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# Electrohypersensitivity: a functional impairment due to an inaccessible environment

DOI 10.1515/reveh-2015-0018

Received July 14, 2015; accepted November 2, 2015

**Abstract:** In Sweden, electrohypersensitivity is recognized as a functional impairment which implies only the environment as the culprit. The Swedish view provides persons with this impairment a maximal legal protection, it gives them the right to get accessibility measures for free, as well as governmental subsidies and municipality economic support, and to provide them with special Ombudsmen (at the municipality, the EU, and the UN level, respectively), the right and economic means to form disability organizations and allow these to be part of national and international counterparts, all with the simple and single aim to allow persons with the functional impairment electrohypersensitivity to live an equal life in a society based on equality. They are not seen as patients, they do not have an overriding medical diagnosis, but the ‘patient’ is only the inferior and potentially toxic environment. This does not mean that a subjective symptom of a functionally impaired can not be treated by a physician, as well as get sick-leave from their workplace as well as economic compensation, and already in the year 2000 such symptoms were identified in the Internal Code of Diagnoses, version 10 (ICD-10; R68.8/now W90), and have been since. But the underlying cause still remains only the environment.

**Keywords:** electrohypersensitivity; functional impairment; immunohistochemistry; skin; UN Convention.

## Background

A functional impairment is defined as difficulties that substantially interfere with or limit functioning in one or more major life activities including the following:

- Basic daily living skills (e.g. eating, bathing, dressing);
- Instrumental living skills (e.g. maintaining a household, managing money, getting around the community, taking prescribed medication); and
- Functioning in social, family, and vocational/educational contexts.

In health, any loss or abnormality of physiological, mental, or anatomical structure or function, whether permanent or temporary, is regarded as a functional impairment. The existence of a medical condition does not necessarily restrict functional capacity, but may form part of the underlying cause for a functional impairment. However, much more common are obstacles in our surrounding environment resulting in everyday functional impairments that all are part of being a human being in a society. Humans, and particularly children, often run into situations where the environment provides hurdles and difficulties. Such can be language barriers, educational hindrances, physical, chemical or physiological blocks or toxicities, and problems of understanding. Neither one of these causes makes anyone a patient; we are all still normal healthy persons as well as citizens, and with correct avoidance or adaptive reactions to an inferior environment.

## The Swedish view

Let me now conclude the following: The Swedish approach to electrohypersensitivity is to view it as a functional impairment, thus focusing on the environment as the culprit (which, as of the above, is the general definition, including the UN one, of functional impairments). This provides persons with this impairment a maximal legal protection, it gives them the right to get accessibility measures for free, as well as governmental subsidies and municipality economic support, and to provide them with special Ombudsmen (at the municipality, the EU, and the UN level, respectively), the right and economic means to form disability organizations and allow these to be part of national and international counterparts, all with the simple and single aim to allow persons with the functional impairment electrohypersensitivity to live an equal life in

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a society based on equality. They are not seen as patients, they do not have an overriding medical diagnosis, but the ‘patient’ is only the environment – inferior and potentially toxic. This does not mean that a subjective symptom of a functionally impaired can not be treated by a physician, as well as get sick-leave from their workplace as well as economic compensation, and already in the year 2000 such symptoms were identified in the Internal Code of Diagnoses, version 10 (ICD-10; R68.8/now W90), and have been since. But the underlying cause still remains only the environment.

Thus, ‘functional impairment’ and ‘medical condition’ are not mutually exclusive. They are different things. In the everyday world, having electrohypersensitivity (EHS) is definitely a huge disability and it impairs the ability of a person to have an optimal quality of life. If it was not an impairment, only those interested in esoterica would care about it. So, the pragmatic aspect that makes it important is the simple fact that it is an impairment that disables people’s lives. (And interventions for people who have the condition include medical treatments of their symptoms, but not of their environmental causes – there we need technicians, physicists, electricians, and others to make the latter accessible.) About this, the current whole society needs to be educated. Furthermore, prevention is yet another aspect that definitely should be in the discussion; when will we see my dream of tomorrow’s green, human-friendly technology come into play?

As stated, in Sweden, electrohypersensitivity (EHS) is an officially fully recognized functional impairment [i.e. it is not regarded as a disease; N.B. this is not special for Sweden, the terms “functional impairment” and “disease” are defined according to various international documents (see below)]. Survey studies (1) show that somewhere between 230,000–290,000 Swedish men and women – out of a population of 9,000,000 – report a variety of symptoms, including typical cutaneous ones such as stinging, burning and itching sensations primarily in the face, upper chest and back, hands and arms, when being in contact with electromagnetic field (EMF) sources. The symptoms of EHS are classified as an occupationally-related symptom-based diagnosis (code ICD-10; R68.8/now W90) by the Nordic Council of Ministers since 2000 (2). Swedish electrohypersensitive people have their own handicap organization, The Swedish Association for the Electrohypersensitive, which has its own websites in both Swedish and English (3). This organization is included in the Swedish Disability Federation (Handikappförbundens SamarbetsOrgan; HSO; as a consequence of this, The Swedish Association for the Electrohypersensitive receives an annual governmental subsidy). HSO is the united voice

of the Swedish disability associations towards the government, the parliament, and national authorities, and is a cooperative body that today consists of 43 national disability organizations (with The Swedish Association for the Electrohypersensitive being 1 of these 43 organizations) comprised of about 500,000 individual members. It has its own website in Swedish, parts of which are also in English (4).

