

REPORT from the BioEM2015

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Introductory comments

This report was prepared for the **Pandora Foundation, Germany**, and **Competence Initiative, Germany**, which supported travel and participation of the author in BioEM2015. Parts of this report were published during the course of the BioEM2015 as blogs on "[BRHP – Between a Rock and a Hard Place](#)" site.

Because of my background in EMF research that focused on the biological and health effects of RF-EMF and because of the justified by scientific evidence concerns about the impact of long-term exposures of over 7 billion of cell phone users to RF-EMF, this report from the BioEM2015 focuses only on few representative examples of studies, from few selected topics to present some of the problems with the scientific evidence:

- The Precautionary Principle
- The causality link between EHS and EMF
- RF-EMF exposure metrics
- The existence of mechanism explaining existence of non-thermal effects of RF-EMF

For the full list of topics presented at the BioEM2015, please, consult the freely available program (<http://www.bioem2015.org/Program.pdf>). However, the full book of extended conference abstracts is accessible only for the registered participants of the BioEM2015, and for the members in good standing of the BEMS and EBEA.

The Precautionary Principle

'2B or not 2B: Should IARC's classification of RF-EMF invoke the precautionary principle?'

The conference was opened by the plenary session dealing with the question whether the Precautionary Principle should, or should not, be implemented for RF-EMF exposures.

This type of sessions, where two scientists present two different, often opposite, opinions on the same subject, followed by ample discussion time, were first introduced by **Dariusz Leszczynski & Guglielmo D'Inzeo** during the BioEM2009 in Switzerland.

The setting stage for the opposite views debate was by **Kurt Straif** of IARC, presenting briefly how the carcinogenicity of chemical and physical agents is reviewed and classified by the IARC.

The second speaker, **Ken Foster**, known from the past for opposing implementation of the Precautionary Principle for RF-EMF exposures, has made some interesting statements (for the slides of the full presentation see Appendix I). In principle, Ken Foster supports the Precautionary Principle, even for RF-EMF but, in his opinion:

- There is no clear agreement what PP is and many differing "definitions" of PP cause confusion
- Often, when PP is applied, it causes economic favoritism; in Foster's opinion it is rather economic tool than health protection tool
- Canadian SC6, in development of which Foster participated, is according to him, based on PP idea
- EHS is a psychological ailment
- EHS is not caused by EMF affecting physiology
- Ban of wifi in schools is a futile endeavor, because kids will make their own hot-spots using smart phones

In the end, **Ken Foster** proposed to "*apply the Precautionary Principle to the Precautionary Principle*"; meaning, to use the Precautionary Principle as sparingly as possible.

Chris Portier, spoke strongly in support of the implementation of the Precautionary Principle and made several interesting statements (for the slides of the full presentation see Appendix II):

- The **idea of ‘Better safe than sorry’ should be applied** and that is why the Precautionary Principle should be considered whenever needed
- Implementation of the Precautionary Principle should consider the following ideas
 - **Do not wait** for the conclusive causation data
 - **Prove safety** instead of proving harm
 - Thoroughly **inform public** about the possible risks
- **Danish Cohort study**, often used as proving that RF-EMF exposures do not cause brain cancer, **is useless** for any decision making because of the serious misclassification of the “exposures”
- Million Women study is a good one [*DL comment: this is surprising statement, considering how poorly the “exposures” were defined in this study*]
- **Ecological studies** following trends of appearance of cancer **are useless** because there can be simultaneously “at work” different factors – some increasing cancer, some preventing cancer – this can make trend data to look like no change is happening in response to studied factor. Reality might be the opposite because of the uncontrolled factors that might be simultaneously preventing the development of cancer
- **Yes, the Precautionary Principle should be used for RF-EMF** and should include, among others:
 - **Stop saying that there are no established non-thermal effects**; if cancer risk increases in epidemiological studies it indicates that non-thermal effects happen
 - **Strengthen the safety standards**; change them to reflect the current scientific evidence, showing the possibility of health effects
 - **Protect the children** – applies to cell phone use; not so much cell towers
 - Develop better technologies that emit less radiation
 - **Reduce exposures of general population** by making health agencies to advise people to do so
- **IARC classification of RF-EMF as possible carcinogen is sufficient to trigger consideration of the Precautionary Principle**
- Recommendations concerning RF-EMF and health effects should be based on science. However, **many committees (SCENIHR, ICNIRP, WHO, HPA, SSI) simply disregard evidence of effects from epidemiological case-control studies and animal studies and say that the effects are not seen in scientific studies**. Such statements disregard the evidence at hand. General public, decision makers and scientists at large have no idea what are the “criteria” used by these committees to dismiss the positive studies because, description of these “criteria”, is not provided.

