS sufferers**

as potential sources of symptoms that merit further investigation in future studies. In the cases of TSH and ALT/AST there were significant differences between cases and controls. The hypotheses of anaemia or kidney dysfunction playing a major role in EHS could be unambiguously refuted. Clinically it is recommended to check for signs of treatable somatic conditions when caring for individuals suffering from self-proclaimed EHS.

99 De Luca et al, 2014, Mediators Inflamm. 2014;2014:924184.
Metabolic and genetic screening of electromagnetic hypersensitive subjects as a feasible tool for diagnostics and intervention.
http://www.ncbi.nlm.nih.gov/pubmed/24812443
Growing numbers of "electromagnetic hypersensitive" (EHS) people worldwide self-report severely disabling, multiorgan, non-specific symptoms when exposed to low-dose electromagnetic radiations, **often associated with symptoms of multiple chemical sensitivity (MCS)** and/or other environmental "sensitivity-related illnesses" (SRI). This cluster of chronic inflammatory disorders still lacks validated pathogenetic mechanism, diagnostic biomarkers, and management guidelines. We hypothesized that SRI, not being merely psychogenic, may share organic determinants of impaired detoxification of common physic-chemical stressors. Based on our previous MCS studies, we tested a panel of 12 metabolic blood redox-related parameters and of selected drug-metabolizing-enzyme gene polymorphisms, on 153 EHS, 147 MCS, and 132 control Italians, confirming MCS altered ($P < 0.05$-0.0001) glutathione-(GSH), GSH-peroxidase/S-transferase, and catalase erythrocyte activities. **We first described comparable-though milder-metabolic pro-oxidant/proinflammatory alterations in EHS with distinctively increased plasma coenzyme-Q10 oxidation ratio.** Severe depletion of erythrocyte membrane polyunsaturated fatty acids with increased ω 6/ ω 3 ratio was confirmed in MCS, but not in EHS. **We also identified significantly ($P = 0.003$) altered distribution-versus-control of the CYP2C19∗1/∗2 SNP variants in EHS, and a 9.7-fold increased risk (OR: 95% C.I. = 1.3-74.5) of developing EHS for the haplotype (null)GSTT1 + (null)GSTM1 variants.** Altogether, results on MCS and EHS strengthen our proposal to adopt this blood metabolic/genetic biomarkers' panel as suitable diagnostic tool for SRI.

100 Gangi and Johansson, 2000, Med Hypotheses. 2000 Apr;54(4):663-71.
A theoretical model based upon mast cells and histamine to explain the recently proclaimed sensitivity to electric and/or magnetic fields in humans.
http://www.ncbi.nlm.nih.gov/pubmed/10859662
The relationship between exposure to electromagnetic fields (EMFs) and human health is more and more in focus. This is mainly because of the rapid increasing use of such EMFs within our modern society. **Exposure to EMFs has been linked to different cancer forms, e.g. leukemia, brain tumors, neurological diseases, such as Alzheimer's disease, asthma and allergy, and recently to the phenomena of 'electrosupersensitivity' and 'screen dermatitis'. There is an increasing number of reports about cutaneous problems as well as symptoms from internal organs, such as the heart, in people exposed to video display terminals (VDTs). These people suffer from subjective and objective skin and mucosa-related symptoms, such as itch, heat sensation, pain, erythema, papules and pustules. In severe cases, people can not, for instance, use VDTs or artificial light at all, or be close to mobile telephones. Mast cells (MCs), when activated, release a spectrum of mediators, among them histamine, which is involved in a variety of biological effects with clinical relevance, e.g. allergic hypersensitivity, itch, edema, local erythema and many types of dermatoses. From the results of recent studies, it is clear that EMFs affect the MC, and also the dendritic cell, population and may degranulate these cells. The release of inflammatory substances, such as histamine, from MCs in the skin results in a local erythema, edema and sensation of itch and pain, and the release of somatostatin from the dendritic cells may give rise to subjective sensations of on-going inflammation and sensitivity to ordinary light.** These are, as mentioned, the common symptoms reported from patients suffering from 'electrosupersensitivity'/'screen dermatitis'. **MCs are also present in the heart tissue and their localization is of particular relevance to their function. Data from studies made on interactions of EMFs with the cardiac function have demonstrated that highly interesting changes are present in the heart after exposure to EMFs**. One could speculate that the cardiac MCs are responsible for these changes due to degranulation after exposure to EMFs. However, it is still not known how, and through which mechanisms, all these different cells are affected by EMFs. In this article, we present a theoretical model, based upon observations on EMFs and their cellular effects, to explain the proclaimed sensitivity to electric and/or magnetic fields in humans.

101 Griesz-Brisson M., 3rd International Conference on Neurology and Epidemiology, Neuroepidemiology 2013;41:223–316
Electrosensitivity from a neurological point of view
http://www.karger.com/Article/Pdf/356326 (page 53)

Objective: The entity of electrosensitivity is still a new and a widely controversial topic in medicine. However, we cannot deny that we are increasingly confronted by patients with a variety of symptoms in the presence of cellphone transmitter masts, computers, cellphones and the like.
Method: 22 electrosensitive patients were tested and treated in a standardised way. The results were audited. Hair and urine was tested for essential elements (Mg, Se, Zn etc) and toxic heavy metals (Hg, Cd, Pb, etc.), blood was tested for genetic detoxification enzymes (Glutathion S-Transferase M1 and T1 und N-Acethyltransferase), blood was tested in the MELISA Test for hypersensitivity to heavy metals, EEG and brain mapping was performed as a baseline and in the presence of a cellphone held to the ear (but not talking), blood pressure and pulse were measured every 5 minutes with an automated blood pressure machine. Subjective symptoms were recoded in a questionnaire.
Results: There was a deficit in essential elements in 81.8% and an overload of toxic elements in 86.4% in the hair, genetic poly- morphysm for GST T1 in 27.3%, GST M1 in 68.0%, GST T1 and M1 in 23% and NAT in 40.9%, hypersensitivity to heavy metals Ni59.1%, Au23.1%, Hg15.4%, Pd7.7%, Ag7.7%, Mo7.7%. **There was evidence of EEG, ECG and blood pressure changes** during and after exposure to electromagnetic fields induced by a mobile phone.
Conclusion: **The audit provided evidence that in electro- sensitive patients there is a deficiency in essential elements and an overload in toxic elements, genetic polymorphysms and hypersensitivities against heavy metals. The EEG/brain mapping showed that the brain reacts promptly in a paradoxical way and the cardio-vascular parameter changes (heart rate and rhythm, and blood pressure) were protracted in time. The questionnaire showed that the subjective symptoms started during exposure and continued after exposure stop.**

102 Havas and Marrongelle, 2013, Electromagn Biol Med. 2013 Jun;32(2):253-66.
Replication of heart rate variability provocation study with 2.4-GHz cordless phone confirms original findings.
https://www.ncbi.nlm.nih.gov/pubmed/23675629
Subjects were exposed to radiation for 3-min intervals **generated by a 2.4-GHz cordless phone base station** (3-8 μW/cm²). A few participants had a severe reaction to the radiation with an increase in heart rate and altered HRV indicative of an alarm response to stress. Based on the HRV analyses of the 69 subjects, 7% were classified as being "moderately to very" sensitive, 29% were "little to moderately" sensitive, 30% were "not to little" sensitive and 6% were "unknown". **These results are not psychosomatic and are not due to electromagnetic interference**.

103 Havas M et al, 2010, European Journal of Oncology library Vol. 5, 273-300, part 2
Provocation study using heart rate variability shows microwave radiation from 2.45GHz cordless phone affects autonomic nervous system.
http://www.icems.eu/papers/ramazzini_library5_part2.pdf
This study provides scientific evidence that some individuals may experience arrhythmia, heart palpitations, heart flutter, or rapid heartbeat and/or vasovagal symptoms such as dizziness, nausea, profuse sweating and syncope when exposed to electromagnetic devices. It is the first study to demonstrate such a dramatic response to pulsed MW radiation at 0.5% of existing federal guidelines (1000 microW/cm2) in both Canada and the US.
[Exposure: 2.4 GHz (pulsed); continuous for 3 min; power flux density 3-5μW/cm²]

104 Landgrebe et al, 2009, PLoS One. 2009;4(3):e5026.
Association of tinnitus and electromagnetic hypersensitivity: hints for a shared pathophysiology?
http://www.ncbi.nlm.nih.gov/pubmed/19325894
BACKGROUND:
Tinnitus is a frequent condition with high morbidity and impairment in quality of life. The pathophysiology is still incompletely understood. Electromagnetic fields are discussed to be involved in the multi-factorial pathogenesis of tinnitus, but data proofing this relationship are very limited. Potential health hazards of electromagnetic fields (EMF) have been under discussion for long. Especially, individuals claiming themselves to be electromagnetic hypersensitive suffer from a variety of unspecific symptoms, which they attribute to EMF-exposure. The aim of the study was to elucidate the relationship between EMF-exposure, electromagnetic hypersensitivity and tinnitus using a case-control design.
METHODOLOGY:
Tinnitus occurrence and tinnitus severity were assessed by questionnaires in 89 electromagnetic hypersensitive patients and 107 controls matched for age-, gender, living surroundings and workplace. Using a logistic regression approach, potential risk factors for the development of tinnitus were evaluated.
FINDINGS:
Tinnitus was significantly more frequent in the electromagnetic hypersensitive group (50.72% vs. 17.5%) whereas tinnitus duration and severity did not differ between groups. **Electromagnetic hypersensitivity and tinnitus were**

independent risk factors for sleep disturbances. However, measures of individual EMF-exposure like e.g. cell phone use did not show any association with tinnitus.
CONCLUSIONS:
Our data indicate that tinnitus is associated with subjective electromagnetic hypersensitivity. An individual vulnerability probably due to an over activated cortical distress network seems to be responsible for, both, electromagnetic hypersensitivity and tinnitus. Hence, therapeutic efforts should focus on treatment strategies (e.g. cognitive behavioral therapy) aiming at normalizing this dysfunctional distress network.

105 Landgrebe et al, 2008, Psychol Med. 2008 Dec;38(12):1781-91.
Cognitive and neurobiological alterations in electromagnetic hypersensitive patients: results of a case-control study.
http://www.ncbi.nlm.nih.gov/pubmed/18366821
BACKGROUND:
Hypersensitivity to electromagnetic fields (EMF) is frequently claimed to be linked to a variety of non-specific somatic and neuropsychological complaints. Whereas provocation studies often failed to demonstrate a causal relationship between EMF exposure and symptom formation, **recent studies point to a complex interplay of neurophysiological and cognitive alterations contributing to symptom manifestation in electromagnetic hypersensitive patients (EHS).** However, these studies have examined only small sample sizes or have focused on selected aspects. Therefore this study examined in the largest sample of EHS EMF-specific cognitive correlates, discrimination ability and neurobiological parameters in order to get further insight into the pathophysiology of electromagnetic hypersensitivity.
METHOD:
In a case-control design 89 EHS and 107 age- and gender-matched controls were included in the study. Health status and EMF-specific cognitions were evaluated using standardized questionnaires. Perception thresholds following single transcranial magnetic stimulation (TMS) pulses to the dorsolateral prefrontal cortex were determined using a standardized blinded measurement protocol. Cortical excitability parameters were measured by TMS.
RESULTS:
Discrimination ability was significantly reduced in EHS (only 40% of the EHS but 60% of the controls felt no sensation under sham stimulation during the complete series), whereas the perception thresholds for real magnetic pulses were comparable in both groups (median 21% versus 24% of maximum pulse intensity). Intra-cortical facilitation was decreased in younger and increased in older EHS. In addition, typical EMF-related cognitions (aspects of rumination, symptom intolerance, vulnerability and stabilizing self-esteem) specifically differentiated EHS from their controls.
CONCLUSIONS:
These results demonstrate significant cognitive and neurobiological alterations pointing to a higher genuine individual vulnerability of electromagnetic hypersensitive patients.

106 Landgrebe et al, 2007, Journal of Psychosomatic Research 62 (2007) 283-288
Altered cortical excitability in subjectively electrosensitive patients: Results of a pilot study
http://www.sciencedirect.com/science/article/pii/S0022399906005095
http://www.researchgate.net/publication/6481169_Altered_cortical_excitability_in_subjectively_electrosensitive_patients_results_of_a_pilot_study/file/d912f50a52e2932c78.pdf (full article)
Objective: Hypersensitivity to electromagnetic fields is frequently claimed to be linked to a variety of unspecific somatic and/or neuropsychological complaints. Whereas provocation studies often failed to demonstrate a causal relationship between electromagnetic field exposure and symptom formation, **neurophysiological examinations highlight baseline deviations in people claiming to be electrosensitive.**
Methods: To elucidate a potential role of dysfunctional cortical regulations in mediating hypersensitivity to electromagnetic fields, cortical excitability parameters were measured by transcranial magnetic stimulation in subjectively electrosensitive patients (n=23) and two control groups (n=49) differing in their level of unspecific health complaints.
Results: Electrosensitive patients showed reduced intracortical facilitation as compared to both control groups, while motor thresholds and intracortical inhibition were unaffected.
Conclusions: This pilot study gives additional evidence that altered central nervous system function may account for symptom manifestation in subjectively electrosensitive patients as has been postulated for several chronic multisymptom illnesses sharing a similar clustering of symptoms.

107 Lyskov et al, 2001, Int J Psychophysiol. 2001 Nov;42(3):233-41.
Neurophysiological study of patients with perceived 'electrical hypersensitivity'.
http://www.ncbi.nlm.nih.gov/pubmed/11812390

The aim of the present study was to investigate baseline neurophysiological characteristics of the central and autonomous regulation and their reactivity to different tests in a group of persons with so-called 'electrical hypersensitivity', which is often considered as a form of psychosomatic disorders. Twenty patients with combinations of neuroasthenic symptoms (general fatigue, weakness, dizziness, headache) and facial skin (itching, tingling, redness) have been investigated. An equal number of symptom-free persons served as a control group. The examination comprised self-reported measures, testing of visual functions, measurements of blood pressure, heart rate and its variability, electrodermal activity, respiration, EEG and visual evoked potentials (VEP). **Several variables were found to differ between the patient and the control groups. The mean value of heart rate in rest condition was higher in the patient group compared to the controls (mean value of inter-beat intervals were 0.80 and 0.90 s, respectively). Heart rate variability and response to standing test were decreased in the patient group compared to the controls. Patients had faster onset, higher amplitudes, and left-right hand asymmetry of the sympathetic skin responses. They had a higher critical fusion frequency (43 vs. 40 Hz), and a trend to increased amplitude of steady-state VEPs at stimulation frequencies of 30-70 Hz. The data indicated that the observed group of patients had a trend to hyper sympathotone, hyperresponsiveness to sensor stimulation and heightened arousal.**

108 Lyskov et al, 2001, Bioelectromagnetics. 2001 Oct;22(7):457-62.
Provocation study of persons with perceived electrical hypersensitivity and controls using magnetic field exposure and recording of electrophysiological characteristics.
http://www.ncbi.nlm.nih.gov/pubmed/11568930
The aim of the present study was to investigate possible neurophysiological effects of intermittent 15 sec on/off cycle, 60 Hz, 10 microT magnetic field exposure on patients with perceived "electromagnetic hypersensitivity" (EHS), and control subjects during rest and performance of a mental arithmetic task. Twenty participants (15 female, 5 male, 31-60 years old, mean 45.8 +/- 0.7 years) were invited from the group of EHS patients. Twenty volunteers (15 female, 5 male, 31-59 years old, mean 45.0 +/- 0.7 years?) served as a control group. The test protocol consisted of a set of examinations: EEG, visual evoked potentials, electrodermal activity, ECG, and blood pressure. The total duration of the test was 40 min, divided into two 10 min rest periods and two 10 min periods of mathematical performance. Magnetic field and sham exposures were presented randomly during these periods, resulting in four different conditions: Field-Rest, Sham-Rest, Field-Math, and Sham-Math. **The data showed significant main effects of the Group factor (EHS vs. control subjects) on heart rate ($F(1,80) = 20.6$; $P < 0.01$), heart rate spectrum ratio ($F(1,80) = 9.5$; $P = 0.02$), and electrodermal activity ($F(1,76) = 4.2$; $P = 0.04$), whereas EEG characteristics did not differ between groups. The Condition factor (mathematical task vs. relaxed) showed main effects for heart rate ($F(1,80) = 14.8$; $P < 0.01$), heart rate spectrum ratio ($F(1,80) = 7.8$; $P = 0.06$), electrodermal activity ($F(1,76) = 56.8$; $P < 0.01$), and alpha and theta spectral bands of EEG.** Magnetic field exposure did not affect autonomous system or electroencephalographic variables of either group. These data do not indicate that EHS patients or control are affected by low-level 60 Hz magnetic field exposure. **However, persons reporting EHS differed from the control subjects in baseline values of investigated physiological characteristics. Perhaps EHS patients have a rather distinctive physiological predisposition to sensitivity to physical and psychosocial environmental stressors.**

109 Nordin et al, 2014, Int J Environ Res Public Health. 2014 Aug 27;11(9):8794-805.
Odor and noise intolerance in persons with self-reported electromagnetic hypersensitivity.
http://www.ncbi.nlm.nih.gov/pubmed/25166918
Lack of confirmation of symptoms attributed to electromagnetic fields (EMF) and triggered by EMF exposure has highlighted the role of individual factors. Prior observations indicate intolerance to other types of environmental exposures among persons with electromagnetic hypersensitivity (EHS). This study assessed differences in odor and noise intolerance between persons with EHS and healthy controls by use of subscales and global measures of the Chemical Sensitivity Scale (CSS) and the Noise Sensitivity Scale (NSS). The EHS group scored significantly higher than the controls on all CSS and NSS scales. Correlation coefficients between CSS and NSS scores ranged from 0.60 to 0.65 across measures. **The findings suggest an association between EHS and odor and noise intolerance, encouraging further investigation of individual factors for understanding EMF-related symptoms.**

110 Sandström et al, 2003, Int J Psychophysiol. 2003 Sep;49(3):227-35.
Holter ECG monitoring in patients with perceived electrical hypersensitivity.
http://www.ncbi.nlm.nih.gov/pubmed/14507441
Earlier studies have indicated that patients claiming to be sensitive to electromagnetic fields, so-called electrical hypersensitivity (EHS), have a dysbalance of the autonomic nervous system (ANS) regulation. This paper focuses on a possible dysbalance in the ANS among EHS patients by the use of long-term monitoring of electrocardiogram (ECG) in both a patient and a matched control group. At the same time, the environmental power frequency magnetic field was

recorded for both groups in order to see if there was any difference in exposure between the groups. ECG, heart rate (HR) and heart rate variability (HRV) as well as the magnetic field exposure were monitored for 24 h. Fourteen patients with perceived EHS symptoms were selected from the University Hospital, Umeå, Sweden. Symptoms indicating autonomic nervous dysregulation were not part of the inclusion criteria of the patient group. Age and sex matched healthy subjects were used as controls. No differences were found between the groups regarding magnetic field exposure or the mean HR for 24 h**. The HRV analyses showed that the high-frequency (HF) component did not have the expected increase with sleep onset and during nighttime in the EHS group. When separating the sleeping and awake time even less differences between the two conditions in the EHS patients, both for the low-frequency and HF components in the HRV spectrum, were seen. EHS patients had a disturbed pattern of circadian rhythms of HRV and showed a relatively 'flat' representation of hourly-recorded spectral power of the HF component of HRV.**