Swedish municipalities, of course, have to follow the UN 22 “Standard Rules on the equalisation of opportunities for people with disabilities” (“Standardregler för att tillförsäkra människor med funktionsnedsättning delaktighet och jämlikhet” (5). Since 2007 they have been upgraded into the UN “Convention on Human Rights for Persons with Functional Impairments”) (5). As a result of this, all people with disabilities shall be given the assistance and service they have the right to according to the Swedish Act concerning Support and Service for Persons with Certain Functional Impairments (“LSS-lagen”) and the Swedish Social Services Act (“Socialtjänstlagen”). The municipalities are responsible for making sure that everyone gets enough support. Everyone is required to remember that such men and women may need individual and different kinds of support. What works for one, may not at all work for another.

In Sweden, impairments are viewed from the point of the environment. No human being is in itself impaired, there are instead shortcomings in the environment that cause the impairment (as with the lack of ramps for the person in a wheelchair, or rooms requiring electro-sanitisation for the person with EHS). This environment-related impairment view, furthermore, means that even though one does not have a complete scientifically based explanation for the impairment EHS, and in contrast to what many individuals involved in EMF discourse at present, the person with EHS shall always be met in a respectful way and with all necessary support with the goal to eliminate the impairment. This implies that the person with EHS shall have the opportunity to live and work in an electro-sanitised environment.

This view can fully be motivated in relation to the present national and international disability laws and regulations, including the UN 22 Standard Rules/UN Convention, the Human Rights Act of the EU, and the Swedish Action Plan for Persons with Impairments (“Den nationella handlingplanen för handikappolitiken – Från patient till medborgare”) (6). The last part of this national Action Plan carries a very important sentence: “Från patient till medborgare” = “From patient to citizen” which stresses the modern view of the functionally impaired: they are not any longer seen as patients but citizens

reacting to an inferior environment with a completely relevant avoidance behavior (cf. below). For such avoidance reactions there are no demands for any official “recognition”, no demands for diagnoses, and – of course not – no medical/psychiatric treatments.

The first step for a person in Sweden with a functional impairment is to contact the municipality’s special civil servant for disability issues, as well as the various handicap organizations and authorities, to achieve accessibility measures of various types with the sole aim to have an equal life in a society based on equality (as being in accordance to the The UN 22 Standard Rules on the Equalization of Opportunities for People with Disabilities/The UN Convention on Human Rights for Persons with Functional Impairments).

An impairment is – by definition – not defined by someone else or proven by certain tests, etc. The impairment is always personal (private) and develops when in contact with an inferior environment. [N.B. Remember that functional impairments are only based upon each individual’s impaired accessibility to – and contact with – an inferior environment (cf. the UN), thus, there is actually no need for any “recognition” in local laws (cf. the UN). In Sweden, the former Minister of Health and Social Affairs, Lars Engqvist – as a member of one of the previous governments – anyhow gave his “approval” in a letter dated May, 2000 [Regeringskansliet 2000-04-06, Dnr S2000/2158/ST]. He also made it clear in his response that for EHS persons there are no restrictions or exceptions in the handicap laws and regulations. Thus, these laws and regulations are to be fully applied also for EHS persons.]

Remember we all must adhere to and follow all the handicap laws and regulations. To do the opposite is a serious violation and should immediately be reported/ filed as an official legal complaint to your local authorities, parliament, government, the EU and the UN. This is of particular importance since Katri Linna, the former Swedish Diskrimineringsombudsman (=the Equality Ombudsman), clearly states in the newspaper *Sydsvenskan* (7) that “electrohypersensitivity is – according to the law – a functional impairment and I recommend EHS persons that are discriminated to file a complaint”

## The history of electrohypersensitivity

Historically, there have been – since the introduction of electricity as a general power source – anecdotal stories about persons whom we today interpret as being actually

electrohypersensitive. The very first case may have been Nikola Tesla (10 July 1856–7 January 1943) a Serbian-American inventor, electrical engineer, mechanical engineer, physicist, and futurist, best known for his contributions to the design of the modern alternating current (AC) electricity supply system. Descriptions of his health status closely resembles what we today would have named electrohypersensitivity. A surge of similar case reports were also seen during the amateur radio (DX) years.

In more recent times, as early as in the 1970s, a report from the former Soviet Union described a “microwave syndrome”. The Soviet military recognized early on the possible side-effects from radar and radio radiation. This microwave syndrome was seen in up to a quarter of the military personnel working with radio and radar equipment. They showed symptoms such as fatigue, dizziness, headaches, problems with concentration and memory, sleep disturbances, and being hot tempered. The treatment suggested was a change of assignments and to keep away from exposure. Rest, physical exercise, and nutritious food were also offered (8).

Also in the 1970s the newspaper industry was one of the first to supply it’s employees with personal computers using visual display terminals. Complaints of headaches and visual problems, as well as clusters of miscarriages and birth defects in children born to female editors and other newspaper employees, generated some publicity. In addition, many people who worked in the electronics industry in Sweden, including an estimated 12% of the electrical engineers in that industry, became electrically sensitive, and helped form the current Swedish disability organization initially called *Föreningen för el-och bildskärmsskadade* (Association for the Electrosensitive), or FEB. This was later renamed *Elöverkänsligas Riksförbund* (The Swedish Association for the Electrohypersensitive).

In the United States, then-Representative Al Gore held Congressional hearings in 1981 on the health effects of computer screens. In Sweden, the hard work of many brilliant trade union officials, members and their affiliates, such as Bruno Hagi, Per-Erik Boivie, Martin Andersson, Jan Åberg, Torbjörn Klittervall, Åke Bergman, and of excellent journalists, especially Gunni Nordström and Carl von Schéele, brought the problem to the attention of the general public during the 1980s and 1990s. Nordström’s and Schéele’s books “*Sjuk av bildskärm*” (9) and “*Fälslaget om de elöverkänsliga*” (10) are regarded as classics.