DL comments

Success and usefulness of such sessions depends on how much the two speakers are willing to debate and argue for their own and against the other opinions. Also, the input of the audience is important to invigorate discussion. Unfortunately, the great opportunity of debate over the possible applicability of the Precautionary Principle to RF-EMF exposures was lost. Speakers were overly “gentlemanly” towards each other and did not engage in real debate. They did not challenge each other in discussion but satisfied themselves with providing own opinions in own presentations. They did not attempt to demonstrate that the opposite opinion might be incorrect.

The Danish Cohort study, considered by Chris Portier as useless for decision making, is indeed useless and it should be retracted by the BMJ. If the study remains as valid peer-reviewed publication it will be used and abused by those wishing to disregard findings of the case-control studies. Cohort studies

are necessary, but the Danish Cohort is not what is needed because of serious misclassifications of exposures. I wrote about this issue in [The Scientist Magazine](#).

DL attempted to broaden the debate over the Precautionary Principle and submitted proposal of a workshop saying “...My workshop would look at the issue from different angle than this in plenary. Not opinions of individual scientists, pro or contra, but opinions of organizations that are involved in the issue: MMF, Bioinitiative, ICNIRP... Why they think PP should or shouldn't be implemented...”. Unfortunately, the proposal was rejected, citing that a workshop, in addition to the plenary session, would be “too much”... From the perspective of time it is obvious that the workshop would not be anything “too much”. I am convinced that it would be as interesting and well attended as the seminar I organized at the BioEM2014 in Cape Town, South Africa on the conflict of interest in bio-electromagnetics. Sadly, the opportunity for another debate over the Precautionary Principle was lost...

Besides the plenary session on the Precautionary Principle, there were only 3 other presentations (posters) devoted to this topic (reviewed below).

Pre-conditions for the implementation of the Precautionary Principle

Dariusz Leszczynski fully agreed with the opinions on the Precautionary Principle presented by Chris Portier. In his poster, Leszczynski listed three pre-conditions necessary for the implementation of the Precautionary Principle and expressed an opinion that all of the pre-conditions are fulfilled:

- Pre-condition: PP can be implemented when the scientific information is "insufficient, inconclusive, or uncertain"
 - IARC classification of cell phone radiation as a possible carcinogen has clearly shown that the information on health effects of cell phone radiation is “insufficient, inconclusive, or uncertain”
- Pre-condition: PP can be implemented when "there are indications that the possible effects on human health may be potentially dangerous"
 - IARC classification of cell phone radiation, based on the evidence from epidemiological case-control studies, has pointed out that avid long-term cell phone users are at an increased brain cancer risk – this is a potential danger to over 7 billion of cell phone users
- Pre-condition: PP can be implemented when "the current situation is inconsistent with the chosen level of protection"
 - IARC classification pointing out to an increased brain cancer risk is based on epidemiological studies where subjects used regular cell phones meeting current safety standards; this means that the current safety standards are insufficient to protect users.

In Leszczynski's opinion the implementation of the Precautionary principle is hampered by misinformation suggesting that this action will have negative economic impact. This is not the truth:

“...Implementation of the Precautionary Principle does not equal prevention of the use of wireless technologies. This policy can help in curbing the current rampant and uncontrolled deployment of wireless networks anywhere and everywhere. The claims that the implementation of the Precautionary Principle will cause economic harm are not justified. **Implementation of the Precautionary Principle will create new knowledge through research aimed at resolving the issue of health risk and developing communication technologies with lower radiation emissions.** It will, in turn, create new jobs and new economic opportunities in research and technology.”