111 Yoshiaki Omura M.D., Sc.D.
Abnormal Deposits of Al, Pb, and Hg in the Brain, Particularly in the Hippocampus, as One of the Main Causes of Decreased Cerebral Acetylcholine, Electromagnetic Field Hypersensitivity, Pre-Alzheimer's Disease, and Autism in Children and Their New Effective Treatment by Removing These Metal Deposits Using Cilantro and the Selective Drug Uptake Enhancement Method (Part I). The journal Acupuncture & Electro-Therapeutics Research, 2000, Vol. 25 Issue ¾
https://www.cognizantcommunication.com/cccSiteFiles/Acupuncture/acutoc25.html

112 Wilén et al, 2006, Bioelectromagnetics. 2006 Apr;27(3):204-14.
Psychophysiological tests and provocation of subjects with mobile phone related symptoms.
http://www.ncbi.nlm.nih.gov/pubmed/16304699
The aim of the present study was to investigate the effect of exposure to a mobile phone-like radiofrequency (RF) electromagnetic field on persons experiencing subjective symptoms when using mobile phones (MP). Twenty subjects with MP-related symptoms were recruited and matched with 20 controls without MP-related symptoms. Each subject participated in two experimental sessions, one with true exposure and one with sham exposure, in random order. In the true exposure condition, the test subjects were exposed for 30 min to an RF field generating a maximum SAR(1g) in the head of 1 W/kg through an indoor base station antenna attached to a 900 MHz GSM MP. The following physiological and cognitive parameters were measured during the experiment: heart rate and heart rate variability (HRV), respiration, local blood flow, electrodermal activity, critical flicker fusion threshold (CFFT), short-term memory, and reaction time. No significant differences related to RF exposure conditions were detected. Also no differences in baseline data were found between subject groups, **except for the reaction time, which was significantly longer among the cases than among the controls the first time the test was performed.** This difference disappeared when the test was repeated. **However, the cases differed significantly from the controls with respect to HRV as measured in the frequency domain. The cases displayed a shift in low/high frequency ratio towards a sympathetic dominance in the autonomous nervous system during the CFFT and memory tests, regardless of exposure condition. This might be interpreted as a sign of differences in the autonomous nervous system regulation between persons with MP related subjective symptoms and persons with no such symptoms.**
[Exposure: 900 MHz; 30 mins; SAR 1 W/kg]

113 Electromagnetic Hypersensitivity
Proceedings International Workshop on EMF Hypersensitivity Prague, Czech Republic October 25-27, 2004
Editors Kjell Hansson Mild Mike Repacholi Emilie van Deventer Paolo Ravazzani
http://www.who.int/peh-emf/publications/reports/EHS_Proceedings_June2006.pdf
Workshop Summary, Recommendations for medical evaluation (Page 3)
Some studies suggest that certain physiological responses of IEI individuals tend to be outside the normal range. In particular, the findings of hyper reactivity in the central nervous system and misbalance in the autonomic nervous system need to be followed up in clinical investigations and the results for the individuals taken as input for possible treatment.

EHS PAPERS DEMONSTRATING GENETIC VARIATIONS:

See also: De Luca 2014[99].

MECHANISMS:

See also: Andrzejak 2008[44], Belpomme 2014[96] , Gangi & Johansson 2000[100], Khullar 2013[52], Lustenberger 2013[87], Maby 2006[55], Maier 2004[56], Mian 2013[78], Papageorgiou 2011[42], Patel 2008[81], Perentos 2013[88], Regel 2007[62], Schmid 2012[65], Vecchio 2010[69].

114 **American Academy of Environmental Medicine (AAEM), 2012**
Electromagnetic and Radiofrequency Fields Effect on Human Health (Dec 2012)
http://aaemonline.org/emf_rf_position.html
Electromagnetic field (EMF) hypersensitivity has been documented in controlled and double blind studies with exposure to various EMF frequencies. Rea et al. demonstrated that under double blind placebo controlled conditions, 100% of subjects showed reproducible reactions to that frequency to which they were most sensitive. Pulsed electromagnetic frequencies were shown to consistently provoke neurological symptoms in a blinded subject while exposure to continuous frequencies did not.

Although these studies clearly show causality and disprove the claim that health effects from RF exposure are uncertain, there is another mechanism that proves electromagnetic frequencies, including radiofrequencies, can negatively impact human health. Government agencies and industry set safety standards based on the narrow scope of Newtonian or "classical" physics reasoning that the effects of atoms and molecules are confined in space and time. This model supports the theory that a mechanical force acts on a physical object and thus, long-range exposure to EMF and RF cannot have an impact on health if no significant heating occurs. However, this is an incomplete model. A quantum physics model is necessary to fully understand and appreciate how and why EMF and RF fields are harmful to humans. In quantum physics and quantum field theory, matter can behave as a particle or as a wave with wave-like properties. Matter and electromagnetic fields encompass quantum fields that fluctuate in space and time. These interactions can have long-range effects which cannot be shielded, are non-linear and by their quantum nature have uncertainty. Living systems, including the human body, interact with the magnetic vector potential component of an electromagnetic field such as the field near a toroidal coil. The magnetic vector potential is the coupling pathway between biological systems and electromagnetic fields. Once a patient's specific threshold of intensity has been exceeded, it is the frequency which triggers the patient's reactions.

Long range EMF or RF forces can act over large distances setting a biological system oscillating in phase with the frequency of the electromagnetic field so it adapts with consequences to other body systems. This also may produce an electromagnetic frequency imprint into the living system that can be long lasting. Research using objective instrumentation has shown that even passive resonant circuits can imprint a frequency into water and biological systems. These quantum electrodynamic effects do exist and may explain the adverse health effects seen with EMF and RF exposure. These EMF and RF quantum field effects have not been adequately studied and are not fully understood regarding human health.

115 **Austrian Medical Association, 2012**
Guideline of the Austrian Medical Association for diagnosis and treatment of EMF-related health problems and illnesses (EMF Syndrome)
http://www.magdahavas.com/wordpress/wp-content/uploads/2012/06/Austrian-EMF-Guidelines-2012.pdf
Background (page 3)
Based on the scientific literature on interactions of EMF with biological systems, several mechanisms of interaction are possible. A plausible mechanism at the intracellular and intercellular level, for instance, is interaction via the formation of free radicals or oxidative and nitrosative stress (Friedmann et al. 2007, Simkó 2007, Pall 2007, Bedard and Krause 2007, Pacher et al. 2007, Desai et al. 2009). It centres on the increased formation of peroxynitrite (ONOO-) from a reaction of nitrogen monoxide (NO) with superoxide (O2-). Due to its relatively long half-life, peroxynitrite damages a large number of essential metabolic processes and cell components.

116 **Canadian Human Rights Commission, May 2007**
The Medical Perspective on Environmental Sensitivities
http://www.chrc-ccdp.gc.ca/sites/default/files/envsensitivity_en.pdf
B Possible explanations (page 23)
a) Chemical exposures
Healthy bodily functions depend upon chemical (e.g. hormonal) as well as electrical signals to keep all systems (e.g. circulatory, digestive, endocrine, respiratory and nervous systems) working harmoniously. Foreign chemicals can mimic signalling chemicals such as hormones (e.g. estrogen,

thyroid hormones, testosterone), thereby sending the wrong messages or blocking their transmission….
Natural or synthetic chemicals may also affect biochemical pathways and development via "epigenetics," whereby genes are marked to be "read" or "silenced." These changes may be passed to successive generations.
[Author's note: EMF can also interfere with signalling and epigenetics in a similar way.]
b) Neural sensitization
The high prevalence of neurological symptoms in people with environmental sensitivities led to interest in "kindling" within the nervous system. **Kindling is a phenomenon whereby repeated low level exposures to chemicals, or electromagnetic currents or fields eventually cause symptoms at levels previously tolerated**. In this process, neurochemical, behavioural, endocrine and/or immunological responses are amplified.
The limbic system is identified as a target for kindling. This is a basic part of the brain, governing autonomic functions that maintain biological homeostasis. It is involved with the sense of smell, sleep, emotions and behaviour, as well as learning and short-term memory. The limbic system can become sensitized to stressors, and once sensitized will react even to very weak stimuli, eliciting symptoms as seen in environmental sensitivities. The limbic system of the brain is affected directly from the nose via the olfactory nerve, and by inhaled chemicals that bypass the blood-brain barrier.

117 Desai et al, 2009, Biol Endocrinol. 2009; 7: 114
Pathophysiology of cell phone radiation: oxidative stress and carcinogenesis with focus on male reproductive system
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2776019/
A review of scientific research.
Conclusion: We have reviewed the literature to better understand the effects of cell phone radiation on human health, especially on fertility and in relation to cancer. Commercially available cellular phones might affect cell function via non-thermal effects. We hypothesized that the plasma membrane might be the target of cell phone radiation. **RF-EMW can increase ROS formation by increasing the activity of plasma membrane NADH oxidase. Prolonged exposure to RF-EMW can also cause DNA damage (by prolonged OS), which may accelerates neuronal and spermatozoal cell death and promote neurodegenerative processes as well as promote brain and testicular carcinogenesis. Any tumor promoting effects of RF-EMW might be due to the effect it has on PKC, ODC, intra cellular calcium spikes and stimulation of stress kinase. Stimulation of plasma membrane NADH oxidase might play central role in above mentioned effects.**
OS and changes in PKC activity might lead to the RF-EMW related infertility observed in numerous studies. Hence, RF-EMW from commercially available cell phones might affect the fertilizing potential of spermatozoa. Therefore, the SAR limit (maximum acceptable exposure limit) should be lowered for cellular phones. However, more studies are necessary to provide definitive evidence against cell phone radiation, which can be provided by in vitro studies combined with computational biomodeling.

118 Elder & Chou, 2003, Bioelectromagnetics. 2003;Suppl 6:S162-73.
Auditory response to pulsed radiofrequency energy.
http://www.ncbi.nlm.nih.gov/pubmed/14628312
The human auditory response to pulses of radiofrequency (RF) energy, commonly called RF hearing, is a well established phenomenon. RF induced sounds can be characterized as low intensity sounds because, in general, a quiet environment is required for the auditory response. The sound is similar to other common sounds such as a click, **buzz, hiss**, knock, or chirp. Effective radiofrequencies range from 2.4 to 10000 MHz, but an individual's ability to hear RF induced sounds is dependent upon high frequency acoustic hearing in the kHz range above about 5 kHz. The site of conversion of RF energy to acoustic energy is within or peripheral to the cochlea, and once the cochlea is stimulated, the detection of RF induced sounds in humans and RF induced auditory responses in animals is similar to acoustic sound detection. **The fundamental frequency of RF induced sounds is independent of the frequency of the radiowaves but dependent upon head dimensions. The auditory response has been shown to be dependent upon the energy in a single pulse and not on average power density. The weight of evidence of the results of human, animal, and modeling studies supports the thermoelastic expansion theory as the explanation for the RF hearing phenomenon. RF induced sounds involve the perception via bone conduction of thermally generated sound transients, that is, audible sounds are produced by rapid thermal expansion resulting from a calculated temperature rise of only 5 x 10(-6) degrees C in tissue at the threshold level due to absorption of the energy in the RF pulse.** The hearing of RF induced sounds at exposure levels many orders of magnitude greater than the hearing threshold is considered to be a biological effect without an accompanying health effect. This conclusion is supported by a comparison of pressure induced in the body by RF pulses to pressure associated with hazardous acoustic energy and clinical ultrasound procedures.

[Author's note: it is possible that the now widely reported tinnitus associated with EHS, but also noted in the general population in a dose response fashion to, for example mobile phone exposure, could be caused by this mechanism.]

119 Friedman et al, 2007, Biochem J. 2007 Aug 1;405(3):559-68.
Mechanism of short-term ERK activation by electromagnetic fields at mobile phone frequencies.
http://www.ncbi.nlm.nih.gov/pubmed/17456048
The exposure to non-thermal microwave electromagnetic fields generated by mobile phones affects the expression of many proteins. This effect on transcription and protein stability can be mediated by the MAPK (mitogen-activated protein kinase) cascades, which serve as central signalling pathways and govern essentially all stimulated cellular processes. **Indeed, long-term exposure of cells to mobile phone irradiation results in the activation of p38 as well as the ERK (extracellular-signal-regulated kinase) MAPKs.** In the present study, we have studied the immediate effect of irradiation on the MAPK cascades, and found that ERKs, but not stress-related MAPKs, are rapidly activated in response to various frequencies and intensities. Using signalling inhibitors, we delineated the mechanism that is involved in this activation. **We found that the first step is mediated in the plasma membrane by NADH oxidase, which rapidly generates ROS (reactive oxygen species). These ROS then directly stimulate MMPs (matrix metalloproteinases) and allow them to cleave and release Hb-EGF [heparin-binding EGF (epidermal growth factor)]. This secreted factor activates the EGF receptor, which in turn further activates the ERK cascade. Thus this study demonstrates for the first time a detailed molecular mechanism by which electromagnetic irradiation from mobile phones induces the activation of the ERK cascade and thereby induces transcription and other cellular processes.**

120 Genuis and Lipp , 2012, Sci Total Environ. 2012 Jan 1;414:103-12.
Electromagnetic hypersensitivity: fact or fiction?
http://www.ncbi.nlm.nih.gov/pubmed/22153604
Some scientists and clinicians acknowledge the phenomenon of hypersensitivity to EMR resulting from common exposures such as wireless systems and electrical devices in the home or workplace; others suggest that electromagnetic hypersensitivity (EHS) is psychosomatic or fictitious. Various organizations including the World Health Organization as well as some nation states are carefully exploring this clinical phenomenon in order to better explain the rising prevalence of non-specific, multi-system, often debilitating symptoms associated with non-ionizing EMR exposure. As well as an assortment of physiological complaints, patients diagnosed with EHS also report profound social and personal challenges, impairing their ability to function normally in society. This paper offers a review of the sparse literature on this perplexing condition and a discussion of the controversy surrounding the legitimacy of the EHS diagnosis. Recommendations are provided to assist health professionals in caring for individuals complaining of EHS.
[Author's note: In Section 2.3 Pathogensis of Electromagnetic Hypersensitivity Genuis describes a) sensitivity related illness (toxicant induced loss of tolerance, Tilt), b) Catecholamine dysregulation].

121 Khamidova, 2014, International Journal of BioMedicine 4(3) (2014) 155-158
The Influence of Radiofrequency Electromagnetic Radiation on the Platelet Aggregation
http://ijbm.org/articles/Article4_3_CR5.pdf
Abstract
The purpose of this study was to examine the impact of radiofrequency electromagnetic fields (RF-EMFs) on platelet aggregation (PA) in individuals working for a long time under a direct and continuous RF-EMF exposure. We examined 119 persons aged from 22 to 65 years. In individuals working under the direct and constant exposure to RF-EMFs, the various changesof PA with a predominance of hyperaggregation are detected. The dependence of the changes in the indicators of PA on length of work in conditions of RF-EMF exposure is determined.
INTRODUCTION
Recently, it has been shown that RF-EMFs with extremely high frequencies may influence practically all known types of cells in systems of arbitrary organization levels of living material.
RESULTS AND DISCUSSION
We have noted significant differences in the parameters of the intensity and the rate of PA in the persons working under the influence of RF-EMF compared with healthy volunteers (Table 1). The rate of PA in Groups III-VI was significantly different from the control values, i.e. in persons working for over 11 years under the influence of RF-EMF. It is known that the cell generates EMF of a wide range during one's lifetime. The millimeter and submillimeter ranges were used by the cells for information exchange, which is necessary for the regulation of intracellular functions and cell-cell interactions. This is supported by the appearance of a number of effects, both in individual cells and the whole organism, in response to RF-EMF. Under the RF-EMF exposure, the directed displacement of ions, the redistribution of electric charges, and polarization take place. Oscillatory motion of the charged corpuscles lead to different intramolecular physicochemical and structural adjustments, promoting change in the functional activity of cells,

including platelets. As a result, the nonspecific metabolic reactions (phosphorylation of proteins, receptor activation) determining the hyperactivity of platelets consistently occur in platelets, which are lined up in the form of the "sludge" chain in parallel to the force lines of the electrical field. Thus, the structure of the cell membrane is changed: the membrane is destroyed and intermolecular bonds are ruptured. Plateletderived factors, such as adenosine diphosphate, thromboxane A2, serotonin and others, are activated. Changes in the structure of the platelet membrane lead to the activation of the receptor complex GPIIβ/IIIα, which mediates PA. The emergence of a large number of circulating platelet aggregates impairs blood rheology and microcirculation. The blockage of microcirculation is accompanied by impaired functioning of organs and systems. It is also known there are low-frequency bio-currents in the human body. The heart generates electrical oscillations with frequencies from 30 to 700Hz and the brain from 200 to 500Hz. If the frequency of bio-currents coincides with the frequency of the EMF, the bio-currents are distorted, which leads to disruption of normal functioning of the body. Microcirculatory disorders and hyperactivity of platelets further exacerbate this situation.

CONCLUSION

The results of our study confirm the deleterious effect RF-EMF both on the blood cells and on blood rheology. In individuals working under the direct and constant exposure to RF-EMFs, the various changes of PA with a predominance of hyperaggregation are detected.

122 McCarty et al, Int J Neurosci. 2011 Dec;121(12):670-6.

Electromagnetic hypersensitivity: evidence for a novel neurological syndrome.

http://www.ncbi.nlm.nih.gov/pubmed/21793784

http://andrewamarino.com/PDFs/171-IntJNeurosci2011.pdf (full paper)

Introduction

The underlying mechanism of field sensory transduction appears to be an electricforce-sensitive ion channel (Marino, Carrubba, Frilot, & Chesson, 2009). Animal studies suggest that the electroreceptor cells and/or afferent processing cells are located in the brain stem (Frilot, Carrubba, & Marino, 2009, 2011).

123 Pacher et al, 2007, Physiol Rev. 2007 Jan;87(1):315-424.

http://www.ncbi.nlm.nih.gov/pubmed/17237348

Nitric oxide and peroxynitrite in health and disease.