During the 1990s the Swedish trade union movement, notably the Swedish Confederation of Professional Employees (TCO) and Union of Clerical and Technical Employees in Industry (Sif), led the world in actively tackling, and working on solutions for the growing problem of

both chemical and electromagnetic pollution in the workplace – and spreading the word internationally. Among very many ventures, Sif's "No-Risk Project", enlisting the involvement of a team of researchers, including Martin Andersson from LIBEREL AB, and myself from the Karolinska Institute, as well as the "Healthy Office Project" in partnership with the Luleå University of Technology (LTU), are both highly important milestones. At that time, Sif was the largest trade union for white-collar workers in Sweden until it merged in January 2008 with another trade union (HTF) to form a new organization, Unionen. Unionen is currently Sweden's largest trade union on the private labour market and one of the largest white-collar unions in the world.

The TCO label is known internationally for its precautionary environmental standards for computer monitors that place limits on both electromagnetic radiation (EMR) and chemical emissions (TCO'92, TCO'95, TCO'99, TCO'03, and soon TCO'15). Although not eliminating EMR and chemical emissions from computer monitors, it was ground-breaking in that it was the first case of a union organization, representing both members and consumers, successfully influencing manufacturers to improve the design of their products to reduce potentially harmful emissions. Their corresponding standards for e.g. smartphones, tablets, and headsets, are currently gaining more and more momentum.

Today the most famous electrohypersensitive person is Gro Harlem Brundtland (20 April 1939), the former Prime Minister of Norway and the former Director General of the UN World Health Organization (WHO).

## Cutaneous analyses

One of the very first to analyze cutaneous biopsies of electrically sensitive individuals, was the late assistant professor and histopathologist Björn Lagerholm at the Karolinska Hospital, Department of Dermatology, in Stockholm, who did these ground-breaking observations already in the middle of the 1980s. He found an increase in the mast cell number, but, unfortunately, he could never publish it in a peer review-based scientific journal.

His interest very much started with a female bank employee that had received a work injury compensation for skin changes after sitting in front of a visual display monitor. Björn Lagerholm described in great detail her skin changes, which turned out to be very similar to the kind of cutaneous alterations you may encounter in connection with ultraviolet light, X-ray or radioactivity damage.

Björn Lagerholm's reputation as a histopathologist was undisputed. In addition to the female bank employee, he also examined nearly 100 further similar cases, all having the same skin changes. The outcome of this analysis was, however, not supported by two other histopathologists, and not by his clinical colleagues, Dr. Mats Berg and professor Sture Lidén.

Björn Lagerholm was never able to pursue his groundbreaking and very elegant studies. They would be buried for several years, until I and my collaborators re-initiated them in the late 1980s and early 1990s.

For me it was immediately clear that persons claiming skin reactions after having been exposed to computer screens very well could be reacting in a highly specific way and with a completely correct avoidance behavior reaction to a toxic environment/world, especially if the provocative agent was radiation and/or chemical emissions, such as plastic components or flame retardants – something later focussed upon by professor Denis L. Henshaw and his collaborators at Bristol University [this is covered in Gunni Nordström's book "Mörkläggning – Elektronikens rättslösa offer" (11)] – just as you would do if you had been exposed to e.g. sun rays, X-rays, radioactivity or chemical odours.

I began to study the skin of electrohypersensitive persons, and provided evidence that they may have a real skin condition that is provoked by sitting in front of a computer screen, using a mobile phone, a tablet, or being close to smart meters, routers, telecom towers and power installations. The damage was similar to that caused by ultraviolet radiation from the sun. I also showed that the radiation from computers causes measurable changes even in the skin of "normal people," and also in the skin of laboratory animals.

I named the new syndrome "screen dermatitis" in *Experimental Dermatology*, 1994 (12), and "electrosuper-sensitivity" at the Workshop on Electromagnetic Hypersensitivity, EU/EC, in Graz, 1995 (13). However, since such individuals also usually complained of other symptoms, such as chest pain, memory loss, fatigue, insomnia, dizziness, nausea, and headache, the more general term "electromagnetic hypersensitivity" later came into use, and it is nowadays shortened to "electrohypersensitivity".

In Sweden the prevalence of electrohypersensitivity was first estimated at 1.5% (14) with a newer estimate of 2.6%–3.2% (15). In Austria the prevalence was estimated to be <2% in 1994 but it had increased to 3.5% in 2001 (16). In Switzerland 5% of the population has been estimated to suffer from EHS (17). In California the prevalence of self-reported sensitivity to electromagnetic fields was 3.2% and with 24.4% of those surveyed reporting sensitivity to

chemicals as well (18). The Canadian Human Rights Commission reported that approximately 3% of Canadians have been diagnosed with environmental sensitivities, including chemicals and EMFs in their environment (19). In the report the author especially recommended improving the environmental quality at work places. Finally, a prevalence as high as 13.3% has been reported in Taiwan (20).

One aim of my and my collaborators studies has been to investigate the presence of intraepidermal nerve fibers in normal human skin from healthy volunteers using the new marker PGP 9.5 (21–23). The intraepidermal nerve fibers are found as close as 20–40  $\mu\text{m}$  from the surface, which makes it highly possible that surrounding electromagnetic fields may affect them.