In the end, Leszczynski concluded that:

“...The IARC review of the scientific evidence and obtained classification of possible carcinogenicity of cell phone radiation, permit implementation of the Precautionary Principle measures, in order to protect the population from the potentially hazardous effects of exposure to radiation

emitted by the wireless communication devices. Concomitantly with the implementation of the protective measures, aimed at reduction of exposures of human population, **scientific research should continue to resolve the contradictions of the scientific evidence.**"

Quality and reliability of the "authoritative reviews of science"

Meg Sears from the Children's Hospital of Eastern Ontario Research Institute in Ottawa, Canada presented poster criticizing the current reviews of science made by various committees. She echoed the concerns expressed by Chris Portier that the criteria for inclusion/exclusion of the scientific evidence exercised by e.g. SCENIHR, ICNIRP, WHO, HPA, SSI are ambiguous, to say the least:

General public, decision makers and scientists at large have no idea what are the "criteria" used by these committees to dismiss the positive studies because, description of these "criteria", is not provided.

Sears said [*emphasis added DL*]:

"...Exposure standards for radiofrequency signals in telecommunications are rooted in a variety of "authoritative reviews." **Methodology and reporting standards for these reviews are not in accordance with standards for clinical medicine, nor with more recently established best practices in environmental health.** In the absence of current, comprehensive, methodologically rigorous reviews in support of exposure standards, precautionary approaches with an emphasis on non-wireless and safer alternatives should guide development and applications of communications technologies."

Sears, speaking about the review of the Canadian Safety Code 6 stated [*emphasis added DL*]:

"...Across all topic areas, at least 140 relevant studies indicating potentially significant or harmful effects were identified as absent from the Canadian review. Of these, 100 were also absent from the subsequent WHO review."

"...Some established best practices for systematic review in clinical medicine are not evident in RF re-reviews, such as broad inclusion of evidence and subsequent discussion of strengths and weaknesses, rather than narrow inclusion of studies."

As practical examples of misrepresentation of published science, Sears mentioned:

- "the exclusion in Canadian documents of research from the Hardell group, with weight given instead to the highly flawed Danish cohort study; "
- "the apparent inclusion/exclusion of studies in the Canadian reports, and the explicit practice per the SCENIHR methodology to include animal studies with exposures from experimental devices, but to exclude studies using commercially available wireless devices"

In conclusion, Sears stated:

- "Updating of systematic reviews should be limited to high quality reviews, which are currently lacking"
- **"In the absence of current, comprehensive, methodologically rigorous reviews in support of exposure standards, precautionary approaches with an emphasis on non-wireless and safer alternatives should guide development and applications of communications technologies."**

DL comment

In presentations of Chris Portier and Meg Sears was expressed the same concern – valid scientific evidence is being excluded by different committees from the reviews of science without valid reasons or clear specification of the criteria for exclusion. The best job at such exclusion is doing, in my opinion, ICNIRP. In reviews authored by ICNIRP all scientific evidence is listed in large tables and the existence of lack of presence of effects is mentioned. Then, somewhat "miraculously" in following the tables conclusions paragraph the overall conclusion is that there are no effects... ICNIRP

does not mention why the studies showing effects, and listed in the table were considered as meaningless. It is as if the use of word “overall” justifies making any conclusions, not looking at the evidence and not explaining why some evidence is arbitrarily disregarded.

Examining the practical implementation of the Precautionary Principle

One of the studies presented at the BioEM2015 examined practical application of the Precautionary Principle in occupational exposures setting. The reason for performing the study was stated by the author, Joseph Bowman of NIOSH, USA, as follows [*emphasis added DL*]:

“Magnetic fields (MF) at extremely low frequencies (ELF) are a possible human carcinogen based on associations of leukemia and brain cancer with time-weighted average (TWA) exposures as low as 0.3 μ T [1]. A quantitative risk assessment indicates that a 1 μ T reduction in TWA occupational magnetic fields might reduce the possible risks of premature cancer deaths by 0.40% (0.07-0.73%), which Figure 1 compares to other common mortality risks. To address these possible cancer risks, the World Health Organization’s 2007 criteria on ELF-MF says: “Provided that the health, social and economic benefits of electric power are not compromised, **implementing very low-cost precautionary procedures to reduce exposures is reasonable and warranted”[2], but such precautionary measures are lacking for workplaces.”**

The pilot study was performed in 35 workplaces in Holland where:

“...precautionary messages were tested in focus groups with occupational hygienists, and used with the management and occupational hygienists at the Dutch factories in an effort to measure the effectiveness of the precautionary strategies.”

Study design relied on voluntary actions and encouragement with incentives:

“...To persuade workers, employers and occupational hygienists to implement these precautions voluntarily, communication materials were developed on the possible cancer risks from workplace ELF-MF, monetary benefits of exposure reductions, and low-cost controls.”