The discovery that mammalian cells have the ability to synthesize the free radical nitric oxide (NO) has stimulated an extraordinary impetus for scientific research in all the fields of biology and medicine. Since its early description as an endothelial-derived relaxing factor, NO has emerged as a fundamental signaling device regulating virtually every critical cellular function, as well as a potent mediator of cellular damage in a wide range of conditions. Recent evidence indicates that most of the cytotoxicity attributed to NO is rather due to peroxynitrite, produced from the diffusion-controlled reaction between NO and another free radical, the superoxide anion. **Peroxynitrite interacts with lipids, DNA, and proteins via direct oxidative reactions or via indirect, radical-mediated mechanisms. These reactions trigger cellular responses ranging from subtle modulations of cell signaling to overwhelming oxidative injury, committing cells to necrosis or apoptosis. In vivo, peroxynitrite generation represents a crucial pathogenic mechanism in conditions such as stroke, myocardial infarction, chronic heart failure, diabetes, circulatory shock, chronic inflammatory diseases, cancer, and neurodegenerative disorders.** Hence, novel pharmacological strategies aimed at removing peroxynitrite might represent powerful therapeutic tools in the future. Evidence supporting these novel roles of NO and peroxynitrite is presented in detail in this review.

[Author's note: Peroxynitrite can be increased in response to RF EMF].

124 Pall, 2013, J Cell Mol Med. 2013 Aug;17(8):958-65.

Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects.

http://www.ncbi.nlm.nih.gov/pubmed/23802593

http://onlinelibrary.wiley.com/doi/10.1111/jcmm.12088/full

The direct targets of extremely low and microwave frequency range electromagnetic fields (EMFs) in producing non-thermal effects have not been clearly established. However, studies in the literature, reviewed here, provide substantial support for such direct targets. **Twenty-three studies have shown that voltage-gated calcium channels (VGCCs) produce these and other EMF effects**, such that the L-type or other VGCC blockers block or greatly lower diverse EMF effects. **Furthermore, the voltage-gated properties of these channels may provide biophysically plausible mechanisms for EMF biological effects. Downstream responses of such EMF exposures may be mediated through Ca(2+) /calmodulin stimulation of nitric oxide synthesis. Potentially, physiological/therapeutic responses may be largely as a result of nitric oxide-cGMP-protein kinase G pathway stimulation.** A well-studied example of such an apparent therapeutic response, EMF stimulation of bone growth, appears to work along this pathway. However,

pathophysiological responses to EMFs may be as a result of nitric oxide-peroxynitrite-oxidative stress pathway of action. A single such well-documented example, EMF induction of DNA single-strand breaks in cells, as measured by alkaline comet assays, is reviewed here. Such single-strand breaks are known to be produced through the action of this pathway. Data on the mechanism of EMF induction of such breaks are limited; what data are available support this proposed mechanism. **Other Ca(2+) -mediated regulatory changes, independent of nitric oxide, may also have roles. This article reviews, then, a substantially supported set of targets, VGCCs, whose stimulation produces non-thermal EMF responses by humans/higher animals with downstream effects involving Ca(2+) /calmodulin-dependent nitric oxide increases, which may explain therapeutic and pathophysiological effects.**
[Author's note: These voltage gated calcium channel changes have been implicated by Professor Pall in the development of EHS. Ref: BSEM conference video March 2014].

125 Redmayne & Johansson, 2014, J Toxicol Environ Health B Crit Rev. 2014;17(5):247-58.
Could myelin damage from radiofrequency electromagnetic field exposure help explain the functional impairment electrohypersensitivity? A review of the evidence.
http://www.ncbi.nlm.nih.gov/pubmed/25205214
Myelin provides the electrical insulation for the central and peripheral nervous system and develops rapidly in the first years of life, but continues into mid-life or later. Myelin integrity is vital to healthy nervous system development and functioning. This review outlines the development of myelin through life, and then considers the evidence for an association between myelin integrity and exposure to low-intensity radiofrequency electromagnetic fields (RF-EMFs) typical in the modern world. **In RF-EMF peer-reviewed literature examining relevant impacts such as myelin sheath, multiple sclerosis, and other myelin-related diseases, cellular examination was included. There are surprisingly little data available in each area, but considered together a picture begins to emerge in RF-EMF-exposed cases: (1) significant morphological lesions in the myelin sheath of rats; (2) a greater risk of multiple sclerosis in a study subgroup; (3) effects in proteins related to myelin production; and (4) physical symptoms in individuals with functional impairment electrohypersensitivity, many of which are the same as if myelin were affected by RF-EMF exposure, giving rise to symptoms of demyelination.** In the latter, there are exceptions; headache is common only in electrohypersensitivity, while ataxia is typical of demyelination but infrequently found in the former group. **Overall, evidence from in vivo and in vitro and epidemiological studies suggests an association between RF-EMF exposure and either myelin deterioration or a direct impact on neuronal conduction, which may account for many electrohypersensitivity symptoms. The most vulnerable are likely to be those in utero through to at least mid-teen years, as well as ill and elderly individuals.**
Extract from full paper (p248):
In yet unpublished studies by Johansson et al. (personal communication), the epidermal nerve fibers of electrohypersensitive persons were markedly reduced in length and number of nerve terminals, indicating apparent damage.
Extract from full paper (p255):
Overall, evidence suggests an association between RF-EMF exposure and either myelin deterioration or a direct impact on neuronal conduction, which may account for many electrohypersensitivity symptoms. The question is whether this occurred due to myelin sheath destruction or functional axonal conduction disruption. In neuroscience it is a well-established fact that reduction of the number of nerve fibers and concomitantly axonal terminals leads to an elevation in sensitivity, the so-called supersensitivity phenomenon (Gerfen, 2003). Can these also be underlying mechanisms for electrohypersensitivity?

126 Simkó M., 2007, Curr Med Chem. 2007;14(10):1141-52.
Cell type specific redox status is responsible for diverse electromagnetic field effects.
http://www.ncbi.nlm.nih.gov/pubmed/17456027
Epidemiologic and experimental research on the potential carcinogenic effects of extremely low frequency electromagnetic fields (ELF-EMF) has been performed for a long time. Epidemiologic studies regarding ELF-EMF-exposure have focused primarily on leukaemia development due to residential sources in children and adults, and from occupational exposure in adults, but also on other kinds of cancer. Genotoxic investigations of EMF have shown contradictory results, a biological mechanism is still lacking that can explain the link between cancer development and ELF-EMF-exposure. Recent laboratory research has attempted to show general biological effects, and such that could be related to cancer development and/or promotion. Metabolic processes which generate oxidants and antioxidants can be influenced by environmental factors, such as ELF-EMF. Increased ELF-EMF exposure can modify the activity of the organism by reactive oxygen species leading to oxidative stress. **It is well established that free radicals can interact with DNA resulting in single strand breaks. DNA damage could become a site of mutation, a key step to carcinogenesis. Furthermore, different cell types react differently to the same stimulus, because of their cell type**

specific redox status. The modulation of cellular redox balance by the enhancement of oxidative intermediates, or the inhibition or reduction of antioxidants, is discussed in this review. **An additional aspect of free radicals is their function to influence other illnesses such as Parkinson's and Alzheimer's diseases. On the other hand, modulation of antioxidants by ELF-EMF can lower the intracellular defence activity promoting the development of DNA damage. It has also been demonstrated that low levels of reactive oxygen species trigger intracellular signals that involve the transcription of genes and leading to responses including cell proliferation and apoptosis.** In this review, a general overview is given about oxidative stress, as well as experimental studies are reviewed as they are related to changes in oxidant and antioxidant content after ELF-EMF exposure inducing different biological effects. **Finally, we conclude from our review that modulations on the oxidant and antioxidant level through ELF-EMF exposure can play a causal role in cancer development.**
[Author's note: this study concerns ELF EMF].

RECOGNISED AS PHYSIOLOGICAL CONDITION:

127 **American Academy of Environmental Medicine (AAEM)**
Electromagnetic and Radiofrequency Fields Effect on Human Health (Dec 2012)
http://aaemonline.org/emf_rf_position.html
For over 50 years, the American Academy of Environmental Medicine (AAEM) has been studying and treating the effects of the environment on human health. In the last 20 years, our physicians began seeing patients who reported that electric power lines, televisions and other electrical devices caused a wide variety of symptoms. **By the mid 1990's, it became clear that patients were adversely affected by electromagnetic fields and becoming more electrically sensitive. In the last five years with the advent of wireless devices, there has been a massive increase in radiofrequency (RF) exposure from wireless devices as well as reports of hypersensitivity and diseases related to electromagnetic field and RF exposure. Multiple studies correlate RF exposure with diseases such as cancer, neurological disease, reproductive disorders, immune dysfunction, and electromagnetic hypersensitivity.**

…Electromagnetic field (EMF) hypersensitivity has been documented in controlled and double blind studies with exposure to various EMF frequencies. Rea et al. demonstrated that under double blind placebo controlled conditions, 100% of subjects showed reproducible reactions to that frequency to which they were most sensitive. Pulsed electromagnetic frequencies were shown to consistently provoke neurological symptoms in a blinded subject while exposure to continuous frequencies did not. …

Although these studies clearly show causality and disprove the claim that health effects from RF exposure are uncertain, there is another mechanism that proves electromagnetic frequencies, including radiofrequencies,…

Furthermore, the AAEM asks for:

- An immediate caution on Smart Meter installation due to potentially harmful RF exposure.
- Accommodation for health considerations regarding EMF and RF exposure, including exposure to wireless Smart Meter technology.
- Independent studies to further understand the health effects from EMF and RF exposure.
- **Recognition that electromagnetic hypersensitivity is a growing problem worldwide.**
- Understanding and control of this electrical environmental bombardment for the protection of society.
- Consideration and independent research regarding the quantum effects of EMF and RF on human health.
- Use of safer technology, including for Smart Meters, such as hard-wiring, fiber optics or other non-harmful methods of data transmission.

128 **Austrian Medical Association, 2012**
Guideline of the Austrian Medical Association for diagnosis and treatment of EMF-related health problems and illnesses (EMF Syndrome)
http://www.magdahavas.com/wordpress/wp-content/uploads/2012/06/Austrian-EMF-Guidelines-2012.pdf

129 **Bioinitiative Report, 2014, Summary for the Public (2014 Supplement)**
A report by 29 independent scientists and health experts from around the world (ten holding medical degrees (MDs), 21 PhDs, and three MSc, MA or MPHs) about possible risks from wireless technologies and electromagnetic fields. Among the authors are three former presidents of the Bioelectromagnetics Society (BEMS), and five full members of

BEMS. One distinguished author is the Chair of the Russian National Committee on Non-Ionizing Radiation. Another is a Senior Advisor to the European Environmental Agency.
http://www.bioinitiative.org/report/wp-content/uploads/pdfs/sec01_2012_summary_for_public.pdf
II. SUMMARY OF THE SCIENCE
E. Evidence for Electrohypersensitivity
What is evident is that a growing number of people world-wide have serious and debilitating symptoms that key to various types of EMF and RFR exposure. Of this there is little doubt. The continued massive rollout of wireless technologies, in particular the wireless 'smart' utility meter, has triggered thousands of complaints of ill-health and disabling symptoms when the installation of these meters is in close proximity to family home living spaces.

130 **Canadian Human Rights Commission, May 2007**
The Medical Perspective on Environmental Sensitivities
http://www.chrc-ccdp.gc.ca/sites/default/files/envsensitivity_en.pdf
Executive Summary (page iv)
Research indicates that sensitivities generally have physical causes, with many neurological and psycho-social factors interwoven. Successfully addressing physical symptoms with safe housing, workplaces, food and water may also alleviate psychological symptoms. This is necessary before other psychosocial interventions may be helpful.
Summary (page 26)
The balance of scientific evidence and experience indicates that environmental sensitivities generally arise from physiological causes, although there are many neurological and psychological consequences.

131 **Freiburger Appeal, 2002**
More than 1000 physicians signed the "Freiburg Appeal" in 2002. It was translated into many languages. As many as 36,000 people from all over the world support its warning about the dangers of radio-frequency radiation.
http://www.powerwatch.org.uk/pdfs/20021019_englisch.pdf
Out of great concern for the health of our fellow human beings do we - as established physicians of all fields, especially that of environmental medicine - turn to the medical establishment and those in public health and political domains, as well as to the public.

We have observed, in recent years, a dramatic rise in severe and chronic diseases among our patients, especially:
· Learning, concentration, and behavioural disorders (e.g. attention deficit disorder, ADD)
· Extreme fluctuations in blood pressure, ever harder to influence with medications
· Heart rhythm disorders
· Heart attacks and strokes among an increasingly younger population
· Brain-degenerative diseases (e.g. Alzheimer–s) and epilepsy
· Cancerous afflictions: leukemia, brain tumors
Moreover, we have observed an ever-increasing occurrence of various disorders, often misdiagnosed in patients as psychosomatic:
· Headaches, migraines
· Chronic exhaustion
· Inner agitation
· Sleeplessness, daytime sleepiness
· Tinnitus
· Susceptibility to infection
· Nervous and connective tissue pains, for which the usual causes do not explain even the most conspicuous symptoms
Since the living environment and lifestyles of our patients are familiar to us, we can see - especially after carefully-directed inquiry - a clear temporal and spatial correla-tion between the appearance of disease and exposure to pulsed high -frequency microwave radiation (HFMR), such as:
· Installation of a mobile telephone sending station in the near vicinity
· Intensive mobile telephone use

· Installation of a digital cordless (DECT) telephone at home or in the neighbourhood

We can no longer believe this to be purely coincidence, for:

· Too often do we observe a marked concentration of particular illnesses in correspondingly HFMR-polluted areas or apartments;

· Too often does a long-term disease or affliction improve or disappear in a relatively short time after reduction or elimination of HFMR pollution in the patient–s environment;

· Too often are our observations confirmed by on-site measurements of HFMR of unusual intensity.

On the basis of our daily experiences, we hold the current mobile communications technology (introduced in 1992 and since then globally extensive) and cordless digital telephones (DECT standard) to be among the fundamental triggers for this fatal development.

One can no longer evade these pulsed microwaves. They heighten the risk of already-present chemical/physical influences, stress the body–s immune system, and can bring the body–s still-functioning regulatory mechanisms to a halt. Pregnant women, children, adolescents, elderly and sick people are especially at risk.

132 **International Doctors Appeal, 2012**

http://freiburger-appell-2012.info/media/International_Doctors_Appeal_2012_Nov.pdf

II. Appeal:

As physicians and scientists, we hereby call on our colleagues; on the leaders of federal, state, and local governments; but also on the wider community to take action and implement the following precautionary strategies, which also include fundamental human rights:

1. Protect the inviolability of the home by minimizing radio-frequency exposure levels, which penetrate through the walls of one's own home.

2. Ensure considerably lower radio-frequency radiation exposures as well as exposure limits that reliably protect humans and nature from adverse biological effects of electromagnetic fields. Any further expansion of wireless technologies is irresponsible.

3. Prefer wired solutions for home use and public institutions, especially at preschools, schools, colleges, universities, nursing homes, and hospitals.

4. Cutback and reprogram continuously emitting devices such as cordless phones, wireless Internet access (Wi-Fi), and wireless smart meters so that they only operate and emit radio-frequency radiation on demand when being used.

5. Provide special protection for children and adolescents: Children below the age of 8 should not use cell phones and cordless phones; children and adolescents between the ages 8 and 16 should also not use cell phones or only use them in the case of an emergency. Cell phone and online device advertisements must not be directed at children and adolescents, and these devices should not be used at schools.

6. Attach clearly visible warning labels and safety guidelines for lowering the radiation exposure on cell phones and other wireless devices, including instruction manuals. An important reminder: do not carry a cell phone right next to your body when it is turned on.

7. **Identify and clearly mark protected zones for electrohypersensitive people; establish public areas without wireless access or coverage, especially on public transport, similar to smoke-free areas for nonsmokers.**

8. Promote the development of communication technologies and electricity use that is more compatible with health. Prefer wired solutions for home use and public facilities. Expand fiber-optic networks as the foundation of a modern, sustainable, and performance-based technology that meets the ever-increasing demand for higher data transmission rates.

9. Provide government funding for industry-independent research and education that do not dismiss strong scientific and medical findings of potential risks, but rather work to clarify those risks.

At the same time, we also call on everyone who cares about health and the environment:

Make wise consumer choices and thus help reduce exposure levels. Favor wired communication technologies. Inform yourself and pass this knowledge on to your family, neighbors, friends, and politicians. Get involved and make a difference so that the protection of human health and the environment is not left to and limited by commercial

interests.

133 Huss & Röösli, 2006, BMC Public Health. 2006 Oct 30;6:267.
Consultations in primary care for symptoms attributed to electromagnetic fields--a survey among general practitioners.
http://www.ncbi.nlm.nih.gov/pubmed/17074080
BACKGROUND:
Five percent of the Swiss population attribute symptoms to electromagnetic fields (EMF). General practitioners (GPs) might play a key role in recognising an emerging health risk, since they are the first to observe and follow up persons who attribute symptoms to EMF. It is unclear to what extent EMFs have become an issue in general practice and which experiences GPs report from the consultations.
METHODS:
We conducted telephone interviews in a random sample of GPs in Switzerland in order to assess the frequency of consultations in primary care due to EMF and the GPs' experience with these patients.
RESULTS:
342 general practitioners were interviewed, corresponding to a response rate of 28.2%. 69% of the GPs reported at least one consultation due to EMF, but GPs with a certificate in complementary medicine were much more likely to report EMF consultations. The median of EMF consultation numbers within one year was three. An overview of the most recent EMF-related consultation per GP yielded sleep disorders, headaches and fatigue as the most often reported symptoms and mobile phone base stations, power lines and the own use of mobile phones as the main EMF sources suspected to be associated to symptoms. GPs judged the association between EMF and the symptoms to be plausible in 54% of the cases. There was no combination of symptoms and EMF sources that was remarkably and consistently judged to be a plausible cause of the symptoms.
CONCLUSION:
In our survey, **GPs often judged the association between the health problems and the suspected exposure to be plausible.** This plausibility assessment seems to be based on grounds of preventive positions in a situation of scientific uncertainty. More research effort is needed to obtain more insight on a potential association between long term EMF exposure and unspecific symptoms.

134 **Irish Doctors Environmental Association (IDEA)**
http://ideaireland.org/library/idea-position-on-electro-magnetic-radiation/
1. An increasing number of people in Ireland are complaining of symptoms which, while they may vary in nature, intensity and duration, can be demonstrated to be clearly related to exposure to electro-magnetic radiation (EMR).

The Irish Doctors' Environmental Association believes that the Irish Government should urgently review the information currently available internationally on the topic of the thermal and non-thermal effects of exposure to electro-magnetic radiation with a view to immediately initiating appropriate research into the adverse health effects of exposure to all forms of non-ionising radiation in this country, and into the forms of treatment available elsewhere. Before the results of this research are available, an epidemiological database should be initiated of individuals suffering from symptoms thought to be related to exposure to non-ionising radiation. Those claiming to be suffering from the effects of exposure to electro-magnetic radiation should have their claims investigated in a sensitive and thorough way, and appropriate treatment provided by the State.

