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Review article

"Sensitivity to electricity" – a new environmental epidemic

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S. Lidén
Department of Dermatology, Karolinska Hospital, Stockholm, Sweden

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Sture Lidén, MD, PhD
Department of Dermatology
Karolinska Hospital
Karolinska Institute
Stockholm
Sweden

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The human body constantly generates symptoms of various types from different organ systems. Mostly these symptoms are innocuous, but sometimes they are indicators of disease. These symptoms can be attributed to internal or external factors. The external factors thought to cause the symptoms can occur in the work environment or in the general environment of modern society. The impetus for this review of "sensitivity to electricity" is a recent and ongoing epidemic in Sweden. This epidemic will be described and analyzed against the background of current scientific work in the field, it will be placed in historical perspective, and strategies for managing it will be given.

The first reports on this phenomenon appeared in Norway at the beginning of the 1980s (1–3). A number of employees at the Norwegian Telephone Company had recently started to use visual display units (VDUs), and they reported problems with their facial skin, problems which they believed to be caused by the VDUs. A considerable work-up was performed in Norway, but after the work environment had been adjusted, the problems subsided, and no definite cause of the skin symptoms was found. Subsequently, isolated reports on a few patients relating skin problems to work with VDUs have appeared from various parts of the world (4–6). In Sweden, however, this problem has grown to epidemic proportions. A search of current databases in January 1996 yielded no reports on an epidemic occurrence of these troubles from other parts of the world. Concern about the more general risks of electromagnetic contamination, "electric smog", has been reported from Germany, among other countries (7).

The epidemic in Sweden

In 1985, three patients working with VDUs presented with skin problems appearing on one side of the face, the side which they turned toward a VDU which was turned on during most of the day. Histopathologic examination revealed a picture considered to deviate from that of normal skin. A causal relationship between the dermatitis and the work could not be excluded, and these patients were reported as having a possibly work-related disease. This assumption was accepted by the local health insurance organization, and this decision was extensively reported by the news media. Afterward, an increasing number of VDU-exposed people reported facial skin symptoms.

During the following years, the situation became more and more alarming, as more and more employees had to take sick leave, sometimes for extended periods of time. Affected employees often worked at the same office, and the performance in these workplaces was severely disturbed.

Moreover, the labor unions were deeply concerned because of this possible new health risk in the workplace. Scientific studies of this new issue were started with the support of the Swedish Work Environment Fund and with the participation of the labor union including many office employees. A clinical study of about 200 patients with suspected work-related facial dermatitis detected no remarkable traits; only ordinary skin diseases were found (8). A large-scale epidemiologic study showed that VDU-exposed subjects had a higher occurrence of subjective symptoms than a control group, but not an increase in objectively visible signs (9). A controlled study of skin biopsies from facial skin did not reveal any specific changes in the VDU-exposed group with facial skin symptoms (10). These initial studies did not support the hypothesis that VDUs *per se* caused dermatologic problems. The same conclusion was reached in a later study which also defined the electromagnetic environment (11).

The hypothesis that exposure to VDUs may cause disease is amenable to experimental testing. In this way, it differs from many other situations in which the question of an environmental hazard is raised. Provocation studies should give valuable information. The first double-blind provocation study (12) focused on the effect of exposure to a specially prepared VDU turned on or off. None of the 30 sensitive subjects participating in this study could detect the difference. After that, the interest of the then newly formed patients' organization was widened from the personal computer (PC) terminal to the electronic environment in general. The number of symptoms also increased, reflecting effects on most organ systems of the body. So far, five different controlled, double-blind, provocation studies, comprising a total of 112 patients, have been published (12–16). In addition, two further studies, comprising another 28 patients, await publication (17, 18). Most of those have been of a "realistic" design with blinded exposure to VDUs. The patients were selected according to their own experience that they reacted rapidly and consistently after exposure. Thus, 140 patients have been tested. None of these subjects have been able to tell when the electromagnetic fields were turned on or off. However, severe symptoms have sometimes appeared also when the current was turned off.