The results of the study were moderately encouraging [*emphasis added DL*]:

The Dutch pilot study showed that **practical low-cost measures can be identified for reducing the TWA of ELF-MF** and therefore the possible cancer risks associated with occupational exposures. However, precautionary exposure reduction through changes in work practices is a **novel paradigm** for occupational health practice, which **faces several barriers to adoption by for managers, workers and occupational hygienists**. Going forward, NIOSH has identified models of health communication that address these barriers and has been using them to strengthen the communication materials on ELF-MF precautionary recommendations. The ultimate goal is to develop a comprehensive package of recommendations for **managing the proven and possible hazards** of occupational ELF-EMF.

DL comment

In sum, this study shows that it is possible to consider and implement low-cost precautionary measures to manage not only the proven risks but also possible hazards. However, one important obstacle, besides the novelty of the approach, is the volunteer approach towards the implementation of the measures. As we know from the past, even for the proven risks, like e.g. car crash deaths and their prevention with the safety belts, industry was unwilling to voluntarily add safety belts to cars. Federal regulation in USA was necessary to implement this life-saving measure. Thus, **as long as any measures of implementation of the Precautionary Principle will not be obligatory for the telecom industry, these measures will likely not be implemented.**

The electrohypersensitivity – the EHS

Plenary on Electrohypersensitivity (Idiopathic environmental intolerance to EMF)

One of the plenary sessions presented two views on EHS. Invited speakers were **Kjell Hansson Mild** and **Gunnhild Oftedal**.

To me the session was a big disappointment. It indicated a stagnation in EHS research and a lack of new ideas to resolve the problem of causality.

Kjell Hansson Mild reviewed the history of EHS research. There were no new ideas for further research. Talk showed a stagnation in research, focused on asking the volunteers "how they feel" and "what they feel" instead of devising studies that would objectively look at the differences in physiology between the unaffected persons and persons self-diagnosed as EHS sufferers.

Kjell Hansson Mild arrived at the conclusion that EHS symptoms "fit" the already known Da Costa's syndrome. By "definition", Da Costa's syndrome is exceptionally unspecific and the majority of human population "has it". Thus is not the way to demonstrate that EMF causes EHS.



EHS: Previously known as Da Costas syndrome??

Symptoms of Da Costa's syndrome include [fatigue](#) upon exertion, [shortness of breath](#), [palpitations](#), [sweating](#), and [chest pain](#). Physical examination reveals no physical abnormalities causing the symptoms.^[9]

Gunnhild Oftedal is known, among others, from her publications with **James Rubin**, the favorite EHS expert of the WHO, ICNIRP, SCENIHR and alike, "no connection between EHS and EMF whatsoever", committees.

Gunnhild Oftedal's presentation went straight to the point - **there is no link between EHS and EMF**. Whatever causes symptoms in people is not the EMF.

Gunnhild Oftedal went even so far as to state that:

"Physiological/health effects in humans in general are not relevant to EHS problem... because there are no known links to EHS."

What is the scientific basis for such definite claim by **Gunnhild Oftedal**? She presented a summary table of EHS provocation and intervention studies:

| Exposure | Number of studies | Number of EHS participants |
|---------------|-------------------|----------------------------|
| Low frequency | 22 | 508 |
| Mobile phone | 15 | 336 |
| Base station | 7 | 219 |
| Total | 44 | 1063 |

This summary indicates that the number of participants in the EHS provocation and intervention studies was very low, totaling only 1063 persons in 44 studies, split between different exposures and experimental approaches.

Is this a sufficient scientific basis to make any definite claims and conclusions about causality between EMF and EHS? Certainly not. **Such amount of "data" is like a small pilot study.**

Therefore, it is not surprising that review by **James Rubin** and collaborators (Rubin et al. 2011, Bioelectromagnetics 32:593-609), and quoted by Gunnhild **Oftedal**, came to the following conclusions:

- there are great variations between studies
- there are no systematic differences between studies with and without positive findings