In facial skin samples of electrohypersensitive persons, the most common finding is a profound increase of mast cells. We have not only used histamine, but also other mast cell markers such as chymase and tryptase, but the pattern is still the same as reported previously for other electrohypersensitive persons (13). From these studies, it is clear that the number of mast cells in the upper dermis is increased in the EHS group. A different pattern of mast cell distribution also occurred in the EHS group, namely, the normally empty zone between the dermo-epidermal junction and mid-to-upper dermis disappeared in the EHS group and, instead, this zone had a high density of mast cell infiltration. These cells also seemed to have a tendency to migrate towards the epidermis (=epidermiotrophism) and many of them emptied their granular content (=degranulation) in the dermal papillary layer. Furthermore, more degranulated mast cells could be seen in the dermal reticular layer in the EHS group, especially in those cases which had the mast cell epidermiotrophism phenomenon described above. Finally, in the EHS group, the cytoplasmic granules were more densely distributed and more strongly stained than in the control group, and, generally, the size of the infiltrating mast cells was found to be larger in the EHS group as well. It should be noted that increases of similar nature later on were demonstrated in an experimental situation employing normal healthy volunteers in front of cathode ray tube (CRT) monitors, including ordinary household television sets and personal computer screens (24).

In one of the early papers (12), we made a sensational finding when we exposed two electrohypersensitive individuals to a TV monitor situated at a distance of 40–50 cm away from them. When we looked at their skin under a microscope, we found something that surprised us. In this article, we used an open-field provocation, in front of an ordinary TV set, of persons regarding themselves as

suffering from skin problems due to work at video display terminals. Employing immunohistochemistry, in combination with a wide range of antisera directed towards cellular and neurochemical markers, we were able to show a high-to-very high number of somatostatin-immunoreactive dendritic cells as well as histamine-positive mast cells in skin biopsies from the anterior neck taken before the start of the provocation. At the end of the provocation the number of mast cells was unchanged, however, the somatostatin-positive cells had seemingly disappeared. The reason for this latter finding was discussed in terms of loss of immunoreactivity, increase of breakdown, etc., but it may simply indicate a common and well-known reaction to radiation, namely the migration of the classical allergen-recognizing dendritic cells from the skin to more deeply located immune-competent organs such as lymph nodes and the spleen. The high number of mast cells present may explain the clinical symptoms of itch, pain, edema, and erythema, and such a high number is again a classical sign of a radiation damage.

We have compared facial skin from electrohypersensitive individuals with corresponding material from normal healthy volunteers (25). The aim of that particular study was to evaluate possible markers to be used for future double-blind or blind provocation investigations. Differences were found for the biological markers calcitonin gene-related peptide (CGRP), somatostatin (SOM), vasoactive intestinal polypeptide (VIP), peptide histidine isoleucine amide (PHI), neuropeptide tyrosine (NPY), protein S-100 (S-100), neuron-specific enolase (NSE), protein gene product (PGP) 9.5, and phenylethanolamine N-methyltransferase (PNMT). The overall impression in the blind-coded material was such that it turned out easy to blindly separate the two groups from each other. However, no single marker was 100% able to pin-point the difference, although some were quite powerful in doing so (CGRP, SOM, S-100). In parallel investigations, we also found alterations of the Merkel cell number in the facial skin of electrohypersensitive persons (unpublished research). However, it has to be pointed out that we can not, based upon those results, draw any definitive conclusions about the cause of the changes observed. Blind or double-blind provocations in a controlled environment (26) are necessary to elucidate the underlying causes for the changes reported in this particular investigation.

I and my collaborator, Dr. Shabnam Gangi, in two papers of theoretical nature (27, 28), have put forward a model for how mast cells and substances secreted from them (e.g. histamine, heparin, and serotonin) could explain sensitivity to electromagnetic fields. The model bounces off from known facts in the fields of UV- and

ionizing irradiation-related damages, and used all the new papers dealing with alterations seen after, e.g. power-frequent or microwave electromagnetic fields, to propose a simple summarizing model for how we can understand the phenomenon of the functional impairment electrohypersensitivity.

In the first paper (27), we describe the fact that an increasing number of persons say that they get cutaneous problems as well as symptoms from certain internal organs, such as the central nervous system and the heart, when being close to electric equipment. A major group of these persons are the users of video display terminals (computers, tablets, mobile phones, etc.), who claim to have subjective and objective skin- and mucosa-related symptoms, such as pain, itch, heat sensation, erythema, papules, and pustules. The central nervous system-derived symptoms are, e.g. dizziness, tiredness, and headache. Erythema, itch, heat sensation, edema, and pain are also common symptoms of sunburn (UV dermatitis). Alterations have been observed in cell populations of the skin of electrohypersensitive persons similar to those observed in the skin damaged due to ultraviolet light or ionizing radiation. In electrohypersensitive persons a much higher number of mast cells has been observed. It is known that UVB irradiation induces mast cell degranulation and release of TNF- $\alpha$ . The high number of mast cells present in the electrohypersensitivity group and the possible release of specific substances, such as histamine, may explain their clinical symptoms of itch, pain, edema, and erythema. The most remarkable change among cutaneous cells, after exposure with the above-mentioned irradiation sources (ultraviolet light, X-rays, ionizing radiation), is the disappearance of the Langerhans' cells (cf. above). This change has also been observed in electrohypersensitive persons, again pointing to a common cellular and molecular basis.

In the second publication (28), the relationship between exposure to electromagnetic fields and human health is even more in focus as are the cutaneous mast cells. Mast cells, 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 our and others studies, it is clear that electromagnetic fields affect the mast cell, and also the dendritic cell, population, and may degranulate these cells. The release of inflammatory substances, such as histamine, from mast cells 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 ongoing inflammation and sensitivity to ordinary light.