The level of stress in office employees with and without symptoms and working in the same office was tested by measuring excretion of stress-related hormones. Both groups were examined after 2 days at work, one day when they were using PCs, and one day when they did other types of work at the office. Persons with VDU-related symptoms had a hormonal excretion pattern consistent with an increased stress level during PC work, an increase in thyroxine level, among other things (19).

The symptoms reported by the patients are mainly of a vegetative type engaging, besides the skin, the central nervous, respiratory, cardiovascular, and digestive systems. It should be stressed that no persistent clinical skin signs have been reported so far, but only transient vascular reactions in the face (11).

The symptoms of "sensitivity to electricity" are very real for the sufferers. Some of them are unable to live in modern communities and have to stay in isolated trailers or cottages without electricity. The cause of this phenomenon is hotly debated in the news media. Obviously, there are two main possibilities. For most clinicians, the type of vegetative symptoms reported by the patients is well known, and it is considered psychosomatic, until shown otherwise. The other possibility is that we are dealing with a totally new pathogenetic principle, i.e., weak electromagnetic fields. The studies referred to above support the psychosomatic explanation, even if they do not prove that this is the only cause. So far, support for the physical hypothesis is limited. In an uncontrolled study of two patients, a total disappearance of dendritic cells from the skin was seen after exposure to a television set for 3 h (20). In a culture of Jurkat cells, some interesting observations were made. Exposure of these cells to electromagnetic fields of the frequency of 50–60 Hz and of a strength comparable to that generated in our daily environment caused intracellular calcium oscillations (21), as well as an increase in inositol-3-phosphate (22). It was also found that the leukocyte common antigen receptor CD45 was essential for this activation to occur (23). Another study investigated the influence of different types of fluorescent light on the sense of well-being (24). It was found that light with a high amplitude was identified as less pleasant than low-amplitude light by 9/14 of subjects with symptoms of sensitivity to electricity, whereas none of the control subjects could distinguish between the two qualities of light. Unlike older tubes, modern tubes often emit high-amplitude light (24).

One main objection to the possibility of a pathogenetic effect of electromagnetic forces of the magnitude that we find in our daily environment is that the natural electromagnetic field strengths generated by the human body are much larger. The situation has been compared with a man shouting outside a football stadium during a game – it would be hard to hear him inside the stadium. On the other hand, pulsating fields – for instance, of the 50-Hz frequency – are not common in nature, and the man-made fields of this frequency are much

larger than the natural ones, 10^7 times that of the natural background (25). Even if these biologic effects have so far been shown to occur only in cell cultures, they are still interesting because they indicate a possible mechanism of an effect of electromagnetic fields of the magnitude occurring in our environment. Many reports of *in vitro* changes in various metabolic steps in cell culture have appeared, but the receptor-like function of CD45 is perhaps the most striking observation.

So far, most of the performed studies are compatible with a psychophysiologic cause of the symptoms of so-called sensitivity to electricity. To the evidence presented previously can be added the good effect of behavioral therapy (17) and of acupuncture, both real and sham (26). In its epidemic form, this phenomenon seems to be restricted to Sweden despite the fact that it has now been known for more than 10 years.

It seems reasonable to conclude that the weight of evidence so far favors a psychosomatic explanation. Thus, this epidemic falls into the well-known pattern of psychosomatic syndromes, a view shared by a commission appointed by the Swedish National Board of Health and Welfare (27).

Psychosomatic disease

An excellent overview of psychosomatic illnesses has recently been published by Shorter (28). This monograph gives a historical account of the many psychosomatic syndromes which have been described during the last 200 years. Even if most of these syndromes are considered to have internal causes, they form a relevant background to the environmental syndromes, as exemplified by the alleged sensitivity to electricity.

Psychosomatic illness is defined (28) as any illness in which physical symptoms, produced by the action of the unconscious mind, are defined by the patient as evidence of organic disease and for which medical help is sought. Such illnesses have always existed because conversion of stress or psychological problems into physical symptoms is a basic natural means of mobilizing the body to cope with mental stress. The symptoms fall into four categories, symptoms from the sensory, motor, or autonomic nervous systems and symptoms of psychogenic pain.