The strictest possible safety regulations should be established for the installation of masts and transmitters, and for the acceptable levels of potential exposure of individuals to electro-magnetic radiation.

135 **Parliamentary Assembly of the Council of Europe, Resolution 1815 (2011) (Doc 12608)**
B. Explanatory memorandum by Mr Huss, rapporteur
http://assembly.coe.int/ASP/Doc/XrefViewPDF.asp?FileID=13137&Language=EN (Draft resolution)
60. Here, too, the rapporteur stresses that some people may be more sensitive than others to electromagnetic radiation or waves. **The research performed, for instance, by Professor Dominique Belpomme, President of the Association for Research on Treatments Against Cancer (ARTAC), on more than 200 people describing themselves as "electrosensitive" succeeded, with corroborative results of clinical and biological analyses, in proving that there was such a syndrome of intolerance to electromagnetic fields across the whole spectrum of frequencies.** According to these results, not only proximity to the sources of electromagnetic emissions was influential, but also the time of exposure and often concomitant exposure to chemicals or to (heavy) metals present in human

tissues. In this context, Sweden has granted sufferers from electromagnetic hypersensitivity the status of persons with reduced capacity so that they receive suitable protection.

RECOGNISED BY WORLD HEALTH ORGANISATION (WHO):

See also: Proceedings International Workshop on EMF Hypersensitivity 2004[113].

136 **World Health Organisation (WHO) Fact Sheet, Backgrounder Dec 2005**
Electromagnetic fields and public health: Electromagnetic hypersensitivity
http://www.who.int/peh-emf/publications/facts/fs296/en/
As societies industrialize and the technological revolution continues, there has been an unprecedented increase in the number and diversity of electromagnetic field (EMF) sources. These sources include video display units (VDUs) associated with computers, mobile phones and their base stations. While these devices have made our life richer, safer and easier, they have been accompanied by concerns about possible health risks due to their EMF emissions.
For some time a number of individuals have reported a variety of health problems that they relate to exposure to EMF. While some individuals report mild symptoms and react by avoiding the fields as best they can, others are so severely affected that they cease work and change their entire lifestyle. This reputed sensitivity to EMF has been generally termed "electromagnetic hypersensitivity" or EHS.
Conclusions
The symptoms are certainly real and can vary widely in their severity. Whatever its cause, **EHS can be a disabling problem for the affected individual.**
Researchers: Some **studies suggest that certain physiological responses of EHS individuals tend to be outside the normal range. In particular, hyper reactivity in the central nervous system and imbalance in the autonomic nervous system need to be followed up in clinical investigations and the results for the individuals taken as input for possible treatment.**

NOCEBO EFFECT – PSYCHOLOGICAL THERAPIES AND RISK PERCEPTION:

See also: Levallois 2002[17].

137 Rubin et al, 2010, Bioelectromagnetics. 2010 Jan;31(1):1-11.
Idiopathic environmental intolerance attributed to electromagnetic fields (formerly 'electromagnetic hypersensitivity'): An updated systematic review of provocation studies.
http://www.ncbi.nlm.nih.gov/pubmed/19681059
Idiopathic Environmental Intolerance attributed to electromagnetic fields (IEI-EMF; formerly 'electromagetic hypersensitivity') is a medically unexplained illness in which subjective symptoms are reported following exposure to electrical devices. In an earlier systematic review, we reported data from 31 blind provocation studies which had exposed IEI-EMF volunteers to active or sham electromagnetic fields and assessed whether volunteers could detect these fields or whether they reported worse symptoms when exposed to them. In this article, we report an update to that review. An extensive literature search identified 15 new experiments. Including studies reported in our earlier review, 46 blind or double-blind provocation studies in all, involving 1175 IEI-EMF volunteers, have tested whether exposure to electromagnetic fields is responsible for triggering symptoms in IEI-EMF. No robust evidence could be found to support this theory. However, the studies included in the review did support the role of the nocebo effect in triggering acute symptoms in IEI-EMF sufferers. Despite the conviction of IEI-EMF sufferers that their symptoms are triggered by exposure to electromagnetic fields, repeated experiments have been unable to replicate this phenomenon under controlled conditions. A narrow focus by clinicians or policy makers on bioelectromagnetic mechanisms is therefore, unlikely to help IEI-EMF patients in the long-term.

138 Hagström et al, 2013, Pathophysiology. 2013 Apr;20(2):117-22.
Electromagnetic hypersensitive Finns: Symptoms, perceived sources and treatments, a questionnaire study.
http://www.ncbi.nlm.nih.gov/pubmed/23557856
According to 76% of 157 respondents the reduction or avoidance of electromagnetic fields (EMF) helped in their full or partial recovery. The best treatments for EHS were given as: "dietary change" (69.4%), "nutritional supplements" (67.8%) and "increased physical exercise" (61.6%). **The official treatment recommendations of psychotherapy (2.6%) and medication (-4.2%) were not significantly helpful.** According to the present results the official treatment protocols

should take better account the EHS person's own experiences**. The avoidance of electromagnetic radiation and fields effectively removed or lessened the symptoms in EHS persons.**

PAPERS REFUTING THE NOCEBO EFFECT
DEMONSTRATING EHS TYPE EFFECTS IN CHILDREN & FOETUSES:

139 **Bioinitiative report 2012**
http://www.bioinitiative.org/
Conclusions: FETAL AND NEONATAL EFFECTS OF EMF
Fetal (in-utero) and early childhood exposures to cell phone radiation and wireless technologies in general may be a risk factor for hyperactivity, learning disorders and behavioral problems in school.
Effects on the developing fetus from in-utero exposure to cell phone radiation have been observed in both human and animal studies since 2006. Sources of fetal and neonatal exposures of concern include cell phone radiation (both paternal use of wireless devices worn on the body and maternal use of wireless phones during pregnancy). Exposure to whole-body RFR from base stations and WI-FI, use of wireless laptops, use of incubators for newborns with excessively high ELF-EMF levels.

140 Divan et al, 2012, J Epidemiol Community Health 2012;66:524-529
Cell phone use and behavioural problems in young children
http://jech.bmj.com/content/66/6/524.short
Background: Potential health effects of cell phone use in children have not been adequately examined. As children are using cell phones at earlier ages, research among this group has been identified as the highest priority by both national and international organisations. The authors previously reported results from the Danish National Birth Cohort (DNBC), which looked at prenatal and postnatal exposure to cell phone use and behavioural problems at age 7 years. **Exposure to cell phones prenatally, and to a lesser degree postnatally, was associated with more behavioural difficulties.** The original analysis included nearly 13 000 children who reached age 7 years by November 2006.
Methods: To see if a larger, separate group of DNBC children would produce similar results after considering additional confounders, children of mothers who might better represent current users of cell phones were analysed. This 'new' dataset consisted of 28 745 children with completed Age-7 Questionnaires to December 2008.
Results: The highest OR for behavioural problems were for children who had both prenatal and postnatal exposure to cell phones compared with children not exposed during either time period. The adjusted effect estimate was 1.5 (95% CI 1.4 to 1.7).
Conclusions: The findings of the previous publication were replicated in this separate group of participants demonstrating that **cell phone use was associated with behavioural problems at age 7 years in children, and this association was not limited to early users of the technology.** Although weaker in the new dataset, even with further control for an extended set of potential confounders, the associations remained.
[Exposure: prenatal and postnatal]

141 Divan, H. et al, 2008, Epidemiology 19 523-529, 2008
Prenatal and postnatal exposure to cell phone use and behavioral problems in children.
http://www.ncbi.nlm.nih.gov/pubmed/18467962
Exposure to cell phones prenatally and, to a lesser degree, postnatally was associated with behavioral difficulties such as emotional and hyperactivity problems around the age of school entry. These associations may be noncausal and may be due to unmeasured confounding. If real, they would be of **public health concern given the widespread use of this technology.**

142 Rezk et al, 2008, Saudi Med J. 2008 Feb;29(2):218-23.
Fetal and neonatal responses following maternal exposure to mobile phones.
http://www.ncbi.nlm.nih.gov/pubmed/18246230
OBJECTIVE:
To study fetal and neonatal heart rate (HR) and cardiac output (COP), following acute maternal exposure to electromagnetic fields (EMF) emitted by mobile phones.
METHODS:
The present study was carried out at Benha University Hospital and El-Shorouq Hospital, Cairo, Egypt, from October 2003 to March 2004. Ninety women with uncomplicated pregnancies aged 18-33 years, and 30 full term healthy newborn infants were included. The pregnant mothers were exposed to EMF emitted by mobile telephones while on

telephone-dialing mode for 10 minutes during pregnancy and after birth. The main outcome were measurements of fetal and neonatal HR and COP.
RESULTS:
A statistical significant increase in fetal and neonatal HR, and statistical significant decrease in stroke volume and COP before and after use of mobile phone were noted. All these changes are attenuated with increase in gestational age.
CONCLUSION:
Exposure of pregnant women to mobile phones significantly increase fetal and neonatal HR, and significantly decreased the COP.
[Exposure: 900 MHz (pulsed); 10 min/day during pregnancy and 48h after birth]

143 Sudan et al, 2012, Open Pediatr Med Journal. 2012 Dec 5;6(2012):46-52.
Prenatal and Postnatal Cell Phone Exposures and Headaches in Children.
http://www.ncbi.nlm.nih.gov/pubmed/23750182
The Danish National Birth Cohort enrolled pregnant women between 1996 and 2002. When their children reached age seven years, mothers completed a questionnaire regarding the child's health, behaviors, and exposures. We used multivariable adjusted models to relate prenatal only, postnatal only, or both prenatal and postnatal cell phone exposure to whether the child had migraines and headache-related symptoms.
Results: Our analyses included data from 52,680 children. Children with cell phone exposure had higher odds of migraines and headache-related symptoms than children with no exposure. The odds ratio for migraines was 1.30 (95% confidence interval: 1.01-1.68) and for headache-related symptoms was 1.32 (95% confidence interval: 1.23-1.40) for children with both prenatal and postnatal exposure.
Conclusions: In this study, cell phone exposures were associated with headaches in children, but the associations may not be causal given the potential for uncontrolled confounding and misclassification in observational studies such as this. However, given the widespread use of cell phones, if a causal effect exists it would have great public health impact.

PAPERS REFUTING THE NOCEBO EFFECT DEMONSTRATING EHS TYPE EFFECTS IN ANIMALS:

144 Aldad T. S. et al, Mar 2012, Scientific Reports, Nature, 5 Mar 2012
Fetal Radiofrequency Radiation Exposure From 800-1900 Mhz-Rated Cellular Telephones Affects Neurodevelopment and Behavior in Mice
http://www.nature.com/srep/2012/120315/srep00312/full/srep00312.html
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3575011/pdf/srep01320.pdf [Erratum does not affect conclusion]
Mice exposed in-utero were hyperactive and had impaired memory as determined using the object recognition, light/dark box and step-down assays. Whole cell patch clamp recordings of miniature excitatory postsynaptic currents (mEPSCs) revealed that **these behavioral changes were due to altered neuronal developmental programming**. Exposed mice had dose-responsive impaired glutamatergic synaptic transmission onto layer V pyramidal neurons of the prefrontal cortex. **We present the first experimental evidence of neuropathology due to in-utero cellular telephone radiation.** Further experiments are needed in humans or non-human primates to determine the risk of exposure during pregnancy.
[Exposure: mobile phone 800-1900 MHz, continuous for 0, 9, 15 or 24 h/day on day 1-17 of gestation; SAR 1.6 W/kg]

145 Balmori et al, 2010, Electromagn Biol Med. 2010 Jun;29(1-2):31-5..
Mobile phone mast effects on common frog (Rana temporaria) tadpoles: the city turned into a laboratory.
http://www.ncbi.nlm.nih.gov/pubmed/20560769
An experiment has been made exposing eggs and tadpoles of the common frog (Rana temporaria) to electromagnetic radiation from several mobile (cell) phone antennae located at a distance of 140 meters. The experiment lasted two months, from the egg phase until an advanced phase of tadpole prior to metamorphosis. Measurements of electric field intensity (radiofrequencies and microwaves) in V/m obtained with three different devices were 1.8 to 3.5 V/m. In the exposed group (n = 70), **low coordination of movements**, an asynchronous growth, resulting in both big and small tadpoles, and a high mortality (90%) was observed. Regarding the control group (n = 70) under the same conditions but inside a Faraday cage, the coordination of movements was normal, the development was synchronous, and a mortality of 4.2% was obtained. **These results indicate that radiation emitted by phone masts in a real situation may affect the**

development and may cause an increase in mortality of exposed tadpoles. This research may have huge implications for the natural world, which is now exposed to high microwave radiation levels from a multitude of phone masts.
[Exposure: 648-2155 MHz; continuous for 2 months (from egg to prior to metamorphosis); electric field strength 1.8-3.5 V/m]

146 Balmori et al, 2007, Electromagn Biol Med. 2007;26(2):141-51.
The urban decline of the house sparrow (Passer domesticus): a possible link with electromagnetic radiation.
http://www.ncbi.nlm.nih.gov/pubmed/17613041
During recent decades, there has been a marked decline of the house sparrow (Passer domesticus) population in the United Kingdom and in several western European countries. The aims of this study were to determine whether the population is also declining in Spain and to evaluate the hypothesis that electromagnetic radiation (microwaves) from phone antennae is correlated with the decline in the sparrow population. Between October 2002 and May 2006, point transect sampling was performed at 30 points during 40 visits to Valladolid, Spain. At each point, we carried out counts of sparrows and measured the mean electric field strength (radiofrequencies and microwaves: 1 MHz-3 GHz range). Significant declines (P = 0.0037) were observed in the mean bird density over time, and **significantly low bird density was observed in areas with high electric field strength.** The logarithmic regression of the mean bird density vs. field strength groups (considering field strength in 0.1 V/m increments) was R = -0.87 (P = 0.0001**). The results of this article support the hypothesis that electromagnetic signals are associated with the observed decline in the sparrow population. We conclude that electromagnetic pollution may be responsible, either by itself or in combination with other factors, for the observed decline of the species in European cities during recent years. The appearently strong dependence between bird density and field strength according to this work could be used for a more controlled study to test the hypothesis.**
[Exposure: 1-3 GHz; 3 years and 8 months; electric field strength 0.4-3.5 V/m]

147 Cammaerts et al, 2013, Electromagn Biol Med. 2013 Aug 26.
Ants can be used as bio-indicators to reveal biological effects of electromagnetic waves from some wireless apparatus.
http://www.ncbi.nlm.nih.gov/pubmed/23977878
Society is confronted with an increasing number of applications making use of wireless communication. We also notice an increasing awareness about potentially harmful effects of the related electromagnetic fields on living organisms. At present, it is not realistic to expect that wireless communication will decrease or disappear within the near future. That is why we currently are investigating the mechanisms behind these effects and the effectiveness of possible solutions. In order to be efficient and effective, we designed and validated a fast and easy test on ants - **these insects being used as a biological model - for revealing the effect of wireless equipments like mobile phones, smartphones, digital enhanced cordless telephone (DECT) phones, WiFi routers and so on. This test includes quantification of ants' locomotion under natural conditions, then in the vicinity of such wireless equipments. Observations, numerical results and statistical results allow detecting any effect of a radiating source on these living organisms.**
Discussion:
(2) It appeared that ants' linear and angular speeds of movement are immediately altered by the presence of electromagnetic waves.
(3) All radiating sources tested in this study on the ants demonstrated clear and statistically significant effects. It was already known that a mobile phone in standby mode affects living organisms (e.g. see Cammaerts et al., 2011; Favre, 2011; Panagopoulos et al., 2004; Sharma and Kumar, 2010). In this study, we showed that a common mobile phone has an effect while in standby mode and even in off-condition. Of course, when activated, the effect of a mobile phone is stronger. Without its battery, such a phone has no longer an effect. Our ants demonstrated that a modern smartphone and even more so a DECT phone do affect living organisms. Furthermore, the electromagnetic waves generated by a WiFi router impact our ants and such an effect increases during the course of the exposure time. Persons working in rooms provided with wireless equipment should note this result.
[Exposure: 900MHz mobile phone, smartphone, DECT phone, 2.45 GHz Wi-Fi router, notebook with Wi-Fi on]

148 Deshmukh et al, 2013, Indian J Biochem Biophys. 2013 Apr;50(2):114-9.
Effect of low level microwave radiation exposure on cognitive function and oxidative stress in rats.
http://www.ncbi.nlm.nih.gov/pubmed/23720885?dopt=Abstract
Use of wireless communicating devices is increasing at an exponential rate in present time and is raising serious concerns about possible adverse effects of microwave (MW) radiation emitted from these devices on human health. The present study aimed to evaluate the effects of 900 MHz MW radiation exposure on cognitive function and oxidative stress in blood of Fischer rats. Animals were divided into two groups (6 animals/group): Group I (MW-

exposed) and Group II (Sham-exposed). Animals were subjected to MW exposure (Frequency 900 MHz; specific absorption rate 8.4738 x 10(-5) W/kg) in Gigahertz transverse electromagnetic cell (GTEM) for 30 days (2 h/day, 5 days/week). Subsequently, cognitive function and oxidative stress parameters were examined for each group**. Results showed significant impairment in cognitive function and increase in oxidative stress, as evidenced by the increase in levels of MDA (a marker of lipid peroxidation) and protein carbonyl (a marker of protein oxidation) and unaltered GSH content in blood. Thus, the study demonstrated that low level MW radiation had significant effect on cognitive function and was also capable of leading to oxidative stress.**
[Exposure: 900 MHz; 2h/day, 5 days/week for 30 days; SAR 84.738 µW/kg mean value]

149 Everaert and Bauwens, 2007, Electromagn Biol Med. 2007;26(1):63-72.
A possible effect of electromagnetic radiation from mobile phone base stations on the number of breeding house sparrows (Passer domesticus).
http://www.ncbi.nlm.nih.gov/pubmed/17454083
A possible effect of long-term exposure to low-intensity electromagnetic radiation from mobile phone (GSM) base stations on the number of House Sparrows during the breeding season was studied in six residential districts in Belgium. We sampled 150 point locations within the 6 areas to examine small-scale geographic variation in the number of House Sparrow males and the strength of electromagnetic radiation from base stations. **Spatial variation in the number of House Sparrow males was negatively and highly significantly related to the strength of electric fields from both the 900 and 1800 MHz downlink frequency bands and from the sum of these bands (Chi(2)-tests and AIC-criteria, P<0.001). This negative relationship was highly similar within each of the six study areas, despite differences among areas in both the number of birds and radiation levels. Thus, our data show that fewer House Sparrow males were seen at locations with relatively high electric field strength values of GSM base stations and therefore support the notion that long-term exposure to higher levels of radiation negatively affects the abundance or behavior of House Sparrows in the wild.**
[Exposure: 925-960 MHz and 1805-1880 MHz; during breeding period; range of electric field strength from 0.04 to 0.245 V/m]