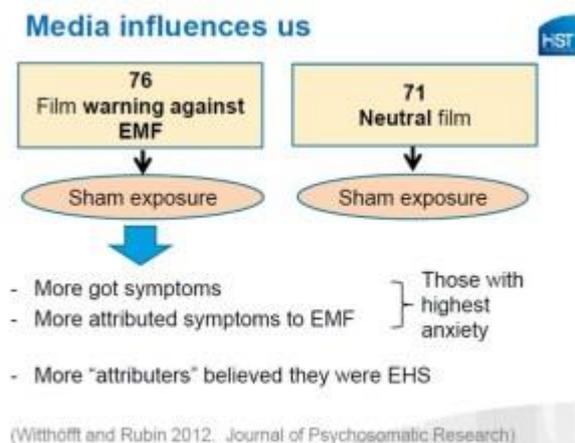
Such conclusions are obvious for such small sample of population studied (1063 subjects) in 44 studies (only ca. 24 subjects per study!).

The other problem, besides the small sample, is the reliability of the experimental data - the answers from the study subjects. In my opinion data is not reliable because it is subjective. Study subjects are asked how and what they feel and their answers provide, by definition, subjective information.

It is not an objective data when EHS person, under stress of experimental setting in laboratory or even at own home, answers questions about how they feel, while being under a real or a sham exposure. **Such subjective data cannot provide reliable evidence for the final scientific proof of the lack of link between EHS and EMF...**

Gunnhild Oftedal, in her presentation, provided evidence to the fact that subjective data is unreliable, no matter that some scientists are trying to claim the contrary.

Gunnhild Oftedal has quoted a study showing how media influences people's opinions. In an experiment, subjects were shown two movies, one warning about health risks of EMF and the other, neutral to EMF and health issue. Following the presentation, it appeared as if the study subjects experienced more EHS symptoms after seeing the movie warning of EMF health risk danger. One important aspect of this study was, again, very small subject sample of 147 persons in total (76 + 71).



This study shows that, indeed, we are affected by what we see and hear around us. That is why court juries, in important cases, are sequestered... Nothing new... Just an obvious - we, the people, are affected by the media...

This particular "movie-show" study is being used as a "proof" that EHS link to EMF is imaginary and that the increasing prevalence of EHS in population is caused by the news media reports, and not by the EMF.

DL comments

There is a very important warning message coming out of the above mentioned “movie-show” study. **The data gathered in studies where persons are asked how they feel when exposed to real or sham radiation are unacceptable as scientific proof of lack of causality link between EMF and EHS... because the study subjects are affected by the experimental setting and their answers are subjective, not objective. The study subjects come to the experiment with their pre-conceptions of what is good and what is bad about EMF exposures. Also, the control group, shown the “neutral” movie comes with own pre-conceptions about EMF and health. Both groups, experimental and control, were before the experiment “exposed” in their daily life to a variety of opinions about EMF and health and such opinions they bring with them to the experiment. This all affects their reactions and responses made to investigators.**

The major obstacle in solving the problem of EHS and EMF, are the attitudes of researchers, lacking ideas for novel approaches. If research on EHS will continue the way, as **Oftedal, Rubin, Croft** and others are doing, we will never resolve this issue.

After the plenary session on EHS, on the Asilomar beach, I met **Junji Miyakoshi**, a molecular biologist from Japan. We discussed the problem of EHS and we came to the same conclusion. **We need studies where study subjects will be exposed to real or sham radiation and provide samples for biochemical analysis of proteins and genes before and after the exposure.** I have been advocating such studies for many years and hit the "brick wall", as I was directly forbidden to even think of such studies by my bosses at STUK - Radiation and Nuclear Safety Authority in Finland. It was very encouraging to hear that such recognized expert in biological effects of EMF, as **Junji Miyakoshi**, agrees with my opinion.

Inadequate design of EHS studies – a case from the Netherlands

The study on ‘Association of EMF exposure with non-specific physical symptoms within individuals’ by **John Bolte, Sander Clahsen, Wendy Vercreuisse, Irene Van Kamp, Anne van Gils, Judith Rosmalen & Rik Bogers** from the Netherlands, is a good example of what is wrong with the EHS research.

Scientists examined whether exposure to wifi radiation affects how people feel mentally and physically. Wifi exposures were measured by using meters carried by study subjects. Changes in physical and mental wellbeing of study subjects was recorded in diaries, carried by the study subjects and filled out at certain time intervals. Few quotes from the description of the study design:

“...Participants registered non-specific physical symptoms and perceived RF-EMF exposure using an electronic diary daily at three set times for a period of three weeks. During the same period personal exposure was monitored using exposimeters.”