Against this background, it is very interesting to see our early findings from the 1980s and 1990s strongly supported by the work of Drs. Belpomme and Irigaray. According to them, both EHS and multiple chemical sensitivity (MCS) appear to paint a common picture of inflammation-related hyper-histaminemia, oxidative stress, autoimmune response and BBB opening, and a deficit in melatonin excretion. According to Belpomme and Irigaray (2015; this volume) EHS and MCS share a common pathological mechanism mainly involving the central nervous system. (Another interpretation is, of course, that the mechanism is not of a pathological central nervous system/brain nature at all but just a correct cellular reaction throughout the body to a toxic environment, moving the focus from the persons affected right to the surrounding environment nowadays filled with anthropogenic electromagnetic fields and chemicals at levels surpassing our most vivid imagination.)

## Perspectives of risk – analysis and management

It is important that people understand that there are real risks associated with exposure to the radiation emitted by cell phones, their base stations, routers, tablets, wireless smart meters, computers, powerlines, and similar gadgets. We know that exposure to this radiation may impact and damage DNA, leading to possible cancer risks, neurological diseases, alter memory and concentration capacity, affect learning, it can alter our immune defence, and also affects male and female germ cells and fertility, it has effects on neurological functions such as cognition, behavior, performance, mood status, learning, memory, concentration, problem solving, morality, disruption of sleep and changing the sleep pattern, and may cause headaches and dizziness. The radiation is also harming animals and nature, and is therefore as much an environmental as human health issue. Important new research has already been presented on EMF impacts on DNA, heart function and the role of electrification in the diseases of civilization, such as heart disease, diabetes, cancer and suicide.

Beyond government regulations, it is imperative that each person educates themselves and employs safer methods when using their modern devices. The complete lack of biologically-based exposure standards or hygienic safety levels by our health protection agencies, and the lack of preventive actions, can turn out to be a huge mistake. To not act today would be deemed ethically and morally completely corrupt in the future.

Many times since the early 1980s I have pointed to that the public's usage of cell phones has become the largest full-scale biological and medical experiment ever with mankind, and I was also the first person to firmly point out that this involuntary exposure violates the Nuremberg Code's principles for human experimentation, which clearly states that voluntary consent of human subjects is absolutely essential. Among many effects seen, the very serious one is the deterioration of the genome. Such an effect — if seen in a food item under development or in a potential pharmaceutical drug — immediately would completely ban it from further marketing and sale — genotoxic effects are not to be allowed or spread. Furthermore, when men place cell phones in their front pocket, it should be noted that experimental studies have demonstrated that after similar exposures there is a decrease in sperm count as well as in the quality of sperm, which is a phenomenon that could affect society's overall ability to procreate in the future. Experiments in mice point to that it may be true already in five generations time. More recently, my colleague Örjan Hallberg and myself have conducted important epidemiological studies (29–34) showing that wireless communication networks may be causing significant illness throughout society. We have also shown that increased rates of asthma as well as certain types of cancer are strongly correlated with exposure to radio broadcasting during the twentieth century.

Strong concern has been voiced by the public, and by scientists as well as public health and environmental policy experts, that the deployment of technologies that constantly expose billions of people worldwide to new sources of electromagnetic fields may pose a pervasive risk to public health (35–38). Such exposures did not exist before the age of industry and information. Prolonged exposure appears to disrupt biological processes that are fundamental to bacterial, plant, animal and human growth and health. Life on earth did not evolve with biological protections or adaptive biological responses to these electromagnetic field exposures. Exceptionally low levels of electromagnetic fields — apart from the sun rays and the geomagnetic field — existed during the time that all life evolved on earth in the order of less than a billionth to one ten-billionth of a Watt per meter squared. A rapidly accumulating body of scientific evidence of harm to health and well-being constitute warnings that adverse health effects can occur with prolonged exposures to artificial electromagnetic fields at biologically active frequencies or frequency combinations.

In November, 2009, the Seletun Scientific Panel adopted a Consensus Agreement (39) that recommends preventive and precautionary actions that are warranted

now, given the existing evidence for potential global health risks. We recognize the duty of governments and their health agencies to educate and warn the public, to implement measures balanced in favor of the Precautionary Principle (40), to monitor compliance with directives promoting alternatives to wireless, and to fund research and policy development geared toward prevention of exposures and development of new public safety measures.

The Panel also strongly recommends that persons with electrohypersensitivity symptoms (EHS) be classified as functionally impaired in all countries 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, and — as a consequence — protect everyone now as well as in the coming generations from toxic environmental exposures. It is important to note that numeric limits recommended by the Seletun Scientific Panel, as well as by other bodies of society, do not yet take into account sensitive populations (EHS, immune-compromised, the fetus, developing children, the elderly, people on medications, etc). Another safety margin is, thus, likely justified further below the numeric limits for EMF exposure recommended by the Panel.

## Legal, moral and ethical as well as practical consequences

As previously mentioned Sweden has officially recognized EHS as a disability. However, a lot of work still has to be carried out by the electrohypersensitive persons, as well as for them, and their disability organization, The Swedish Association for the Electrohypersensitive to achieve complete equality. Accessibility and adaptation are key issues for allowing EHS, and others with recognized functional impairments, to gain/regain their rightful independence. As is well known and well documented, such support can also benefit the entire society.

Society must recognize in practical applications the right of the electrohypersensitive to be different, to their distinguishing feature. Society must recognize the right of the electrohypersensitive to have an equal life in a society based on equality. Treating members of the community equally is not something that should be done as a favor; nor is it something that any parliament or government should politely request other inhabitants to provide

others with. Equality is not something to be done “out of the goodness of one’s heart”. It is something one does because it is expected of every citizen, because inaccessibility and discrimination are prohibited by law. Thus, it is not legal to deliberately make the situation worse for persons with functional impairments.