150 Fragopoulou A.F. et al., 2009,. Pathophysiology, 17, pp. 179-187.
Whole body exposure with GSM 900 MHz affects spatial memory in mice
http://www.ncbi.nlm.nih.gov/pubmed/19954937
Extended work has been performed worldwide on the effects of mobile phone radiation upon rats' cognitive functions, however there is great controversy to the existence or not of deficits. The present work has been designed in order to test the effects of mobile phone radiation on spatial learning and memory in mice Mus musculus Balb/c using the Morris water maze (a hippocampal-dependent spatial memory task), since there is just one other study on mice with very low SAR level (0.05W/kg) showing no effects. We have applied a 2h daily dose of pulsed GSM 900MHz radiation from commercially available mobile phone for 4 days at SAR values ranging from 0.41 to 0.98W/kg. **Statistical analysis revealed that during learning, exposed animals showed a deficit in transferring the acquired spatial information across training days (increased escape latency and distance swam, compared to the sham-exposed animals, on the first trial of training days 2-4). Moreover, during the memory probe-trial sham-exposed animals showed the expected preference for the target quadrant, while the exposed animals showed no preference, indicating that the exposed mice had deficits in consolidation and/or retrieval of the learned spatial information.** Our results provide a basis for more thorough investigations considering reports on non-thermal effects of electromagnetic fields (EMFs).
[Overview given by wifiinschools: http://wifiinschools.org.uk/6.html found that exposure for approximately 2 hours /day to a mobile phone (0.9GHz GSM modulated mobile phone; 23-36V/m, 0.41-0.98W/Kg whole body exposure) for four days resulted in cognitive deficits in the Morris water maze, a test of spatial learning and memory. Exposed mice were less able to transfer learned information to the next day, and had deficits in consolidation and/or retrieval of the learned information.]
[Exposure: 900 MHz (pulsed); 1 h 55 min. for the first 3 days (1 h prior to the first trial, 3 x 15 min. between trials, 10 min. after the last trial); 3 hr 45 min. on the fourth days (1 h prior to the first trial, 3 x 15 min. between trials, 2 h prior to the probe trial; SAR 0.41-0.98 W/kg whole body]

151 Khadrawy et al, 2009, Rom. J. Biophys. 2009 19(4):295-305
Effect of Electromagnetic Radiation from mobile phone on the levels of cortical amino acid neurotransmitters in adult and young rats
http://www.biophysicsnet.ro/rjb/articles/260/yakha.pdf (full article)
The present study aims to investigate the effect of electromagnetic radiation (EMR) generated by mobile phones on the levels of amino acid neurotransmitters; glutamate, aspartate, GABA, glycine and taurine in the cortex of adult and

young rats. Several studies showed that EMR could influence normal brain physiology, probably by changing cortical excitability. In the present study, adult and young rats were exposed to EMR for one hour/day. Amino acids were measured after 1 hour, 1, 2 and 4 months of daily EMR exposure and after 1 month of stopping exposure that extended daily for 4 months. **The present data showed that in adult rats EMR induced significant changes in the cortical levels of some studied amino acids throughout the exposure periods. However, in young rats EMR induced significant changes after 4 months of daily exposure and after stopping exposure. It could be suggested that the changes in amino acid neurotransmitters may underlie the EMR-induced changes in cortical excitability.**
[Exposure: 900 MHz; continuous for 1 h/day for up to 4 months; SAR 1.165 W/kg average mass (partial body/rat's head)]

152 Maaroufi et al, 2014, Behav Brain Res. 2014 Jan 1;258:80-9.
Spatial learning, monoamines and oxidative stress in rats exposed to 900 MHz electromagnetic field in combination with iron overload.
http://www.ncbi.nlm.nih.gov/pubmed/24144546
The increasing use of mobile phone technology over the last decade raises concerns about the impact of high frequency electromagnetic fields (EMF) on health. More recently, a link between EMF, iron overload in the brain and neurodegenerative disorders including Parkinson's and Alzheimer's diseases has been suggested. Co-exposure to EMF and brain iron overload may have a greater impact on brain tissues and cognitive processes than each treatment by itself. To examine this hypothesis, Long-Evans rats submitted to 900 MHz exposure or combined 900 MHz EMF and iron overload treatments were tested in various spatial learning tasks (navigation task in the Morris water maze, working memory task in the radial-arm maze, and object exploration task involving spatial and non spatial processing). Biogenic monoamines and metabolites (dopamine, serotonin) and oxidative stress were measured. **Rats exposed to EMF were impaired in the object exploration task but not in the navigation and working memory tasks. They also showed alterations of monoamine content in several brain areas but mainly in the hippocampus.** Rats that received combined treatment did not show greater behavioral and neurochemical deficits than EMF-exposed rats. None of the two treatments produced global oxidative stress**. These results show that there is an impact of EMF on the brain and cognitive processes** but this impact is revealed only in a task exploiting spontaneous exploratory activity. In contrast, there are no synergistic effects between EMF and a high content of iron in the brain.
[Exposure: 900 MHz; 1 h/day for 21 consecutive days; SAR 0.05-0.18 W/kg]

153 Margaritis et al, 2013, Electromagn Biol Med. 2013 Aug 5.
Drosophila oogenesis as a bio-marker responding to EMF sources (Fly)
http://www.ncbi.nlm.nih.gov/pubmed/23915130
The model biological organisms Drosophila melanogaster and Drosophila virilis have been utilized to assess effects on apoptotic cell death of follicles during oogenesis and reproductive capacity (fecundity) decline. A total of 280 different experiments were performed using newly emerged flies exposed for short time daily for 3-7d to **various EMF sources including: GSM 900/1800MHz mobile phone, 1880-1900MHz DECT wireless base, DECT wireless handset, mobile phone-DECT handset combination, 2.44GHz wireless network (Wi-Fi), 2.44GHz blue tooth, 92.8MHz FM generator, 27.15MHz baby monitor, 900MHz CW RF generator and microwave oven's 2.44GHz RF and magnetic field components.** Mobile phone was used as a reference exposure system for evaluating factors considered very important in dosimetry extending our published work with D. melanogaster to the insect D. virilis. Distance from the emitting source, the exposure duration and the repeatability were examined. **All EMF sources used created statistically significant effects regarding fecundity and cell death-apoptosis induction, even at very low intensity levels (0.3V/m blue tooth radiation), well below ICNIRP's guidelines, suggesting that Drosophila oogenesis system is suitable to be used as a biomarker for exploring potential EMFbioactivity**. Also, there is no linear cumulative effect when increasing the duration of exposure or using one EMF source after the other (i.e. mobile phone and DECT handset) at the specific conditions used. The role of the average versus the peak E-field values as measured by spectrum analyzers on the final effects is discussed.
[Exposure: various real device sources (see abstract)]

154 Megha et al, 2012, Indian J Exp Biol. 2012 Dec;50(12):889-96.
Microwave radiation induced oxidative stress, cognitive impairment and inflammation in brain of Fischer rats.
http://www.ncbi.nlm.nih.gov/pubmed/23986973
Public concerns over possible adverse effects of microwave radiation emitted by mobile phones on health are increasing. To evaluate the intensity of oxidative stress, cognitive impairment and inflammation in brain of Fischer rats exposed to microwave radiation, male Fischer-344 rats were exposed to 900 MHz microwave radiation (SAR = 5.953 x 10(-4) W/kg) and 1800 MHz microwave radiation (SAR = 5.835 x 10(-4) W/kg) for 30 days (2 h/day). **Significant**

impairment in cognitive function and induction of oxidative stress in brain tissues of microwave exposed rats were observed in comparison with sham exposed groups. Further, significant increase in level of cytokines (IL-6 and TNF-alpha) was also observed following microwave exposure. Results of the present study indicated that increased oxidative stress due to microwave exposure may contribute to cognitive impairment and inflammation in brain.
[Exposure: 900/1800 MHz; 2 h/day, 5 days/week for 30 days; SAR 0.5953 and 0.5835 MW/kg]

155 Narayan et al, 2014, Bratisl Lek Listy. 2014;115(5):260-6.
Evaluation of oxidant stress and antioxidant defense in discrete brain regions of rats exposed to 900 MHz radiation.
http://www.ncbi.nlm.nih.gov/pubmed/25174055
http://www.elis.sk/download_file.php?product_id=3853&session_id=deqm9crfh6sl8r7oiqtla0khc0 (full paper)
In the current study, the effects of 900 MHz radio-frequency electromagnetic radiation (RF-EMR) on levels of thiobarbituric acid-reactive substances (TBARS), total antioxidants (TA), and glutathione S-transferase (GST) activity in discrete brain regions were studied in adolescent rats.
MATERIALS AND METHODS:
Thirty-six male Wistar rats (6-8 weeks old) were allotted into three groups (n = 12 in each group). Control group (1) remained undisturbed in their home cage; sham group (2) was exposed to mobile phone in switch off mode for four weeks; RF-EMR-exposed group (3) was exposed to 900 MHz of RF-EMR (1 hr/day with peak power density of 146.60 µW/cm2) from an activated Global System for Mobile communication (GSM) mobile phone (kept in silent mode; no ring tone and no vibration) for four weeks. On 29th day, behavioral analysis was done. Followed by this, six animals from each group were sacrificed and biochemical parameters were studied in amygdala, hippocampus, frontal cortex, and cerebellum.
RESULTS:
Altered behavioral performances were found in RF-EMR-exposed rats. Additionally, elevated TBARS level was found with all brain regions studied. RF-EMR exposure significantly decreased TA in the amygdala and cerebellum but its level was not significantly changed in other brain regions. **GST activity was significantly decreased in the hippocampus** but, its activity was unaltered in other brain regions studied.
CONCLUSION:
RF-EMR exposure for a month induced oxidative stress in rat brain, but its magnitude was different in different regions studied. RF-EMR-induced oxidative stress could be one of the underlying causes for the behavioral deficits seen in rats after RF-EMR exposure (Fig. 5, Ref. 37).
[Exposure: mobile phone 890=915 MHz; continuous for 1 h/day for 28 days (in silent mode, no ring tone and vibration); SAR 1.58 W/kg (according to manufacturer)]

156 Narayanan et al, 2013, Neurol Sci. 2013 Jul;34(7):1117-24.
Analysis of emotionality and locomotion in radio-frequency electromagnetic radiation exposed rats.
http://www.ncbi.nlm.nih.gov/pubmed/22976773
In the current study the modulatory role of mobile phone radio-frequency electromagnetic radiation (RF-EMR) on emotionality and locomotion was evaluated in adolescent rats. Male albino Wistar rats (6-8 weeks old) were randomly assigned into the following groups having 12 animals in each group. Group I (Control): they remained in the home cage throughout the experimental period. Group II (Sham exposed): they were exposed to mobile phone in switch-off mode for 28 days, and Group III (RF-EMR exposed): they were exposed to RF-EMR (900 MHz) from an active GSM (Global system for mobile communications) mobile phone with a peak power density of 146.60 µW/cm(2) for 28 days. On 29th day, the animals were tested for emotionality and locomotion. **Elevated plus maze (EPM) test revealed that, percentage of entries into the open arm, percentage of time spent on the open arm and distance travelled on the open arm were significantly reduced in the RF-EMR exposed rats. Rearing frequency and grooming frequency were also decreased in the RF-EMR exposed rats. Defecation boli count during the EPM test was more with the RF-EMR group.** No statistically significant difference was found in total distance travelled, total arm entries, percentage of closed arm entries and parallelism index in the RF-EMR exposed rats compared to controls. **Results indicate that mobile phone radiation could affect the emotionality of rats without affecting the general locomotion.**
[Exposure: mobile phone 900 MHz; continuous for 1h/day for 28 days (activated giving missed or unattended calls, 20 calls/h, phone allowed to ring for 45 s followed by a 15 s interval before the next call); peak power density 146.60 µW/cm^2, SAR 1.15 W/kg]

157 Narayanan et al, 2010, Ups J Med Sci. 2010 May;115(2):91-6.
Effect of radio-frequency electromagnetic radiations (RF-EMR) on passive avoidance behaviour and hippocampal morphology in Wistar rats.
http://www.ncbi.nlm.nih.gov/pubmed/20095879

INTRODUCTION:
The interaction of mobile phone radio-frequency electromagnetic radiation (RF-EMR) with the brain is a serious concern of our society.
OBJECTIVE:
We evaluated the effect of RF-EMR from mobile phones on passive avoidance behaviour and hippocampal morphology in rats.
MATERIALS AND METHODS:
Healthy male albino Wistar rats were exposed to RF-EMR by giving 50 missed calls (within 1 hour) per day for 4 weeks, keeping a GSM (0.9 GHz/1.8 GHz) mobile phone in vibratory mode (no ring tone) in the cage. After the experimental period, passive avoidance behaviour and hippocampal morphology were studied.
RESULTS:
Passive avoidance behaviour was significantly affected in mobile phone RF-EMR-exposed rats demonstrated as shorter entrance latency to the dark compartment when compared to the control rats. Marked morphological changes were also observed in the CA(3) region of the hippocampus of the mobile phone-exposed rats in comparison to the control rats.
CONCLUSION:
Mobile phone RF-EMR exposure significantly altered the passive avoidance behaviour and hippocampal morphology in rats.
[Exposure: mobile phone 900MHz/1.8GHz; 50 times 45s/h once per day for 4 weeks]

158 Nittby et al, 2008, Bioelectromagnetics. 2008 Apr;29(3):219-32.
Cognitive impairment in rats after long-term exposure to GSM-900 mobile phone radiation.
http://www.ncbi.nlm.nih.gov/pubmed/18044737
Considering the frequent use of mobile phones, we have directed attention to possible implications on cognitive functions. In this study we investigated in a rat model the long-term effects of protracted exposure to Global System for Mobile Communication-900 MHz (GSM-900) radiation. Out of a total of 56 rats, 32 were exposed for 2 h each week for 55 weeks to radio-frequency electromagnetic radiation at different SAR levels (0.6 and 60 mW/kg at the initiation of the experimental period) emitted by a (GSM-900) test phone. Sixteen animals were sham exposed and eight animals were cage controls, which never left the animal house. After this protracted exposure, GSM-900 exposed rats were compared to sham exposed controls. Effects on exploratory behaviour were evaluated in the open-field test, in which no difference was seen. Effects on cognitive functions were evaluated in the episodic-like memory test. **In our study, GSM exposed rats had impaired memory for objects and their temporal order of presentation, compared to sham exposed controls** (P = 0.02). Detecting the place in which an object was presented was not affected by GSM exposure. **Our results suggest significantly reduced memory functions in rats after GSM microwave exposure (P = 0.02).**
[Exposure: 900 MHz (pulsed); 2 h/week for 55 weeks; SAR 0.6 mW/kg (at 33 mW/m2) and 60 mW/kg (at 3.3 W/m2) average over mass (whole body)]

159 Ntzouni et al, 2013, Electromagn Biol Med. 2013 Mar;32(1):95-120.
Transient and cumulative memory impairments induced by GSM 1.8 GHz cell phone signal in a mouse model.
http://www.ncbi.nlm.nih.gov/pubmed/23320614
This study was designed to investigate the transient and cumulative impairments in spatial and non-spatial memory of C57Bl/6J mice exposed to GSM 1.8 GHz signal for 90 min daily by a typical cellular (mobile) phone at a specific absorption rate value of 0.11 W/kg. Free-moving male mice 2 months old were irradiated in two experimental protocols, lasting for 66 and for 148 days respectively. Each protocol used three groups of animals (n = 8 each for exposed, sham exposed and controls) in combination with two behavioural paradigms, the object recognition task and the object location task sequentially applied at different time points. One-way analysis of variance **revealed statistically significant impairments of both types of memory gradually accumulating, with more pronounced effects on the spatial memory. The impairments persisted even 2 weeks after interruption of the 8 weeks daily exposure**, whereas the memory of mice as detected by both tasks showed a full recovery approximately 1 month later. Intermittent every other day exposure for 1 month had no effect on both types of memory**. The data suggest that visual information processing mechanisms in hippocampus, perirhinal and entorhinal cortex are gradually malfunctioning upon long-term daily exposure, a phenotype that persists for at least 2 weeks after interruption of radiation, returning to normal memory performance levels 4 weeks later.** It is postulated that cellular repair mechanisms are operating to eliminate the memory affecting molecules. The overall contribution of several possible mechanisms to the observed cumulative and transient impairments in spatial and non-spatial memory is discussed.
[Exposure: mobile phone (speaking mode) 1800 MHz; 90 min/day or every second day for up to 83 days; SAR 0.11 W/kg effective value]

160 Ntzouni et al, 2011, Pathophysiology. 2011 Jun;18(3):193-9.
Short-term memory in mice is affected by mobile phone radiation.
http://www.ncbi.nlm.nih.gov/pubmed/21112192
The effects of mobile phone electromagnetic fields (EMFs) were studied on a non-spatial memory task (Object Recognition Task - ORT) that requires entorhinal cortex function. The task was applied to three groups of mice Mus musculus C57BL/6 (exposed, sham-exposed and control) combined with 3 different radiation exposure protocols. In the first protocol designated "acute exposure", mice 45 days old (PND45 - postnatal day 45) were exposed to mobile phone (MP) radiation (SAR value 0.22W/kg) during the habituation, the training and the test sessions of the ORT, but not during the 10min inter-trial interval (ITI) where consolidation of stored object information takes place. On the second protocol designated "chronic exposure-I", the same mice were exposed for 17 days for 90min/per day starting at PND55 to the same MP radiation. ORT recognition memory was performed at PND72 with radiation present only during the ITI phase. In the third protocol designated "chronic exposure-II", mice continued to be exposed daily under the same conditions up to PND86 having received radiation for 31 days. One day later the ORT test was performed without irradiation present in any of the sessions. **The ORT-derived discrimination indices in all three exposure protocols revealed a major effect on the "chronic exposure-I" suggesting a possible severe interaction of EMF with the consolidation phase of recognition memory processes. This may imply that the primary EMF target may be the information transfer pathway connecting the entorhinal-parahippocampal regions which participate in the ORT memory task.**
[Exposure:mobile phone 1800 MHz; 90 min/day for 3 days, 17 days or 31 days; SAR 0.22 W/kg average over mass (brain)]