“...The study consists of two steps. First, in order to find suited participants, a preliminary set of questions to discriminate subgroups of IEI-EMF”

“...potential participants had to attribute their symptoms to sources in frequency bands that were in the measuring range of our type of exposimeter”

“...In the second step, seven volunteers were recruited from the group identified in the first step. They were requested to register NSPS, momentary mood states and perceived RF-EMF exposure using an electronic diary for a period of three weeks. The electronic diary was filled out three times a day, with six-hour intervals (e.g. 9:00, 15:00, and 21:00). During the same period, personal radiofrequency (RF) EMF exposure was monitored using RF-EMF exposimeters”

“...To diminish the risk of false-positive associations, the focus will be on specific EMF frequency bands and symptoms that the participants indicated to be relevant for their particular situation”

The final conclusion of the study was that there is no correlation or, if it was “seen” (=imagined), it was a very weak.

However, there is a major problem with the design of this study. Mood or wellbeing of study subject can, and certainly is, affected by situations they find themselves in during the day. This was not corrected for in the study. Study was designed as if the “only” reason for headache is wifi exposure... There was no correcting for other parameters affecting wellbeing. This makes results of this study unreliable, misleading and useless.

Exposure information in epidemiological and human studies

Wrong radiation measure “assures” the no effect outcome

There is a serious problem with all to date published epidemiology and human studies because nearly all of them measure cell phone radiation exposure as minutes/day of cell phone use. This is a wrong “measure” of radiation exposure and it causes serious problems for finding effects, if there are any...

Minutes of use of cell phone do not represent well person's radiation exposure. Two persons, using cell phone in different quality coverage areas, can be, and certainly are, differently exposed to radiation. In good coverage field, cell phone is emitting much less radiation than the phone being used in poor coverage area.

This means that two persons speaking for the same length of time receive dramatically different radiation exposures. However, in studies using minutes/day as exposure metrics, these two differently exposed persons are placed in the same exposed group and analyzed as having “the same” exposure, what is not the truth.

This erroneous metrics causes that the existence of any effect is seriously underestimated because the size of the effect in such mixed-exposure group will be diminished by averaging.

This might be the main reason why none of the epidemiological or human volunteer studies was able to show any dose-dependent effect. If there are any dose-dependent effects they are very well “muffled” by having exposed groups defined as minutes of use of cell phone.

What is “disturbing”, research with such exposure metrics is being published as peer-reviewed studies and becomes a “valid scientific evidence”. This might be a correct conclusion or a wrong conclusion - we do not know which one because of missing of adequate and reliable radiation exposure data.

Here is an example, one of the “misguided” studies that analyzes exposure as minutes of use and, not surprisingly, finds no effect.

Valborg Baste, Gunnhild Oftedal, Ole Møllerlokken, Kjell Hansson Mild & Bente Elisabeth Moen from Norway and Sweden, examined **Pregnancy outcomes after parental cell phone exposure**. Result of their study was stated as follows [*emphasis added DL*]:

“Based on the Norwegian Mother and Child Cohort Study (1999-2009), information on maternal cell phone use during pregnancy and paternal cell phone use prior to conception was obtained. The cohort was linked to the Medical Birth Register, Norway to obtain information about all singleton pregnancy. **The cohort comprises 100730 singleton births, response rate: 38.7%**. There was no association between maternal cell phone use and adverse pregnancy outcomes. Fathers with testis exposure when using cell phones were associated with a borderline increased risks of perinatal mortality and slightly decreased risk of partner experience of preeclampsia during pregnancy compared with no cell phone exposure of head or testis.”

Here is this “peer-reviewed” but useless study: Baste V, Oftedal G, Møllerløykken OJ, Hansson Mild K, Moen BE. Prospective study of pregnancy outcome after maternal and paternal cell phone exposure. The Norwegian Mother and Child Cohort Study. Accepted for publication in *Epidemiology*.

DL Comments

Large cohort might look good on paper, but the response rate was low. The radiation exposure information was nonexistent. Therefore, any attempts to link exposures with pregnancy outcomes are useless. Incredibly, this study was already published. It means that in some journal it went through peer-review. This is yet another example of poor peer-review process. Not everything what is published in peer-review journal is good science or even science at all, as in this case, of examining pregnancy outcomes and nonexistent information on RF-EMF exposures.