Some medical doctors and dentists have described at an early stage the electrohypersensitive persons as “old crones in the throes of the menopause”, “the poorly educated”, “hypochondriacs”, “radiation ladies”, or victims of union-driven fears, mass media-based psychoses, imagination phenomena, Pavlovian conditioning, techno-stress alterations, etc. These prejudiced care-providers used these terms despite often never having met an electrohypersensitive person or carrying out research in the field. Unfortunately, some medical doctors and a few scientists still instead want EHS to be a medical/psychiatric diagnosis, i.e. with patients with an undefined disease syndrome, the latter instead being the focus of medical/psychiatric treatments (thus, no automatic accessibility measures, including shielding of the environment).

In January 2015, we could witness in Sweden a huge massmedia-based attack launched against persons with the functional impairment electrohypersensitivity. They were accused of not having a proper medical diagnosis, no proofs to back their claims of ill health when exposed to the moderns society’s artificial electrosmog, and so it was meant that they obviously should not be entitled to any economic support from the Swedish state.

Medical doctors (including the head of the Swedish Medical Association, Dr. Heidi Stensmyren), journalists, reporters, news anchors, and newspaper editors, all participated in this witch-hunt. This could be read in major newspapers, and heard and viewed in radio and TV channels. One Swedish medical doctor, Lena Hillert – on prime time public TV news – even introduced Santa Claus as a way of trying to ridicule persons with the functional impairment electrohypersensitivity.

The odd thing was that The Swedish Association for the Electrohypersensitive had done nothing wrong. In Sweden all disability organizations can apply for economic support, and – based on the number of members – a fixed governmental subsidy per person is granted via The National Board of Health and Welfare (Sw. “Socialstyrelsen”).

There is much that could be done to increase accessibility: educating architects, planners, scientists, technologists and the general public more effectively about EHS, its causes and how it can be minimized; undertaking properly funded independent multidisciplinary research into EHS

and showing that such work can make a difference. Creating work, home and general environments that are more user-friendly for EHS sufferers so that they feel included and not excluded in the rich tapestry of life (cf. ref. 41).

In a recent paper by Hagström et al. (42), it is concluded that “the official treatment options, psychotherapy and medication, did not have any significant effect. Instead, according to 76% of 157 respondents the reduction or avoidance of electromagnetic fields helped in their full or partial recovery. The best additional support for EHS were given as: “dietary change” (69.4%), “nutritional supplements” (67.8%) and “increased physical exercise” (61.6%)”. Their results rhyme very well with previous studies (43–46).

Also remember that forcing people with such functional impairments out into various sanctuaries or zones is completely in opposition to the UN disability laws, the Standard Rules, and it’s Convention, and could be the beginning of a terrible trend. No, instead make it easy for you – make sure to connect to all the UN texts, realize that it’s the whole environment that must be accessibility-adapted, and do not forget that such accessibility measures actually are 100% positive for everyone to share. People with functional impairments should have full access to the entire society, not just a small part of it.

It is proposed that, as with those with other recognized disabilities, the electrohypersensitive persons must therefore, in every situation and by all available means, demand respect, representation and power. They shall very clearly reject all approaches which reflect a mentality of “feeling pity for them” or “caring for them” by introducing flimsy medical diagnostic criteria and ‘treatments’ based on cognitive behavioral therapy, antidepressants, vitamins, minerals, and massage (!). Inaccessibility is not a personal problem. It is a problem for society. Inaccessibility is not about attitudes. It is about discrimination. And discriminatory actions and conduct shall not be dealt with by well-meaning talk about treatment. Discrimination is already illegal!

In addition, to all such well-meaning medical/psychological treatments there is a potentially very dark backside: The possibly induced long-term health effect of any given treatment. I discussed it for the first time already back in the mid-80s when it was suggested that cognitive therapy should be used to ‘teach’ EHS persons that computers and computer screens were completely “safe”. I then asked the clinical dermatologists and psychologists (who were in charge of that particular project) who would take the personal responsibility for future long-term health effects, such as cancer, in these employees. But no one stepped forward.



## Complete accessibility

The former Swedish Prime Minister Göran Persson has declared that 2010 should be the final target year for the “Swedish Disability Action Plan” – “From patient to citizen” – adopted in 2000, according to which the whole of Sweden is to be completely adapted to those with disabilities (7). In addition, there is the EU “Human Rights Act” and the UN “Standard Rules on Equalization of Opportunities for People with Disabilities”, nowadays updated to the UN “Convention on Human Rights for Persons with Functional Impairments” (6).

One of the most important ideas in these documents is the “principle of accessibility” stating that people with disabilities are to have full access to public services. This is the basis for the fast introduction in Sweden and other countries of kneeling buses, wheelchair ramps, hearing loops, automatic door-openers, beveled pavement edges, etc. However, it has to be asked where are the measures for the electrohypersensitive persons?

How are they to be able to be a normal part of the community with complete access to council offices, post offices, means of transport, cinemas, restaurants, hospital care and other facilities when electromagnetic pollution can affect them detrimentally? Providing every electrohypersensitive person with individually designed assistance, good care and stimulation to create participation in the community are very responsible tasks that require a high level of skill.

Considerably greater demands must be made on education, training and work supervision than has been the case to date. Sharing experiences between different activities must take place much more smoothly and in a way that is completely free of prestige.

People with the disability EHS have an exciting future ahead of them. Work has already started to produce results on a number of these issues, including building planning and construction (44). However, a lot more can and must be done. There are still many years of hard, constructive and consistent work waiting. I hope that everyone with the functional impairment EHS all over the world can find a common platform for this work, and help move the work forward through community and solidarity in the interdisciplinary work that is required.