161 Sarapultseva et al, 2013, Int J Radiat Biol. 2013 Nov 25.
The in-vivo effects of low-intensity radiofrequency fields on the motor activity of protozoa
http://www.ncbi.nlm.nih.gov/pubmed/24266430
Purpose: To analyze the direct and transgenerational effects of exposure to low-dose 1 GHz (mobile phone/wireless telecommunication range) and 10 GHz (radar/satellite communication range) radiofrequency electromagnetic fields (RF-EMF) on the motility of ciliates Spirostomum ambiguum.
Materials and Methods: S. ambiguum were exposed to 1 GHz and 10 GHz RF-EMF with power flux densities (PD) ranging from 0.05 to 0.5 W/m2 over a period of time from 0.05 to 10 h. The motility of directly exposed ciliates and their non-exposed progeny across 10-15 generations was measured.
Results: **Exposure to 0.1 W/m2 of either 1 or 10 GHz RF-EMF resulted in a significant decrease in the motility. The dose of exposure capable of altering the mobility of ciliates was inversely correlated with the flux density of RF-EMF. The motility of the non-exposed progeny of ciliates irradiated with 0.1 W/m2 of 10 GHz RF-EMF remained significantly compromised, at least, across 10-15 generations, thus indicating the presence of transgenerational effects.**
Conclusions: **The results of our study show that low-dose exposure to RF-EMF can significantly affect the motility of irradiated ciliates and their non-exposed offspring, thus providing further insights into the unknown mechanisms underlying the in vivo effects of RF-EMF.**
[Exposure: 1GHz and 10GHz; 0.05-10h; 0.05-0.5W/m^2]

162 Sinha RK, 2008, Int J Radiat Biol, 84(6):505-513, 2008
Chronic non-thermal exposure of modulated 2450 MHz microwave radiation alters thyroid hormones and behavior of male rats.
http://www.ncbi.nlm.nih.gov/pubmed/18470749
The purpose of this investigation was to analyze the effects of leakage microwave (2450 MHz) irradiation on thyroid hormones and behavior of male rats.
MATERIALS AND METHODS:
Experiments were carried out on two groups of male rats (exposure and control, respectively). Radio-immuno assay (RIA) methods were used for estimation of 3,5,3'-triiodothyronine (T3), thyroxine (T4) and thyrotrophin or thyroid stimulating hormone (TSH). The assessments of behavioral changes were performed in Open-Field (OF) and Elevated Plus-Maze (EPM) apparatuses.
RESULTS:
Following chronic microwave exposure, rats were found hyperactive and aggressive on the 16th and 21st days. Behavioral changes in OF were analyzed and found to be significantly changed from controls ($p < 0.05$) for immobilization, rearing and ambulation behavior. In EPM, rats showed increased activity with decreased time spent in the open arm and more time spent in the center on the 11th ($p < 0.05$), 16th ($p < 0.05$) and 21st day ($p < 0.01$) after

irradiation. Changes in behavioral parameters are also correlated with the trend of changes, compared to control animals, in hormonal blood levels of T3 (decreased on the 16th day, $p < 0.05$ and 21st day, $p < 0.01$) and T4 (increased on the 21st day, $p < 0.05$).
CONCLUSION:
Low energy microwave irradiation may be harmful as it is sufficient to alter the levels of thyroid hormones as well as the emotional reactivity of the irradiated compared to control animals.
[Exposure: 2450 MHz pulsed; repeated daily exposure 2 h/day for up to 21 days; SAR 0.98 and 3.6µW/g average over mass (whole body)]

163 Zhao et al, 2012, Biomedical and Environmental Sciences, 2012, 2,2,182-188
Relationship between Cognition Function and Hippocampus Structure after Long-term Microwave Exposure
http://www.ncbi.nlm.nih.gov/pubmed/22998825
To analyze the effects of long-term microwave exposure on hippocampal structure and function in the rat. Experiments were performed on 184 male Wistar rats (three exposure groups and a sham group). Microwaves were applied daily for 6 min over 1 month at average power densities of 2.5, 5, and 10 mW/cm2. Learning and memory abilities were assessed by Morris water maze. High performance liquid chromatography was used to detect neurotransmitter concentrations in the hippocampus. Hippocampal structures were observed by histopathological analysis. **Following long-term microwave exposure there was a significant decrease in learning and memory activity in the 7 d, 14 d, and 1 m in all three microwave exposure groups.** Neurotransmitter concentrations of four amino acids (glutamate, aspartic acid, glycine, and gamma-aminobutyric acid) in hippocampus were increased in the 2.5 and 5 mW/cm2 groups and decreased in the 10 mW/cm2 group. **There was evidence of neuronal degeneration and enlarged perivascular spaces in the hippocampus in the microwave exposure groups. Further, mitochondria became swollen and cristae were disordered. The rough endoplasmic reticulum exhibited sacculated distension and there was a decrease in the quantity of synaptic vesicles. These data suggest that the hippocampus can be injured by long-term microwave exposure, which might result in impairment of cognitive function due to neurotransmitter disruption.**
[Exposure: unspecified frequency; continuous for 6 min/day for up to 1 month; SAR 1.05 / 2.1 / 4.2 W/kg average over time]

RECOGNISED AS A FUNCTIONAL IMPAIRMENT:

164 Johansson, 2006, Electromagn Biol Med. 2006;25(4):245-58.
Electrohypersensitivity: state-of-the-art of a functional impairment.
http://www.ncbi.nlm.nih.gov/pubmed/17178584
http://www.national-toxic-encephalopathy-foundation.org/esen.pdf (full paper)

165 **Sweden**
http://www.es-uk.info/information/8-ehs-in-sweden.html
In Sweden, electrohypersensitivity (EHS) is an officially fully recognized functional impairment (i.e., it is not regarded as a disease, thus no diagnosis* exists; N.B. This is not special for Sweden, the terms "functional impairment" and "disease" are defined according to various international documents).

166 **USA, United States Access Board**
http://www.access-board.gov/guidelines-and-standards/buildings-and-sites/about-the-ada-standards/background/ada-accessibility-guidelines-for-recreation-facilities/general-issues
"**The Board recognizes that multiple chemical sensitivities and electromagnetic sensitivities may be considered disabilities under the ADA if they so severely impair the neurological, respiratory or other functions of an individual that it substantially limits one or more of the individual's major life activities.** The Board plans to closely examine the needs of this population, and undertake activities that address accessibility issues for these individuals".

167 Genuis and Lipp , 2012, Sci Total Environ. 2012 Jan 1;414:103-12.
Electromagnetic hypersensitivity: fact or fiction?
http://www.ncbi.nlm.nih.gov/pubmed/22153604

LEGAL CASES:

168 Australia, 2013, McDonald and Comcare, 2013, AATA 105
http://www.austlii.edu.au/au/cases/cth/aat/2013/105.html
http://www.news.com.au/technology/csiro-scientist-dr-david-mcdonald-wins-compensation-for-wifi-pain/story-e6frfrnr-1226729178281
Australian legal case. "The AAT ruling means he will continue to be paid **75 per cent of his salary**, as compensation for his illness."

169 **France, 2014**
http://www.journaldelenvironnement.net/article/dans-l-essonne-l-electrosensibilite-reconnue-comme-un-handicap,45060 **[Author's note: translated using Google Translate].**
The county house of Disabled Persons (MDPH) Essonne granted late January financial assistance to a person Electro, a first in France, according to the Collective of Electro France.

Living in the south of the Essonne, Jerome, 32, had to stop work in 2011 because of an EHS (EHS) contracted at work [1]. In question according to him, a device it was, as a technician in a public laboratory chemistry research, confronted daily.

If the status of occupational disease was refused -decision taken despite the positive opinion of a medical expert, and is now challenging before justice-, Jerome had more success with the MDPH of Essonne, structure that depends on the General Council.

A pioneer in the field, this department has included in its EHS health scheme for the period 2013-2018, recognizing the de facto disability, recalls Sophie Pelletier, co-chair of the Collective of electro de France, contacted by the JDLE.

If the MDPH of Essonne has already granted several electro disabled worker status, his decision in late January to provide financial assistance to Jerome seems a first in France, at least to "knowledge" of the Collective of Electro de France, says Sophie Pelletier.

Help to develop home

Contacted by the JDLE, Jerome says that this aid has been granted to convert his home and protect personally: he was able to buy grounding hardware [2], a voice recognition system allowing it to stay away from his computer, an anti-waves canopy bed, the anti-wave tissue to cover when it comes out in the city, as well as measuring equipment -in this case the antennas for its wave detector.

Discreet on the amount of this aid, Jerome says she allows it to cover about 75% of its needs equipment. It includes one-time assistance for the most expensive equipment, and monthly assistance for those that must be renewed, especially the anti-wave which he covers his clothes and cap fabric. All allocated for a period of three years.

"What has brought us to this recognition, is the fact that this issue was supported by very credible testimony of the medical profession, leaving no doubt about the reality of the disease," equivalent to a 80 disability rate % JDLE explains to the director of the MDPH, Olivier Desmazeaud. He is to date the only application for financial assistance that the structure is treated for electro.

On sick leave since 2011, Jerome hopes to undertake training to retrain with the aim to find a job he could do at home.

[1] The name has been changed.
[2] This material is evacuated to the ground the electric charge in the surroundings.

170 **Spain, 2011, Spanish Labour Court of Madrid**
http://www.portalesmedicos.com/medicina/noticias/10451/1/La-hipersensibilidad-a-las-ondas-que-producen-los-telefonos-moviles-se-convierte-en-una-nueva-causa-de-incapacidad-permanente/Page1.html
'This has been ruled by the Labour Court to declare Madrid 24 permanent incapacitation of a college professor who suffered from chronic fatigue and environmental and electromagnetic hypersensitivity. The ruling is unique in this regard and make a precedent for future conditions related to hypersensitivity to these waves. The verdict was issued on 23 May and gave the **teachers 100% of his base salary'**.

171 **UK, 2012, British Tibunal Case Won**

[Author's note: text directly from claimant].

The case was heard in the Social Entitlement Chamber in July 2012. The claimant was awarded Employment and Support Allowance under ESA Regulation 29 (Exceptional Circumstances)

ESA Regulation 29 (Exceptional circumstances**)**

29.—(1) A claimant who does not have limited capability for work as determined in accordance with the limited capability for work assessment is to be treated as having limited capability for work if paragraph (2) applies to the claimant.

(2) This paragraph applies if—

(a)the claimant is suffering from a life threatening disease in relation to which—

(i)there is medical evidence that the disease is uncontrollable, or uncontrolled, by a recognised therapeutic procedure; and

(ii)in the case of a disease that is uncontrolled, there is a reasonable cause for it not to be controlled by a recognised therapeutic procedure; or

(b)the claimant suffers from some specific disease or bodily or mental disablement and, by reasons of such disease or disablement, there would be a substantial risk to the mental or physical health of any person if the claimant were found not to have limited capability for work.

The Judge stated that "were it not for EMR the appellant would lead a normal life with little or no functional impairment". Further that "……the condition described was not one commonly found but the Tribunal considered the reality of life…..Considerations included the fact that the appellant would be unable to work in any 'normal' working environment indoors or outside- anywhere there was Wi-fi, mobile phones or mobile phone masts…….the jobs where this could be done were few and far between and even then such jobs would almost inevitably entail use of computer Wi-fi which the appellant could not tolerate. Taken together the prospects of the appellant being able to 'work' …were effectively nil"

172 **US, 2014, Los Angeles Unified School District**

Los Angeles Unified School District Accommodates Teacher Who Fell Ill After Wireless Installation

http://www.prlog.org/12381499-los-angeles-unified-school-district-accommodates-teacher-who-fell-ill-after-wireless-installation.html

On September 18, 2014, LAUSD, the second largest public school district in the US, officially accommodated teacher Ms. Anura Lawson by approving her request to have the Wi-Fi turned off in her classroom during the 2014-2015 school year and alternatively approving a reassignment to a different school site where Wi-Fi has yet to be installed.

The Middle School teacher reported that she fell seriously ill after a wireless system upgrade in her school in Spring 2014. She described her cardiac symptoms during a May 28, LAUSD Common Core Tech Project meeting. Ms. Lawson also stated, "The students are having nosebleeds and the main offices are refusing to do incident reports. I have had two seventh grade students bleeding out of their ears." See https://www.youtube.com/watch?v=wghaMbzRnb4

This is the first accommodation in a US public school system for microwave sickness.

Microwave sickness, also known as electro hypersensitivity (EHS), is not widely recognized in the US. However, physicians in many other countries are familiar with this medical condition and the diagnosis is more common. EHS symptoms include: headaches, dizziness, anxiety, rapid heart beat (tachycardia) and irregular heart beat (arrhythmia), ear and nose bleeds, tinnitus, red and irritated eyes, increased mucous and upper airway congestion, itchy skin rashes, abdominal pain, poor focus and attention, memory and sleep problems.

In March 2012, the Austrian Medical Association recognized and developed EHS treatment guidelines. In the United States, adverse effects were identified before 1988 when a US Air Force Review stated that "Experimental evidence has shown that exposure to low intensity radiation can have a profound effect on biological processes."

The LAUSD Board of Education went ahead with a wireless technology plan in February 2013, even after they were presented with numerous letters from many noted medical doctors and researchers, including the American Academy of Environmental Medicine, imploring them to use wired technology in the classroom because of the health impacts from wireless radiation. See http://wifiinschools.com/lausd-testimony.html

Wireless LAUSD classrooms typically employ 30+ devices (iPads) in addition to an industrial-sized router. These devices all emit microwave radiation and represent an unprecedented level of exposure to children.

Decades of accumulated research show wireless radiation damages neurological, immune, and reproductive systems in addition to increasing cancer risk. Professor Olle Johansson, Karolinksa Institute, Stockholm Sweden, has stated that wireless radiation exposure studies have indicated "irreversible sterility within five generations." As this damage is cumulative, the longer the radiation exposure, the greater the health impact over time.

"We are getting reports of headaches and cardiac issues from across the country. The time to act is now," stated a spokesperson for the National Association for Children and Safe Technology (NACST).

NACST is an organization dedicated to raising awareness of the health impacts of wireless radiation on children. They are calling for schools to use wired Internet only. Their website details both the accumulated research showing wireless radiation's acute as well as long term health impacts.

Letter from Los Angeles Unified School District
http://thefullertoninformer.com/wp-content/uploads/2014/10/Lawson-Anura.Reasonable-...dation.092214-2-11.pdf
The Committee reconvened September 9, 2014. After reviewing and taking into consideration all of the documentation you submitted as part of your request, the information you presented during the meeting, and reviewing alternate accommodations, the Committee approved your request to have the Wi-Fi turned of in your classroom during the 2014-2015 school year. As an alternate accommodation the Committee also approved a reassignment to a different school site where Wi-Fi has yet to be installed. If you wish to avail yourself to a reassignment, please contact Dina Bobadill-Aguilar or me.

173 **US, 2012**
Eger H, 2014, Umwelt - Medizin - Gesellschaft 2014; 27 (3): 176 - 181
Causal, Legally Recognized Proof of the Damage Potential of Technical Highfrequency Fields - a Case Report.
http://www.umg-verlag.de/umwelt-medizin-gesellschaft/314e_z.pdf
In the middle of the year 2006, an US-American patient moved to Bavaria for job reasons. At his new living place, he suffered from multiple symptoms mostly unknown from his past. First, **his night sleep was disturbed for several hours by different high and low tones. Later, he suffered from tachycardias, cephalgias and nose bleeding as well as pains all over the body. After that neurological deficits appeared also during the day: coordination difficulties, difficulties finding words, even word loss, confusion, difficulties in concentrating and dizziness.** At first, it was not possible for any doctor to associate this great variety of symptoms with an underlying disease.

Technical high-frequency measurements carried out in 2007 detected signals appearing at night which were above the limiting value stipolated in Germany by the 26th Bundesimmissionsschutzverordnung (BImSchV) (= German Emission Control Act) of 10 watts per square meter. The patient was able to define the beginning of the exposition at night as well as the time of his health problems without knowing the measurement results.

Therapeutically, the patient was locally de-exposed by moving to a different place. As a consequence, the symptoms gradually got better. The problems recurred under the daily highfrequency impact at technical working places, which is very common nowadays, so that working became impossible for the patient.

With the judicial acknowledgment of the electromagnetic sensitivity disorder in the year 2012, the diagnosed health damage was classified as pension relevant retroactively as of 2008.

RECOGNISED AS FUNCTIONAL IMPAIRMENT – HOSPITALS:

174 Johansson, 2006, Electromagn Biol Med. 2006;25(4):245-58.
Electrohypersensitivity: state-of-the-art of a functional impairment.
http://www.ncbi.nlm.nih.gov/pubmed/17178584
http://www.national-toxic-encephalopathy-foundation.org/esen.pdf (full paper)
Some hospitals in Sweden (e.g., in Umeå, Skellefteå, and Karlskoga) also have built special rooms with very low EMFs so that people who are hypersensitive can get medical care.

ACADEMIC BODIES URGE PROTECTION FOR THOSE WITH EHS:

175 **Bioinitiative Report, 2014, Summary for the Public (2014 Supplement)**
A report by 29 independent scientists and health experts from around the world (ten holding medical degrees (MDs), 21 PhDs, and three MSc, MA or MPHs) about possible risks from wireless technologies and electromagnetic fields. Among the authors are three former presidents of the Bioelectromagnetics Society (BEMS), and five full members of BEMS. One distinguished author is the Chair of the Russian National Committee on Non-Ionizing Radiation. Another is a Senior Advisor to the European Environmental Agency.
http://www.bioinitiative.org/report/wp-content/uploads/pdfs/sec01_2012_summary_for_public.pdf
RECOMMENDED ACTIONS
A. Defining Preventative Actions for Reduction in RFR Exposures
Sensitive Populations Must Be Protected
Safety standards for sensitive populations will more likely need to be set at lower levels than for healthy adult populations. **Sensitive populations include the developing fetus, the infant, children, the elderly, those with pre-existing chronic diseases, and those with developed electrical sensitivity (EHS).**
Protecting New Life – Infants and Children
Strong precautionary action and clear public health warnings are warranted immediately to help prevent a global epidemic of brain tumors resulting from the use of wireless devices (mobile phones and cordless phones). Commonsense measures to limit both ELF-EMF and RFR in the fetus and newborn infant (sensitive populations) are needed, especially with respect to avoidable exposures like baby monitors in the crib and baby isolettes (incubators) in hospitals that can be modified; and where education of the pregnant mother with respect to laptop computers, mobile phones and other sources of ELF-EMF and RFR are easily instituted.
Wireless laptops and other wireless devices should be strongly discouraged in schools for children of all ages.

176 **Seletun Panel, 2010**
http://wifiinschools.org.uk/resources/Seletun+2010.pdf
The Panel strongly recommends that persons with electrohypersensitivity symptoms (EHS) be classified as functionally impaired rather than with 'idiopathic environmental disease' or similar indistinct categories. This terminology will encourage governments to make adjustments in the living environment to better address social and well-being needs of this subpopulation of highly sensitive members of society.