Mechanisms

An interesting discussion of the understanding of mechanisms of the effects was presented by **Raymond Neutra** 'A typology of EMF physical induction mechanisms'. For sake of exactness, here is the full abstract of the poster [*emphasis added DL*]:

"In this presentation I will challenge unacknowledged assumptions that have restricted some investigators' conceptualization of how EMFs might work. **Engineers and physicists who doubt that ambient exposures to magnetic, electric or electromagnetic fields could have any biological effect are dubious because their model of how such fields might produce chemical-molecular change suggest that ambient exposures should not have any effect. They cannot imagine other models.** Researchers who have provided evidence for physiological or pathological effects at ambient exposure levels (such as avian navigation/disruption, shark prey detection and epidemiological findings among others) have not been able to demonstrate the mechanism by which a change in an ambient level EMF field is able to produce a chemical-molecular change that in turn leads to the demonstrated physiological or pathological effect. In this presentation I will challenge unacknowledged assumptions that have restricted some investigators' conceptualization of how EMFs might work such as:

- 1) The physical induction mechanism will resemble that of ionizing radiation in which a physical agent damages molecules in many tissues but with more physiological effect in some tissues than others.
- 2) Like ionizing radiation, dose is related to the time-integral of exposure intensity over time. Peaks and valleys in intensity, frequency composition of the field, polarization, orientation with regard to the geomagnetic field, resonance effects should not be important.
- 3) EMFs could not work by conveying information that interferes with information processing in an intact organism but must be demonstrable at lower levels of organization.
- 4) There may be more than one way that EMFs produce molecular-chemical changes, not all of which go on to produce physiological or pathological effects.
- 5) A physical induction mechanism might occur in a chemical preparation but not in a cell membrane preparation, an isolated cell, an organelle or an intact organism.
- 6) A physical induction mechanism might not occur in a chemical preparation but could require a higher level of organization or a higher level organization in a particular state of activation.
- 7) Whole organisms or cell lines may differ in their responsiveness to EMFs due to poorly understood genetic or epigenetic differences.
- 8) Failure to replicate results must always be due to faulty technique in one of the experiments and not in interesting confounding factors.

The elucidation of the physical induction mechanism that makes possible **phenomena such as bird navigation that "are impossible" under current biophysical theory** ought to lead reasonable people to accept that other "impossible" effects might also be genuine even though they may

depend on a different physical induction mechanism. **A challenge for public policy is to pursue precautionary exposure avoidance while considering how different physical induction theories would predict the effects of such precautionary action."**

Closing words...

BioEM meetings attempt to be the primary event for the scientists in this area of research. Unfortunately, in spite of the efforts from BEMS, EBFA and meeting organizers, year after year some of the important projects are missing from the meeting. Many name own examples. I was missing researchers from actively publishing Hardell group and from the French CERENAT study. What is happening within the GERONIMO project led by Elizabeth Cardis or what is happening in animal study executed under supervision of the US National Toxicology Program? Also, what many would appreciate is information from the WHO and ICNIRP on the status of the Environmental Health Criteria for RF-EMF. Why such important projects are "missing" from this primary event?

Looking at the topics of presentations submitted for the BioEM2015 it appears clear that the bioelectromagnetics research is extremely diverse. Striking shortage is seen in research on biological effects of EMF executed in human volunteers. It is puzzling why such research is not being pursued. Is such research being avoided or prevented? However, without research on biological effects of EMF executed in human volunteers it will be nearly impossible to prove the existence of effects and assess their physiological significance. In vitro research, that dominates, is too distant from the real life to provide information directly applicable to humans. Also, animal studies might be of insufficient usability. If animals respond to EMF then we may suspect that similar might happen to humans. However, when animals do not respond to EMF it does not mean that humans will not respond too. When animals do not respond it does not provide any useful information for human health considerations. Epidemiology, to date executed and ongoing studies have no reliable dosimetry what affects the reliability and accuracy of the results. Furthermore, epidemiological studies will not prove causality. These studies will not prove that given cancer in given patient was caused by EMF. **The only way to demonstrate that EMF affects human physiology in a way that has physiological impact is to expose human volunteers, within the ethically permitted setting, and analyze biochemical changes in human tissues and organs. Such research is however not being done. I even dare to say, from my own experience, that such research is being prevented, either by arbitrary administrative decisions or by measures preventing funding of such projects.**