One common denominator of all these symptoms is that they *could* be caused by organic disease. Thus, clinical work-up to exclude this possibility often is necessary. The "symptom pool" reaches back into antiquity. The motor symptoms of seizures and epileptic fainting are perhaps the most noticeable. Over the centuries, many remarkable explanations of such symptoms have appeared. The concept of spinal irritation was accepted by medical science during the 19th century. This theory, as well as the reflex theory, offered explanations of most symptoms of disease except trauma. The reflex theory, put forward in Britain in the 1830s, postulated that nervous connections running via the spine regulate all bodily organs, including the brain, quite independently of human will. Thus, an organ may exercise its influence at far-distant sites and, thus, a disease at these sites may be treated by treating that specific organ. This theory influenced medicine in sometimes quite unexpected ways. Thus, German ophthalmologists described the disease kopiopia hysterica, i.e., eyestrain of uterine origin. During the latter half of the 19th century, a school of psychiatry and gynecology held that women's internal sexual organs could make them mad and that the best cure for pelvic madness lay in a gynecologic operation. Therefore, series of oophorectomies were performed.

Shorter (28) points out the changing fashions in the psychosomatic diagnoses. Appendicitis was long in vogue, but when it became possible to operate on this indication, this disorder was replaced by the concept of "colitis" – a term then not used in its present meaning. Probably the best-known example of psychosomatic disease is Charcot's hysteria. This diagnosis seems to have dominated neurology and internal medicine for decades until 1893 when Charcot died. After that, this disease disappeared within the astonishingly short time of 10 years.

This account tells us that the medical profession has provided rather fantastic explanations of symptoms which we now regard as psychosomatic.

Environmental somatization syndromes

There are also numerous examples of external, environmental factors which have been thought to cause disease. To use a modern term, they could be labeled "environmental somatization syndromes" (29).

For 80 years, from about 1840, environmental arsenical poisoning was considered to be a reality. The source was supposed to be wallpaper with arsenic-containing colors and also wet paint. This syndrome was the source of extreme concern and suffering, and a considerable source of income for doctors and pharmacists. In 1920, the whole discussion suddenly ceased when it was discovered that all people excrete arsenic because of the natural arsenical content in soil and water (30).

New technologies often cause concern. The introduction of steel nibs instead of goose quills in the 1830s caused the so-called writer's cramp (31). This work-related disorder was succeeded by tele-

graphist's spasm in the 1890s. This latter epidemic is interesting because it was almost totally restricted to the British Isles. The number of affected people rose sharply after 1908 when the symptoms were classified as work related and thus qualifying for compensation. Later, when a governmental commission rescinded this decision and withdrew the compensation, the epidemic receded (32). In 1971, an epidemic among Australian civil servants began after the introduction of PCs. An increasing number of employees suffered from motor symptoms of their hands and arms, symptoms considered to be caused by work with computer keyboards. Up to one-third of the employees were afflicted in some regions when the epidemic was at its height (33). The losses of the companies were enormous, and the discussion in the media was rancorous. After more than 15 years, the epidemic gradually subsided (34).

Contemporary examples of environmental epidemics are the chronic fatigue syndrome (CFS) and the total allergy syndrome. CFS has dominated medical discussion during the last two decades, at least in the USA. In 1990, it was estimated that at least a million Americans suffered from what was then called "chronic fatigue immune dysfunction syndrome" (28). The addition of the phrase "immune dysfunction" rests upon so far unsubstantiated reports of various, inconsistent immunologic deviations. In the USA, there are about 400 local support groups, and the Centres for Disease Control in Atlanta, Georgia, receive up to 2000 telephone calls a month about CFS (35).

The total allergy syndrome is also called multiple chemical hypersensitivity (MCH) or environmental illness (36). It is prevalent mostly in English-speaking countries. The concepts associated with MCH originated in 1962 (37) and have subsequently been expanded and modified. The reasoning behind this is illustrated by the metaphor of a bucket into which is poured one external chemical after another. When the bucket is filled, there is an overflow manifesting itself as disease. So far, this concept has received no scientific support; nevertheless, a widespread subculture has developed. For example, there are special hospitals offering various regimens testifying to the high level of creativity among the proponents of this theory, who offer their therapy at high prices (38).