UN AND EUROPEAN PARLIAMENT – EQUAL OPPORTUNITIES FOR THOSE WITH EHS:

177 **UN Convention on the Rights of Persons with Disabilities**
http://www.un.org/disabilities/convention/conventionfull.shtml
e. Recognizing that disability is an evolving concept and **that disability results from the interaction between persons with impairments** and attitudinal and environmental barriers that hinders their full and effective participation in society on an equal basis with others,
Article 2 – Definitions
For the purposes of the present Convention:
"Discrimination on the basis of disability" means any distinction, exclusion or restriction on the basis of disability which has the purpose or effect of impairing or nullifying the recognition, **enjoyment or exercise, on an equal basis with others**, of all human rights and fundamental freedoms in the political, economic, social, cultural, civil or any other field. It includes all forms of discrimination, including denial of reasonable accommodation;

178 **UN Resolution 48/96, Annex of 20 December 1993 (UN 1993)**
The Standard Rules on the Equalization of Opportunities for Persons with Disabilities
http://www.un.org/esa/socdev/enable/dissre00.htm
II. Target Areas for Equal Participation
Rule 5. Accessibility
States should recognize the overall importance of accessibility in the process of the equalization of opportunities in all spheres of society. For persons with disabilities of any kind, States should (a) introduce programmes of action to make the physical environment accessible; and (b) undertake measures to provide access to information and communication.

- Access to the physical environment
    - States should initiate measures to remove the obstacles to participation in the physical environment. Such measures should be to develop standards and guidelines and to consider

enacting legislation to **ensure accessibility to various areas in society, such as housing, buildings, public transport services and other means of transportation, streets and other outdoor environments.**

- States should ensure that architects, construction engineers and others who are professionally involved in the design and construction of the physical environment have access to adequate information on disability policy and measures to achieve accessibility.
- Accessibility requirements should be included in the design and construction of the physical environment from the beginning of the designing process.
- **Organizations of persons with disabilities should be consulted when standards and norms for accessibility are being developed.** They should also be involved locally from the initial planning stage when public construction projects are being designed, thus ensuring maximum accessibility.

- Access to information and communication
  - **Persons with disabilities and, where appropriate, their families and advocates should have access to full information on diagnosis, rights and available services and programmes, at all stages. Such information should be presented in forms accessible to persons with disabilities.**
  - States should develop strategies to make information services and documentation accessible for different groups of persons with disabilities. Braille, tape services, large print and other appropriate technologies should be used to provide access to written information and documentation for persons with visual impairments. Similarly, appropriate technologies should be used to provide access to spoken information for persons with auditory impairments or comprehension difficulties.
  - Consideration should be given to the use of sign language in the education of deaf children, in their families and communities. Sign language interpretation services should also be provided to facilitate the communication between deaf persons and others.
  - **Consideration should also be given to the needs of people with other communication disabilities.**
  - States should encourage the media, especially television, radio and newspapers, to make their services accessible.
  - **States should ensure that new computerized information and service systems offered to the general public are either made initially accessible or are adapted to be made accessible to persons with disabilities.**
  - Organizations of persons with disabilities should be consulted when measures to make information services accessible are being developed.

Rule 6. Education

States should recognize the principle of equal primary, secondary and tertiary educational opportunities for children, youth and adults with disabilities, in integrated settings. They should ensure that the education of persons with disabilities is an integral part of the educational system.

- General educational authorities are responsible for the education of persons with disabilities in integrated settings. **Education for persons with disabilities should form an integral part of national educational planning, curriculum development and school organization.**
- Education in mainstream schools presupposes the provision of interpreter and other appropriate support services. Adequate accessibility and support services, designed to meet the needs of persons with different disabilities, should be provided.
- Parent groups and organizations of persons with disabilities should be involved in the education process at all levels.
- **In States where education is compulsory it should be provided to girls and boys with all kinds and all levels of disabilities, including the most severe.**
- Special attention should be given in the following areas:
  - Very young children with disabilities;
  - Pre-school children with disabilities;
  - Adults with disabilities, particularly women.
- To accommodate educational provisions for persons with disabilities in the mainstream, States should:
  - Have a clearly stated policy, understood and accepted at the school level and by the wider community;
  - Allow for curriculum flexibility, addition and adaptation;
  - Provide for quality materials, ongoing teacher training and support teachers.

- Integrated education and community-based programmes should be seen as complementary approaches in providing cost-effective education and training for persons with disabilities. **National community-based programmes should encourage communities to use and develop their resources to provide local education to persons with disabilities.**
- In situations where the general school system does not yet adequately meet the needs of all persons with disabilities, **special education may be considered**. It should be aimed at preparing students for education in the general school system. The quality of such education should reflect the same standards and ambitions as general education and should be closely linked to it. **At a minimum, students with disabilities should be afforded the same portion of educational resources as students without disabilities. States should aim for the gradual integration of special education services into mainstream education.** It is acknowledged that in some instances special education may currently be considered to be the most appropriate form of education for some students with disabilities.
- Owing to the particular communication needs of deaf and deaf/blind persons, their education may be more suitably provided in schools for such persons or special classes and units in mainstream schools. At the initial stage, in particular, special attention needs to be focused on culturally sensitive instruction that will result in effective communication skills and maximum independence for people who are deaf or deaf/blind.

Rule 7. Employment

States should recognize the principle that **persons with disabilities must be empowered to exercise their human rights, particularly in the field of employment. In both rural and urban areas they must have equal opportunities for productive and gainful employment in the labour market.**

- Laws and regulations in the employment field must not discriminate against persons with disabilities and must not raise obstacles to their employment.
- States should actively support the integration of persons with disabilities into open employment. This active support could occur through a variety of measures, such as vocational training, incentive-oriented quota schemes, reserved or designated employment, loans or grants for small business, exclusive contracts or priority production rights, tax concessions, contract compliance or other technical or financial assistance to enterprises employing workers with disabilities. **States should also encourage employers to make reasonable adjustments to accommodate persons with disabilities.**
- States' action programmes should include:
    - **Measures to design and adapt workplaces and work premises in such a way that they become accessible to persons with different disabilities;**
    - **Support for the use of new technologies and the development and production of assistive devices, tools and equipment and measures to facilitate access to such devices and equipment for persons with disabilities to enable them to gain and maintain employment;**
    - **Provision of appropriate training and placement and ongoing support such as personal assistance and interpreter services.**
- **States should initiate and support public awareness-raising campaigns designed to overcome negative attitudes and prejudices concerning workers with disabilities.**
- **In their capacity as employers, States should create favourable conditions for the employment of persons with disabilities in the public sector.**
- **States, workers' organizations and employers should cooperate to ensure equitable recruitment and promotion policies, employment conditions, rates of pay, measures to improve the work environment in order to prevent injuries and impairments and measures for the rehabilitation of employees who have sustained employment-related injuries.**
- The aim should always be for persons with disabilities to obtain employment in the open labour market. For persons with disabilities whose needs cannot be met in open employment, small units of sheltered or supported employment may be an alternative. It is important that the quality of such programmes be assessed in terms of their relevance and sufficiency in providing opportunities for persons with disabilities to gain employment in the labour market.
- Measures should be taken to include persons with disabilities in training and employment programmes in the private and informal sectors.
- States, workers' organizations and employers should cooperate with organizations of persons with disabilities concerning all measures to create training and employment opportunities, including flexible hours, part-time work, job-sharing, self-employment and attendant care for persons with disabilities.

179 **European Parliament resolution, 2 April 2009, Health concerns associated with electromagnetic fields (2008/2211(INI)**

http://www.europarl.europa.eu/sides/getDoc.do?type=TA&language=EN&reference=P6-TA-2009-216
28. **Calls on Member States to follow the example of Sweden and to recognise persons that suffer from electrohypersensitivity as being disabled so as to grant them adequate protection as well as equal opportunities;**

NOTABLE PERSONS WITH EHS:

180 **Dr Gro Harlem Brundtland, Former Director-General of WHO and Norwegian Prime Minister**
http://www.magdahavas.com/gro-harlem-brundtland-talks-at-the-university-of-waterloo/
Dr. Brundtland said, "Based on your question, I assume you know that I am electrically sensitive. I never place a mobile phone next to my head because in one second I would develop a bad headache. I use the phone in speaker mode," and she demonstrated with her cell phone, holding it away from her head.

181 **Nokia's former Technology Chief, Matti Niemelä**
http://betweenrockandhardplace.wordpress.com/2014/10/18/former-nokia-technology-chief-mobile-phones-wrecked-my-health/
For Tampere-based Matti Niemelä, age 44, life was like in the movies when he as a young man was recruited to work for Nokia in 1997. The brilliant young man quickly advanced to become Nokia's Chief Technology Officer for ten years, and was involved in developing the world's first mobile phones, memory sticks and WLAN [Wi-Fi] connections.
In 2007, Niemelä's career hit a brick wall as his health finally failed. Today, he is only able to move using a walker. Niemelä refuses to use a wheelchair.
– The irony of this is that I'm no longer able to use any of those devices that I had been developing, Niemelä says with a smile…..
…..**Even a small radiation exposure is too much.**

– **I can no longer go to the cinema or stay in public areas with lots of radiation for long. I have not been anywhere for a long time says Niemelä who in his forties, must accept that the four walls of his home are now a prison…..**
…. Niemelä explains that the subject of mobile phone radiation has always been kept silent at Nokia.
– You couldn't talk about it within the company. Yet, among the staff, it was speculated whether the radiation could cause damage. However, no one dared to bring it up, because it could get them fired.
Niemelä says he brought up the matter with the doctor for the first time in 2006.
– The doctor told me about a number of patients who are suffering from the same symptoms as me, Niemelä reveals.
Niemelä is particularly concerned about the children and their mobile phone use, because the continuous exposure to the ear and head does not do any good.
– These things have been kept silent for too long. I hope it will become possible to discuss the symptoms openly, and without fear.

MEDICAL GUIDELINES EXIST:

See also: Tuengler & von Klitzing 2013[95].

182 **Austrian Medical Association, 2012**
Guideline of the Austrian Medical Association for diagnosis and treatment of EMF-related health problems and illnesses (EMF Syndrome)
http://www.magdahavas.com/wordpress/wp-content/uploads/2012/06/Austrian-EMF-Guidelines-2012.pdf
5. Diagnosis (page 11)
A diagnosis of EMF syndrome will largely be based on a comprehensive case history, focusing in particular on correlations between health problems and times and places of EMF exposure, as well as the progression of symptoms over time. In addition, measurements of EMF exposure and the results of additional diagnostic tests (laboratory tests, cardiovascular system) serve to support the diagnosis. Moreover, all other potential causes should be excluded as far as possible.

We recommend that the code Z58.4 (Exposure to radiation) under the International Classification of Diseases (ICD-10) be used for EMF syndrome for the time being.

183 **Austrian Medical Association, 2012**

Guideline of the Austrian Medical Association for diagnosis and treatment of EMF-related health problems and illnesses (EMF Syndrome)
http://www.magdahavas.com/wordpress/wp-content/uploads/2012/06/Austrian-EMF-Guidelines-2012.pdf
How to proceed if EMF-related health problems are suspected (page 4)
The recommended approach to diagnosis and treatment is intended as an aid and should, of course, be modified as each individual case requires.
1. History of health problems and EMF exposure
2. Examination and findings
3. Measurement of EMF exposure
4. Prevention or reduction of EMF exposure
5. Diagnosis 6. Treatment
6. Treatment (page 11)
The primary method of treatment should consist in the prevention or reduction of EMF exposure, taking care to reduce or eliminate all sources of EMF if possible. Many examples have shown that such measures can prove effective.

184 **Canadian Human Rights Commission, May 2007**
The Medical Perspective on Environmental Sensitivities
http://www.chrc-ccdp.gc.ca/sites/default/files/envsensitivity_en.pdf
A Diagnostic criteria (page 4)
With regard to multiple chemical sensitivity, thirty-four experienced North American physicians and researchers who had examined patterns of symptoms in thousands of people reached a consensus regarding criteria to establish a diagnosis:
• symptoms are reproducible with repeated exposure;
• the condition is chronic;
• low levels of exposure [lower than previously or commonly tolerated] result in manifestations of the syndrome;
• symptoms improve or resolve when the incitants are removed;
• responses occur to multiple chemically unrelated substances; and
• symptoms involve multiple organ systems.
[Author's note: Whilst these diagnostic criteria were devised for multiple chemical sensitivity (MCS) they are applicable also for EHS, with a correction to the 5th bullet point for 'responses occur to multiple electromagnetic field exposures; and'.]

A systematic literature review confirmed the diagnostic criteria, and suggested that neurological symptoms could be an additional criterion.
The consensus diagnostic criteria were also validated, as they identified those most and least likely to be affected among 2,546 patients in Toronto medical practices with high and low prevalence of patients with sensitivities. In the same study, a combination of four neurological symptoms also discerned people most likely affected by multiple chemical sensitivities: **having a stronger sense of smell than others; feeling dull/groggy; feeling "spacey;" plus having difficulty concentrating. A pattern consistent with these diagnostic criteria is also reported for sensitivities to electromagnetic phenomena.**
VI Diagnosis and treatment of sensitivities (page 27)
Investigation requires a complete assessment of the patient's chronological health and exposure histories, a thorough physical examination and routine tests. Other possible conditions are ruled out, or are treated so that their contributions to ill health are minimized. Then, the consensus diagnostic criteria for environmental sensitivities, strengthened by discriminating symptoms, may be used to "rule in" the condition of environmental sensitivities, using a diagnostic checklist for physicians.

185 Genuis and Lipp , 2012, Sci Total Environ. 2012 Jan 1;414:103-12.
Electromagnetic hypersensitivity: fact or fiction?
http://www.ncbi.nlm.nih.gov/pubmed/22153604
3. Management of electromagnetic hypersensitivity (page 107)
[Author's note: Management guidelines in this paper are categorised 1. Avoidance of triggers, 2. Biochemical restoration, 3. Elimination of bioaccumulated toxicant load].

ADVICE TO LOWER EXPOSURE:

See also: Also refer to Sweden 2000[164], Canadian Human Rights 2007[167].

186 **American Academy of Environmental Medicine (AAEM)**
American Academy of Environmental Medicine Recommendations Regarding Electromagnetic and Radiofrequency Exposure (Dec 2012)
http://aaemonline.org/AAEMEMFmedicalconditions.pdf
Physicians of the American Academy of Environmental Medicine recognize that patients are being adversely impacted by electromagnetic frequency (EMF) and radiofrequency (RF) fields and are becoming more electromagnetically sensitive.

The AAEM recommends that physicians consider patients' total electromagnetic exposure in their diagnosis and treatment, as well as recognition that electromagnetic and radiofrequency field exposure may be an underlying cause of a patient's disease process.

Based on double-blinded, placebo controlled research in humans, medical conditions and disabilities that would more than likely **benefit from avoiding electromagnetic and radiofrequency exposure** include, but are not limited to:
• Neurological conditions such as paresthesias, somnolence, cephalgia, dizziness, unconsciousness, depression
• Musculoskeletal effects including pain, muscle tightness, spasm, fibrillation
• Heart disease and vascular effects including arrhythmia, tachycardia, flushing, edema
• Pulmonary conditions including chest tightness, dyspnea, decreased pulmonary function
• Gastrointestinal conditions including nausea, belching
• Ocular (burning)
• Oral (pressure in ears, tooth pain)
• Dermal (itching, burning, pain)
• Autonomic nervous system dysfunction (dysautonomia).
[Author's note: the above are all symptoms of electromagnetic hypersensitivity].

187 **ANSES (French Government Agency for Food, Environmental and Occupational Health), 2013**
https://www.anses.fr/en/content/radiofrequencies-mobile-telecommunications-and-wireless-technology
Radiofrequencies, mobile telecommunications and wireless technology (updated 16/4/2013)
Health effects of wireless communication technologies and other radiofrequency applications
Recommendations of the Agency
The possible impact of radiofrequency exposure on health is a subject of debate in the scientific community, in an environment where technologies have been rapidly deployed. This is specifically due to the lack of clear evidence of non-thermal effects and because there is still uncertainty surrounding evidence of various effects on cell mechanisms. This issue is also part of the wider debate concerning multiple environmental exposure to low levels of electromagnetic fields, and the possible associated health risks. Additional research studies carried out with suitable methodologies are justified in order to provide answers to these various questions.
However, given the level of uncertainty, the Agency emphasises that reduction of environmental exposure should be considered in all cases where this is possible, particularly through deployment of the best available technologies at economically acceptable costs.
There is indeed potential for reduction in the area of exposure to radiofrequencies. **Examples include the use of mobile telephones with low specific absorption rates (SARs), lowering levels in zones with the highest degree of exposure, sharing transmitters, and measured use of wireless technologies.**

188 **Austrian Medical Association, 2012**
Guideline of the Austrian Medical Association for diagnosis and treatment of EMF-related health problems and illnesses (EMF Syndrome)
http://www.magdahavas.com/wordpress/wp-content/uploads/2012/06/Austrian-EMF-Guidelines-2012.pdf
4. Prevention or reduction of EMF exposure Preventing or reducing EMF exposure after consultation of a measurement engineer is advantageous for several reasons: a) to prevent and reduce risks to the individual and to public health, b) to treat the causes of EMF syndrome and c) to aid in identifying any links to health problems.

189 **BioInitiative Report, 2012.**
A report by 29 independent scientists and health experts from around the world (ten holding medical degrees (MDs), 21 PhDs, and three MSc, MA or MPHs) about possible risks from wireless technologies and electromagnetic fields. Among the authors are three former presidents of the Bioelectromagnetics Society (BEMS), and five full members of

BEMS. One distinguished author is the Chair of the Russian National Committee on Non-Ionizing Radiation. Another is a Senior Advisor to the European Environmental Agency.
http://www.bioinitiative.org/conclusions/
SENSITIVE POPULATIONS MUST BE PROTECTED
Safety standards for sensitive populations will more likely need to be set at lower levels than for healthy adult populations. **Sensitive populations include the developing fetus, the infant, children, the elderly, those with pre-existing chronic diseases, and those with developed electrical sensitivity (EHS).**

190 **Canadian Human Rights Commission, May 2007**
The Medical Perspective on Environmental Sensitivities
http://www.chrc-ccdp.gc.ca/sites/default/files/envsensitivity_en.pdf
Abstract (page ii)
Avoidance of triggers is an essential step to regaining health.
Executive Summary (page iii)
The symptoms are reproducible with repeated exposures, and resolve with avoidance of the environmental factor(s).
VI Diagnosis and treatment of sensitivities (page 27)
Once a diagnosis of environmental sensitivities has been established, there are a variety of strategies for treating and living with the condition. **Avoidance of symptom triggers** and removal of toxic chemicals stored in the body are key to treating environmental sensitivities.