It is now so important for everyone to decide on the continued direction of their activities as well as their focus and for people to work together with integrity as a team. A continued energetic action plan for the next few months and years together with a broad collaboration with other disability associations are of the utmost

importance here. As clearly stated by the UN (6), there must be an end to nonchalance, lack of consideration, indifference and lack of respect on the part of society for those with disabilities for all our sakes. As moral human beings we should never accept negative discriminatory treatment or an insulting special treatment of those with impairments.

## An equal life in a society based upon equality

When it comes to functional impairments, it is always only action that speaks, nothing else. To ensure that everyone acts within the UN Human Rights Convention is of paramount importance, and that persons with EHS is promptly given complete accessibility is the only acceptable goal, as is proper symptom identification and treatment when possible, but only when asked for by the disabled person Himself/Herself. However, the latter should never be used instead of the first.

Finally, to water the existing legislation down would make matters far worse for all the persons with EHS and/or multiple chemical sensitivity (MCS), as well as for their relatives. Therefore one must question attempts to move EHS from the functional impairment paradigm to the patient/disease one. It took me, and others, decades to get the EHS persons the protection of The UN 22 Standard Rules on the Equalization of Opportunities for People with Disabilities/The UN Convention on Human Rights for Persons with Functional Impairments. It will take less than a minute to destroy this. Mark my words.

The world is watching what we do, and we have the opportunity to do the right thing. Biomedical research is of immense importance to form a potential base for further symptom relief as well as for understanding the mechanisms behind, but let it not stand in the way of the human right of persons with EHS, MCS, and other functional impairments, to live an equal life in a society based upon equality.

**Acknowledgments:** Supported by the Karolinska Institute, Stockholm, Sweden, and a grant from Mr. Einar Rasmussen, Kristiansand S, Norway. Mr. Brian Stein, Melton Mowbray, Leicestershire, UK, the Irish Campaign against Microwave Pollution, and the Irish Doctors Environmental Association (IDEA; Cumann Comhshaoil Dhoctuirí na hÉireann) are gratefully acknowledged for their general support.

## References

- Miljöhälsorapport 2001, The National Board of Health and Welfare (in Swedish; ISBN: 91-7201-495-4).
- DIVS: 2000:839; ISBN: 92-893-0559-2, [http://www.nordclass.se/ICD-10\\_Nordic%20Occupational\\_2000.pdf](http://www.nordclass.se/ICD-10_Nordic%20Occupational_2000.pdf).
- The Swedish Association for the Electrohypersensitive (<http://www.feb.nu>; <http://www.feb.se>; the website has an English version).
- HSO, Handikappförbundens SamarbetsOrgan; <http://www.hso.se>.
- UN 22 Standard Rules/UN Convention, see website: <http://www.un.org>.
- The Swedish Action Plan for Persons with Impairments (“Den nationella handlingplanen för handikappolitiken – Från patient till medborgare”; Proposition 1999/2000:79, bet. 1999/2000:SoU14).
- Sydsvenskan, January 23-26, 2009; <http://sydsvenskan.se/chattarkiv/article408013.ece>.
- Petrov IR, editor. Influence of Microwave Radiation on the Organism of Man and Animals. Report from Academy of Medical Sciences of the USSR. Translated to English “Vliyaniye SVChl-zlucheniya na Organizm Cheloveka I Zhivotnykh”. Meditsina Press, Leningrad, 1970. Report from NASA TT F-708, Springfield, Virginia.
- Nordström G, von Schéele C. Sjuk av bildskärm, Tidens Förlag, 1989, ISBN 91-550-3484-5.
- Nordström G, von Schéele C. Fälslaget om de elöverkänsliga, Tidens Förlag, 1995, ISBN 91-550-4083-7.
- Nordström G. Mörkläggning – Elektronikens rättslösa offer, Hjalmarson & Högberg Förlag, 2000, ISBN 91-89080-41-6.
- Johansson O, Hilliges M, Björnhagen V, Hall K. Skin changes in patients claiming to suffer from “screen dermatitis”: a two-case open-field provocation study. *Exp Dermatol* 1994;3:234–8.
- Johansson O, Liu P-Y. “Electrosensitivity”, “electrosupersensitivity” and “screen dermatitis”: preliminary observations from on-going studies in the human skin. In: Simunic D, editor. Proceedings of the COST 244: Biomedical Effects of Electromagnetic Fields – Workshop on Electromagnetic Hypersensitivity. Brussels/Graz: EU/EC (DG XIII), 1995;52–7.
- Hillert L, Berglind N, Arnetz BB, Bellander T. Prevalence of self-reported hypersensitivity to electric or magnetic fields in a population based questionnaire survey. *Scand J Work Environ Health* 2002;28:33–41.
- Johansson O. Electrohypersensitivity: state-of-the art of a functional impairment. *Electromagn Biol Med* 2006;25:245–58.
- Schröttner J, Leitgeb N. Sensitivity to electricity-temporal changes in Austria. *BMC Public Health* 2008;8:310.
- Schreier N, Huss A, Rössli M. The prevalence of symptoms attributed to electromagnetic field exposure: a cross-sectional representative survey in Switzerland. *Soz Präventivmed* 2006;51:202–9.
- Levallois P, Neutra R, Lee G, Histova L. Study of self reported hypersensitivity to electromagnetic fields in California. *Environ Health Perspect* 2002;110:619–23.
- Sears ME. The Medical Perspective on Environmental Sensitivities. Ottawa, Canada: Canadian Human Rights Commission 2007.
- Meg Tseng MC, Lin YP, Cheng TJ. Prevalence and psychiatric comorbidity of self-reported electromagnetic field sensitivity in Taiwan: a population-based study. *J Formos Med Assoc* 2011;110:634–41.
- Hilliges M, Wang L, Johansson O. Ultrastructural evidence for nerve fibers within all vital layers of the human epidermis. *J Invest Dermatol* 1995;104:134–7.
- Johansson O, Wang L, Hilliges M, Liang Y. Intraepidermal nerves in human skin: PGP 9.5 immunohistochemistry with special reference to the nerve density in skin from different body regions. *J Peripher Nerv Syst* 1999;4:43–52.
- Wang L, Hilliges M, Jernberg T, Wiegleb-Edstrom D, Johansson O. Protein gene product 9.5-immunoreactive nerve fibres and cells in human skin. *Cell Tiss Res* 1990;261:25–33.
- Johansson O, Gangi S, Liang Y, Yoshimura K, Jing C, et al. Cutaneous mast cells are altered in normal healthy volunteers sitting in front of ordinary TVs/PCs – results from open-field provocation experiments. *J Cutan Pathol* 2001;28:513–9.
- Johansson O, Hilliges M, Han SW. A screening of skin changes, with special emphasis on neurochemical marker antibody evaluation, in patients claiming to suffer from screen dermatitis as compared to normal healthy controls. *Exp Dermatol* 1996;5:279–85.
- Johansson O. Elöverkänslighet samt överkänslighet mot mobiltelefoner: Resultat från en dubbel-blind provokationsstudie av metodstudiekaraktär (=Electrohypersensitivity 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 (First study on humans).
- Gangi S, Johansson O. Skin changes in “screen dermatitis” versus classical UV- and ionizing irradiation-related damage – similarities and differences. Two neuroscientists’ speculative review. *Exp Dermatol* 1997;6:283–91.
- Gangi S, Johansson O. A theoretical model based upon mast cells and histamine to explain the recently proclaimed sensitivity to electric and/or magnetic fields in humans. *Med Hypotheses* 2000;54:663–71.
- Hallberg Ö, Johansson O. Melanoma incidence and frequency modulation (FM) broadcasting. *Arch Environ Health* 2002;57:32–40.
- Hallberg Ö, Johansson O. Malignant melanoma of the skin – not a sunshine story! *Med Sci Monit* 2004;10:CR336–40.
- Hallberg Ö, Johansson O. Mobile handset output power and health. *Electromag Biol Med* 2004;23:229–39.
- Hallberg Ö, Johansson O. Alzheimer mortality – why does it increase so fast in sparsely populated areas? *Europ Biol Bioelectromag* 2005;1:225–46.
- Hallberg Ö, Johansson O. Apparent decreases in Swedish public health indicators after 1997 – are they due to improved diagnostics or to environmental factors? *Pathophysiology* 2009;16:43–6.
- Hallberg Ö, Johansson O, Horst E. A melanoma trend forecast from 2002 – what happened then? *Electromagn Biol Med* 2015;21:1–3.
- Belpoggi F, Blackman CF, Blank M, Bobkova N, Boella F, et al. Benevento Resolution 2006. *Electromagn Biol Med* 2006;25:197–200.
- Blackman CF, Blank M, Kundi M, Sage C, Carpenter DO, et al. The Bioinitiative Report – A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF). 2007, <http://www.bioinitiative.org>.