One last example of an environmental epidemic is that of the supposed risk posed by mobile telephones to people – and forests. The Swiss authorities felt it necessary to investigate this possibility and they have concluded that the less than optimal health of their forests is not attributable to the electromagnetic waves used in mobile telephone communication (7).

Aversion to psychological explanations

In most societies, a diagnosis of organic disease is more acceptable to patients than a psychiatric one. The resistance to psychiatric/psychological explanation can vary, however. It has been noted that patients with CFS reject psychiatric diagnoses much more violently than what is normal in medical patients. This has been regarded as characteristic of the illness (28). This is the case also with sensitivity to electricity. One investigator was reported to the legal committee of the Swedish National Board of Health because he had referred patients with sensitivity to electricity for psychological consultation. Another characteristic of these syndromes is what has been called "pathoplasticity", i.e., willingness to change symptoms and attributions and to include new causes in the pathogenesis (28). *Candida* infections, multiple food allergies, worry about mercury dental fillings, and environmental hypersensitivity are often found in combination, a feature which also has been noted in patients sensitive to electricity.

Why this situation?

The population of the industrialized world today is better educated and more enlightened than ever before. One might reasonably expect that this fact should facilitate rational decisions and behavior. Obviously, this is not always the case. The nonscientific approach of our medical predecessors has been adopted by the mass media. It is usually possible to find physicians who, for one reason or another, support the nonscientific interpretations of the sufferers. Even if the psychological explanations have massive scientific and clinical support, they are disregarded by journalists, who are looking for the more sensational aspects offered by new threats in our environment.

One method of creating journalistic interest is to look for controversies and, if possible, magnify them. In this way, a real scientific controversy could be transformed into a scientifically based controversy by the media. In a scientifically based controversy, the different opinions are based upon more or less valid scientific data, but, in addition, other ingredients are added such as ethical, political, legal, or other convictions. For many of the epidemics referred to above, there is very little, sometimes nothing, motivating a scientific controversy. Nevertheless, the debate in the media can be quite intense. How does it come about? The fuel seems to be "preliminary data". Such premature information, not validated by external assessment as by referees of scientific journals, is exploited and inflated by the media. This introduces a political

dimension. Politicians have to act, and this they can do by funding research in the area but also by enacting new regulations without rational basis or by ordering new investigations. Such measures are also very palatable for the media. It would be unfair to say that all journalists are uncritical in matters like these. However, what matters are the journalists who publish results not well founded, not those responsible ones who have a more critical and thoughtful attitude. A current issue in this category is the "mad cow disease" now perturbing much of Europe.

Obviously, it is quite possible to create situations in our society which can be quite hard to master. The natural task for scientists is to supply sound information about questions arising in society. Often, these questions do not seem very relevant to a critical mind. Nevertheless, they can be very important, and the scientific community cannot neglect such issues. Admittedly, it is usually impossible to "guarantee that factor X is totally without risk". But, usually, information can be provided which shows the risk level with a reasonable degree of probability. Such information must then be used sensibly by other groups in society. This process is not always easy, and governments must be alert to prevent disastrous consequences for society. To quote a member of the German government: "If this question [about electromagnetic smog] is not handled correctly, it may assume proportions which will make the problems concerning nuclear power seem rather unimportant" (7).

Preventive strategies

Certain companies in Sweden have had major problems with the epidemic of sensitivity to electricity. The problems have arisen either because the proportion of affected employees was high or because key personnel were afflicted. To cope with the situation, the companies had to find solutions to the problem. The experience from these attempts can be summarized as follows.

Information about the results of scientific work is essential. It should include assurances that no long-term effects are reported if the problems are dealt with early. The most important part in this early intervention is scrutiny of the total work situation. Changes in working hours at the VDU, in office equipment, in work schedules, in level of information about the work, etc. have been very successful in reducing the number of new sufferers as well as in diminishing the symptoms in most of those already afflicted. The focus should not be on the electronic equipment, as such an attitude tends to focus the mind of the exposed worker on this factor. Measurement of electromagnetic forces should also be avoided for the same reason. However, it is essential to realize that the symptoms are as real as physical pain and that they cannot be dismissed unsympathetically.

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