191 **International Doctors Appeal, 2012.**
[Author's note: point 7 specifically relates to protection via reduced exposure].
Observations & Findings: Wireless Radiation Poses a Health Risk. Physicians Demand Overdue Precaution!
http://freiburger-appell-2012.info/en/observations-findings.php
The number of those who suffer from electrohypersensitivity is steadily growing. They can develop severe symptoms immediately or even several hours after the exposure to technical electromagnetic fields. As physicians we welcome that Sweden has recognized electrohypersensitivity as a functional impairment. We would also like to point out and emphasize that the European Parliament has called on its member states "to follow the example of Sweden," and that U.S. State Governors have raised public awareness about the serious consequences of electrohypersensitivity. The initiative of the Austrian Medical Association, which has released a guideline for the diagnosis and treatment of EMF-related health problems and illnesses, hopefully will also catch on in other countries.
Recommendations:
http://freiburger-appell-2012.info/en/recommendations.php
More than 1000 physicians signed the "Freiburg Appeal" in 2002. It was translated into many languages. As many as **36,000** people from all over the world support its warning about the dangers of radio-frequency radiation. Today—ten years later—we as physicians and scientists call again on our colleagues and the wider global community, but also on all politicians around the world.
As physicians and scientists, we hereby call on our colleagues; on the leaders of federal, state, and local governments; but also on the wider community to take action and implement the following precautionary strategies, which also include fundamental human rights:
1. Protect the inviolability of the home by minimizing radio-frequency exposure levels, which penetrate through the walls of one's own home.
2. Ensure considerably lower radio-frequency radiation exposures as well as exposure limits that reliably protect humans and nature from adverse biological effects of electromagnetic fields. **Any further expansion of wireless technologies is irresponsible.**
3. **Prefer wired solutions for home use and public institutions, especially at preschools, schools, colleges, universities, nursing homes, and hospitals.**
4. Cutback and reprogram continuously emitting devices such as cordless phones, wireless Internet access (Wi-Fi), and wireless smart meters so that they only operate and emit radio-frequency radiation on demand when being used.
5. Provide special protection for children and adolescents: **Children below the age of 8 should not use cell phones and cordless phones; children and adolescents between the ages 8 and 16 should also not use cell phones or only use them in the case of an emergency.** Cell phone and online device advertisements must not be directed at children and adolescents, and these devices should not be used at schools.
6. Attach clearly visible warning labels and safety guidelines for lowering the radiation exposure on cell phones and other wireless devices, including instruction manuals. An important reminder: do not carry a cell phone right next to your body when it is turned on.

7. **Identify and clearly mark protected zones for electrohypersensitive people; establish public areas without wireless access or coverage, especially on public transport, similar to smoke-free areas for nonsmokers.**
8. Promote the development of communication technologies and electricity use that is more compatible with health. Prefer wired solutions for home use and public facilities. Expand fiber-optic networks as the foundation of a modern, sustainable, and performance-based technology that meets the ever-increasing demand for higher data transmission rates.
9. Provide government funding for industry-independent research and education that do not dismiss strong scientific and medical findings of potential risks, but rather work to clarify those risks.

192 **Parliamentary Assembly of the Council of Europe, Resolution 1815 (2011)**
http://www.assembly.coe.int/Mainf.asp?link=/Documents/AdoptedText/ta11/ERES1815.htm (Final resolution)
5. As regards standards or threshold values for emissions of electromagnetic fields of all types and frequencies, the Assembly strongly recommends that the ALARA (as low as reasonably achievable) principle is applied, covering both the so-called thermal effects and the athermic or biological effects of electromagnetic emissions or radiation. Moreover, the precautionary principle should be applied when scientific evaluation does not allow the risk to be determined with sufficient certainty. Given the context of growing exposure of the population, in particular that of vulnerable groups such as young people and children, there could be extremely high human and economic costs if early warnings are neglected.

8. In light of the above considerations, the Assembly recommends that the member states of the Council of Europe:
8.1. in general terms:
8.1.1. take all reasonable measures to reduce exposure to electromagnetic fields, especially to radio frequencies from mobile phones, and particularly the exposure to children and young people who seem to be most at risk from head tumours;
8.1.2. reconsider the scientific basis for the present standards on exposure to electromagnetic fields set by the International Commission on Non-Ionising Radiation Protection, which have serious limitations, and apply ALARA principles, covering both thermal effects and the athermic or biological effects of electromagnetic emissions or radiation;
8.1.3. put in place information and awareness-raising campaigns on the risks of potentially harmful long-term biological effects on the environment and on human health, especially targeting children, teenagers and young people of reproductive age;
8.1.4. **pay particular attention to "electrosensitive" people who suffer from a syndrome of intolerance to electromagnetic fields and introduce special measures to protect them, including the creation of wave-free areas not covered by the wireless network;**

193 **Swiss Physicians for the Environment (MfE), 2012** (Basel, March 16, 2012)
Non-ionizing radiation (NIR): As much as necessary and as little as possible
http://www.aefu.ch/fileadmin/user_upload/aefu-data/b_documents/Aktuell/120316_Brief_NIS.pdf
Dear Federal Councillors, Dear national councilors, Dear StänderätInnen

The International Agency IARC cancer called mobile phone radiation as "possibly carcinogenic ". The IARC classifies the cancer risk of this radiation is thus equal to one as in prohibited rightly insects DDT.

The radiation exposure from mobile phone has increased greatly in recent years and will continue to rise.

We, the Doctors for the Environment (AefU) note with concern that the NIS Regulation, the Swiss population - but especially sensitive population groups such as children and pregnant women - does not provide sufficient negative Health- impacts of the electromagnetic fields protects.

We appeal to you in your decisions and actions around electricity and radio equipment applications, the precautionary principle "as much as necessary and as little as possible" taken into account.

3. The precautionary principle should be applied to non-ionizing radiation (NIR) strictly We therefore call on you in your decisions
   • given the recent studies on a tightening of NIS Regulation to work
   • a precaution field reduced infrastructure planning to pursue
   • legal basis for mandatory declaration of NIS-emitting devices to create
   • the upcoming expansion of the electricity network without additional exposure of the population to plan
   • continuous, independent, practical and interdisciplinary research

Focus on vulnerable groups such as children, pregnant women, chronically ill to assist and electro-sensitive patients.

[Author's note: translated using Google Translate].

194 **US, 2005, National Institute of Building Sciences**
IEQ Indoor Environmental Quality
http://web.archive.org/web/20060714175343/ieq.nibs.org/ieq_project.pdf (page 11)
The National Institute for Occupational Safety and Health (NIOSH) notes that scientific studies have raised questions about the possible health effects of EMF's. **NIOSH recommends the following measures for those wanting to reduce EMF exposure – informing workers and employers about possible hazards of magnetic fields, increasing workers' distance from EMF sources, using low-EMF designs wherever possible (e.g., for layout of office power supplies), and reducing EMF exposure times** .

AVOIDANCE ONLY RELIABLE FORM OF MANAGEMENT:

See also: Hagström et al, 2013[138].

195 Röösli et al, 2004, Int J Hyg Environ Health. 2004 Feb;207(2):141-50.
Symptoms of ill health ascribed to electromagnetic field exposure--a questionnaire survey.
http://www.ncbi.nlm.nih.gov/pubmed/15031956
From June 2001, health questionnaires were distributed to people who complained about symptoms of ill health which they ascribed to exposure to electromagnetic fields (EMF). The objective of the survey was to gain a better knowledge of the anxieties of complainants, to obtain hints of possible problems and of actions that should be taken to solve the problems. The survey was not designed to establish a causal association between exposure to EMF and symptoms of ill health. Within one year, 429 questionnaires were returned of which 394 persons reported symptoms. The average age of the complainants was 51.0 years and 57 percent were female. The complainants were older, had a higher educational level and were more likely to be married compared to the general Swiss population. A mean of 2.7 different symptoms were reported. **Sleep disorders (58%), headaches (41%), nervousness or distress (19%), fatigue (18%), and concentration difficulties (16%) were most common complaints. Complainants related their symptoms most frequently to exposure to mobile phone base stations (74%), followed by mobile phones (36%), cordless phones (29%) and power lines (27%).** No distinct symptoms related to a specific field source could be identified. Eighty-five percent of the people who consulted a public authority because of their symptoms were unsatisfied with the response, whereas consultation of self-help groups or building ecologists usually fulfilled expectations. Two thirds of complainants had taken some action to reduce their symptoms. **The most common measure was to avoid exposure if possible. Removing or disconnecting indoor sources was judged to be the most effective action.**

IT IS A CLINICAL DIAGNOSIS:

See also: Austrian Guidelines 2012[182].

CHILDREN HAVE EHS:

196 **Department for Education, Supporting pupils at school with medical conditions, April 2014**
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/349435/Statutory_guidance_on_supporting_pupils_at_school_with_medical_conditions.pdf
Excepts:
Key points (page 4)
• Pupils at school with medical conditions should be properly supported so that they have full access to education, including school trips and physical education.
• Governing bodies must ensure that arrangements are in place in schools to support pupils at school with medical conditions.
• Governing bodies should ensure that school leaders consult health and social care professionals, pupils and parents to ensure that the needs of children with medical conditions are effectively supported.
Introduction (page 5)

1. The aim is to ensure that all children with medical conditions, in terms of both physical and mental health, are properly supported in school **so that they can play a full and active role in school life, remain healthy and achieve their academic potential.**
2. It is crucial that schools receive and fully consider advice from healthcare professionals **and listen to and value the views of parents and pupils.**
3. In addition to the educational impacts, there are social and emotional implications associated with medical conditions. In particular, long-term absences due to health problems affect children's educational attainment, impact on their ability to integrate with their peers and affect their general wellbeing and emotional health.
4. Some children with medical conditions may be considered to be disabled under the definition set out in the Equality Act 2010. Where this is the case governing bodies must comply with their duties under that Act.

The role of governing bodies, proprietors and management committees (page 7)

5 The governing body, proprietor or management committee remains legally responsible and accountable for fulfilling their statutory duty.
6. The governing body must ensure that arrangements are in place to support pupils with medical conditions. In doing so they should ensure that **such children can access and enjoy the same opportunities at school as any other child.**
8. The governing body should ensure that their arrangements give parents and pupils confidence in the school's ability to provide effective support for medical conditions in school. They should ensure that staff are properly trained to provide the support that pupils need.
9. **Children and young people with medical conditions are entitled to a full education and have the same rights of admission to school as other children.** This means that no child with a medical condition should be denied admission or prevented from taking up a place in school because arrangements for their medical condition have not been made. However, in line with their safeguarding duties, **governing bodies should ensure that pupils' health is not put at unnecessary risk.**

Policy implementation (page 8)

12. Governing bodies should ensure that the arrangements they set up include details on how the school's policy will be implemented effectively, including a named person who has overall responsibility for policy implementation.

Procedure to be followed when notification is received that a pupil has a medical condition (page 9)

14. **Schools do not have to wait for a formal diagnosis before providing support to pupils. In cases where a pupil's medical condition is unclear, or where there is a difference of opinion, judgements will be needed about what support to provide based on the available evidence.**

Individual healthcare plans (page 10)

17. Partners should agree who will take the lead in writing the plan, but responsibility for ensuring it is finalised and implemented rests with the school. The governing body should ensure that plans are reviewed at least annually, or earlier if evidence is presented that the child's needs have changed. They should be developed with the child's best interests in mind and ensure that the school assesses and manages risks to the child's education, health and social wellbeing, and minimises disruption.

Roles and responsibilities (page 12)

Headteachers - They should also make sure that school staff are appropriately Insured.

Pupils – with medical conditions will often be best placed to provide information about how their condition affects them. They should be fully involved in discussions about their medical support needs and contribute as much as possible to the development of, and comply with, their individual healthcare plan. Other pupils will often be sensitive to the needs of those with medical conditions.

Parents – should provide the school with sufficient and up-to-date information about their child's medical needs. They may in some cases be the first to notify the school that their child has a medical condition. Parents are key partners and should be involved in the development and review of their child's individual healthcare plan, and may be involved in its drafting.

Local authorities – Statutory guidance for local authorities sets out that they should be ready to make arrangements under this duty when it is clear that a child will be away from school **for 15 days or more** because of health needs (whether consecutive or cumulative across the school year).

Ofsted – their inspection framework places a clear emphasis on meeting the needs of disabled children and pupils with SEN, and considering the quality of teaching and the progress made by these pupils. Inspectors are already briefed to consider the needs of pupils with chronic or long-term medical conditions alongside these groups and to report on how well their needs are being met. Schools are expected to have a policy dealing with medical needs and to be able to demonstrate that this is implemented effectively.

Staff training and support (page 15)

29. This includes **preventative** and emergency measures so that staff can recognise and act quickly when a problem occurs.

30. **The family of a child will often be key in providing relevant information to school staff about how their child's needs can be met**, and parents should be asked for their views. They should provide specific advice, but should not be the sole trainer.

Day trips, residential visits and sporting activities (page 18)

41. Schools should consider what reasonable adjustments they might make to enable children with medical needs **to participate fully and safely on visits**. It is best practice to carry out a risk assessment so that planning arrangements take account of any steps needed to ensure that pupils with medical conditions are included.

Other issues for consideration (page 18)

Schools are advised to consider purchasing a defibrillator as part of their first-aid equipment

Unacceptable practice (page 19)

43. It is not generally acceptable practice to:

• ignore the views of the child or their parents; or ignore medical evidence or opinion (although this may be challenged);

- No parent should have to give up working because the school is failing to support their child's medical needs;
- prevent children from participating, or create unnecessary barriers to children participating in any aspect of school life, including school trips

Liability and indemnity (page 20)

44. **Governing bodies of maintained schools and management committees of PRUs should ensure that the appropriate level of insurance is in place and appropriately reflects the level of risk. [Author's note: the author is not aware of any insurance companies that insured against health effects of RF radiation exposure].**

46. In the event of a claim alleging negligence by a member of staff, civil actions are likely to be brought against the employer.

Further sources of information (page 21)

Other safeguarding legislation

Section 21 of the Education Act 2002 provides that governing bodies of maintained schools must, in discharging their functions in relation to the conduct of the school, **promote the wellbeing of pupils at the school.**

Section 175 of the Education Act 2002 provides that governing bodies of maintained schools must make arrangements for ensuring that their functions relating to the conduct of the school are exercised with a view to **safeguarding and promoting the welfare of children who are pupils at the school.** Paragraph 7 of Schedule 1 to the Independent School Standards (England)Regulations 2010 set this out in relation to academy schools and alternative provision academies.

Section 3 of the Children Act 1989 provides a duty on a person with the care of a child (who does not have parental responsibility for the child) to **do all that is reasonable in all the circumstances for the purposes of safeguarding or promoting the welfare of the child.**

Section 17 of the Children Act 1989 gives local authorities a general duty to **safeguard and promote the welfare of children in need in their area.**

Section 10 of the Children Act 2004 provides that the local authority must make arrangements to promote co-operation between the authority and relevant partners (including the governing body of a maintained school, the proprietor of an academy, clinical commissioning groups and the NHS Commissioning Board) with a view to **improving the wellbeing of children, including their physical and mental health,** protection from harm and neglect, and education. **Relevant partners are under a duty to co-operate in the making of these arrangements.**

The NHS Act 2006: Section 3 gives Clinical Commissioning Groups a duty to arrange for **the provision of health services to the extent the CCG considers it necessary to meet the reasonable needs of the persons for whom it is responsible.**

Section 3A provides for a CCG to arrange such services as it considers appropriate to **secure improvements in physical and mental health of, and in the prevention, diagnosis and treatment of illness,** in, the persons for whom it is responsible. **Section 2A provides for local authorities to secure improvements to public health**, and in doing so, to commission school nurses.

Governing Bodies' duties towards disabled children and adults are included in the **Equality Act 2010**, and the key elements are as follows:

- **They must not discriminate against**, harass or victimise **disabled children** and young **people [Author's note: EHS is classified as a functional impairment under the Disability Act under some countries.[164]]**
- They must make reasonable adjustments to ensure that disabled children and young people are not at a substantial disadvantage compared with their peers. This duty is anticipatory: adjustments must be planned and put in place in advance, to prevent that disadvantage

Other relevant legislation (page 22)

Section 2 of the Health and Safety at Work Act 1974, and the associated regulations, provides that it is the duty of the employer (the local authority, governing body or academy trust) to **take reasonable steps to ensure that staff and pupils are not exposed to risks to their health and safety.**

VULNERABLE GROUPS AND WHITE ZONES:

197 **Benevento Resolution, 2006, ICEMS** (International Commission for Electromagnetic Safety).
http://www.icems.eu/benevento_resolution.htm
We encourage governments to adopt a framework of guidelines for public and occupational EMF exposure that reflect the Precautionary Principle.
Promote alternatives to wireless communication systems.
Designate wireless-free zones in cities, in public buildings (schools, hospitals, residential areas) and, on public transit, to permit access by persons who are hypersensitive to EMF.

198 **International Doctors Appeal, 2012.**
Radio-frequency Radiation Poses a Health Risk. Physicians Demand Overdue Precaution.
http://freiburger-appell-2012.info/en/observations-findings.php
More than 1000 physicians signed the "Freiburg Appeal" in 2002. It was translated into many languages. As many as **36,000** people from all over the world support its warning about the dangers of radio-frequency radiation. Today—ten years later—we as physicians and scientists call again on our colleagues and the wider global community, but also on all politicians around the world.
As physicians and scientists, we hereby call on our colleagues; on the leaders of federal, state, and local governments; but also on the wider community to take action and implement the following precautionary strategies, which also include fundamental human rights:
7. **Identify and clearly mark protected zones for electrohypersensitive people; establish public areas without wireless access or coverage, especially on public transport, similar to smoke-free areas for nonsmokers.**

199 **Parliamentary Assembly of the Council of Europe, Resolution 1815 (2011)**
http://www.assembly.coe.int/Mainf.asp?link=/Documents/AdoptedText/ta11/ERES1815.htm (Final resolution)
8. In light of the above considerations, the Assembly recommends that the member states of the Council of Europe:
8.1. in general terms:
8.1.4. **pay particular attention to "electrosensitive" people who suffer from a syndrome of intolerance to electromagnetic fields and introduce special measures to protect them, including the creation of wave-free areas not covered by the wireless network;**

SOCIOECONOMIC IMPACT OF EHS AND HUMAN RIGHTS:

200 **Canadian Human Rights Commission, May 2007**
The Medical Perspective on Environmental Sensitivities
http://www.chrc-ccdp.gc.ca/sites/default/files/envsensitivity_en.pdf
Executive Summary (page v)
There are high costs to society of not caring for people with sensitivities, and workplace environmental quality affects workers' productivity, health and attendance.

ALL EHS PERSONS REQUIRE 'COMPREHENSIVE HEALTH EVALUATION':

201 De Luca et al, 2014, Mediators Inflamm. 2014;2014:924184.
Metabolic and genetic screening of electromagnetic hypersensitive subjects as a feasible tool for diagnostics and intervention.
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4000647/