37. Avino P, d'Alessandro A, Bedini A, Belyaev I, Belpoggi F, et al. The Venice Resolution 2008, <http://www.icems.eu/resolution.htm>.
38. Johansson O. The London Resolution. *Pathophysiology* 2009;16:247–8.
39. Fragopoulou A, Grigoriev Y, Johansson O, Margaritis LH, Morgan L, et al. Scientific panel on electromagnetic field health risks: consensus points, recommendations, and rationales. Scientific Meeting: Seletun, Norway, November 17-21, 2009. *Rev Environ Health* 2010;25:307–17.
40. Dämvik M, Johansson O. Health risk assessment of electromagnetic fields: a conflict between the precautionary principle and environmental medicine methodology. *Rev Environ Health* 2010;25:325–33.
41. Hagström M, Auranen J, Johansson O, Ekman R. Reducing electromagnetic irradiation and fields alleviates experienced health hazards of VDU work. *Pathophysiology* 2012;19:81–7.
42. Hagström M, Auranen J, Ekman R. Electromagnetic hypersensitive Finns: symptoms, perceived sources and treatments, a questionnaire study. *Pathophysiology* 2013;20:117–22.
43. Holmboe G, Johansson O. Symptombeskrivning samt förekomst av IgE och positiv Phadiatop Combi hos personer med funktionsnedläggningen elöverkänslighet (=Description of symptoms as well as occurrence of IgE and positive Phadiatop Combi in persons with the physical impairment electrohypersensitivity, in Swedish). *Medicinsk Access* 2005;1:58–63.
44. Lindberg E-R. Building planning for persons with the functional impairment electrohypersensitivity – a project in the voltage field between belief and knowledge (in Swedish with English summaries). Doctoral Dissertation, The Royal Institute of Technology, School of Architecture and the Built Environment, and the Karolinska Institute, Department of Neuroscience, Stockholm, Sweden, 2011, <http://kth.diva-portal.org/smash/record.jsf?pid=diva2:455407>.
45. Kato Y, Johansson O. Reported functional impairments of electrohypersensitive Japanese: a questionnaire survey. *Pathophysiology* 2012;19:95–100.
46. Kato Y, Johansson O. The situation of electrohypersensitivity: Symptoms, EMF sources, economic and social problems, and precautionary approach. *Jap J Clin Ecol* 2012;21:123–30.