

The Director General

Maisons-Alfort, 13 March 2018

OPINION

of the French Agency for Food, Environmental and Occupational Health & Safety

regarding the expert appraisal on “electromagnetic hypersensitivity (EHS) or idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF)”

ANSES undertakes independent and pluralistic scientific expert assessments.

ANSES's public health mission involves ensuring environmental, occupational and food safety as well as assessing the potential health risks they may entail.

It also contributes to the protection of the health and welfare of animals, the protection of plant health and the evaluation of the nutritional characteristics of food.

It provides the competent authorities with all necessary information concerning these risks as well as the requisite expertise and scientific and technical support for drafting legislative and statutory provisions and implementing risk management strategies (Article L.1313-1 of the French Public Health Code).

Its opinions are published on its website.

This opinion is a translation of the original French version. In the event of any discrepancy or ambiguity the French language text dated 13 March 2018 shall prevail.

Amid much controversy, both in the scientific community and in public debates, ANSES decided to give due attention to the issue of electromagnetic hypersensitivity (EHS) or idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF) – the two expressions referring to the same condition – through a specific, in-depth expert appraisal. As a reminder, in the expert appraisal report dedicated to the health effects of radiofrequencies published by AFSSET in 2009, a separate section had been devoted to EHS. However, the investigation of this topic was intentionally deferred during the update of the expert appraisal on radiofrequencies published by ANSES in 2013 (internal request of 14 June 2011). The group of experts had considered that the issue of EHS required the collection of additional data as well as due attention through a specific collective expertise appraisal, now described in this Opinion.

1. BACKGROUND AND PURPOSE OF THE REQUEST

Since the beginning of the 1980s, the scientific literature has regularly reported cases of people complaining of various functional disorders¹ (dermatological disorders attributed to exposure to cathode ray tubes as well as a wider variety of disorders attributed to exposure to the fields emitted by household appliances and electrical facilities) that they have attributed to exposure to electromagnetic fields. This “clinical picture” has been given several successive names, reflecting

¹ The term “functional disorder” encompasses all symptoms and conditions without any lesions or identifiable organ dysfunction, as opposed to organic diseases.

evolving concepts as commonly observed in the history of medicine, especially in situations of uncertainty.

One of the particularities of EHS is that the symptoms reported by EHS individuals are attributed to exposure both to radiofrequencies (most often for sources from a few hundred megahertz to a few gigahertz) and to extremely low frequencies (primarily 50 Hz in Europe), complicating the investigation of the topic. After discussing this challenge, the Working Group chose to consider all EHS individuals, regardless of the field sources involved.

The objectives of this expert appraisal were to attempt to understand EHS in its complexity, characterise it, and examine the plausibility of the various assumptions made to explain the causes of the reported disorders.

2. ORGANISATION OF THE EXPERT APPRAISAL

This expert appraisal falls within the sphere of competence of the Expert Committee (CES) on "Assessment of the risks related to physical agents, new technologies and development areas". ANSES entrusted the expert appraisal to the Working Group on "Radiofrequencies and Health", which had been created following a public call for expert applications issued on 1 December 2010. The experts were recruited for their scientific and technical skills in the areas of epidemiology, medicine, biology, metrology, electromagnetic field dosimetry, and human and social sciences. A total of 16 independent experts were appointed on 30 June 2011 for a period of three years. Among other things, this group produced an update to the health risk assessment on exposure to radiofrequencies in October 2013. The composition of the Working Group was then partly renewed and supplemented on 9 July 2014 to undertake the expert appraisal on EHS and the group's mandate was extended to 31 December 2017 to enable it to finalise its work. This expert appraisal was therefore conducted by groups of experts with complementary skills.

Interests declared by the experts were analysed by ANSES before they were appointed and throughout their work in order to prevent risks of conflicts of interest in relation to the points addressed in the expert appraisal. The experts' declarations of interests are made public *via* the ANSES website (www.anses.fr).

Literature search and collection of information

Like all of ANSES's expert appraisals, this one was based primarily on an analysis of the available scientific literature. The reference period for the literature search ran from April 2009² to July 2016³. However, to provide additional background information on certain issues, following the public consultation, some references from outside of this period were also added to the report. Various types of documents were examined (scientific articles published in independent peer-reviewed journals, expert appraisal reports by European and international organisations, research reports funded by ANSES, etc.). In December 2014, the Agency's Dialogue Committee on "Radiofrequencies and Health"⁴ was also invited to supplement the list of references analysed by the Working Group.

² End of the literature analysis period taken into account in the Agency's previous report dealing with EHS published in October 2009.

³ End date of the literature review corresponding to the submission of the preliminary report for public consultation.

⁴ ANSES's Dialogue Committee on "Radiofrequencies and Health" is a forum for exchanges, discussion and information on scientific matters relating to the potential health effects of radiofrequencies and the assessment thereof. It was created in June 2011 to build on the experience acquired in the framework of the Health and Radiofrequency Foundation. It brings together representatives of associations and trade unions, mobile telephone operators and

To supplement the aforementioned documents, written contributions were requested from doctors and sociologists in relation to specific points of the expert appraisal. In addition, research and development contracts (RDCs) for specific studies were established with the French Scientific and Technical Centre for Building (CSTB) and the IFSTTAR and Claude Bernard Lyon 1 University joint epidemiological research and surveillance unit on transport, labour and the environment (UMRESTTE), in order to acquire new data.

Moreover, given the complexity of the topic, the methodological limitations of numerous scientific articles, the lack of studies addressing certain issues, and the controversies sometimes arising from these challenges, the Working Group also took field experience into consideration. It thus examined the testimonials of various stakeholders (hospital physicians and general practitioners, associations and groups of citizens, elected officials, researchers, etc.) through around 20 hearings. These testimonials fuelled the Working Group's discussions and sometimes offered explanatory assumptions for EHS, which were then analysed during the expert appraisal.

Expert appraisal procedure

Between July 2014 and October 2017, the Working Group met 29 times in plenary sessions to conduct the hearings, analyse the articles, and study and discuss the plausibility of the various assumptions made to explain the origins of the disorders.

The quality of the scientific publications (essentially clinical and epidemiological studies) was assessed based on various criteria (rigour of the protocol, characterisation of exposure, etc.), regardless of their results and conclusions.

The methodological and scientific aspects of the expert appraisal work were submitted to the CES on several occasions between September 2014 and November 2017. The CES's comments were taken into account by the Working Group throughout the expert appraisal.

It was carried out in accordance with French Standard NF X 50-110 "Quality in Expert Appraisals – General Requirements of Competence for Expert Appraisals (May 2003)".

Public consultation

Considering the importance, complexity and controversial nature of the topic, the Agency decided to submit a preliminary version, i.e. with no conclusions or recommendations, of the "Electromagnetic hypersensitivity or idiopathic environmental intolerance attributed to electromagnetic fields" report to members of the scientific community and interested stakeholders during a public consultation.

This consultation ran from 27 July to 15 October 2016. Its purpose was to collect data and scientific comments likely to be taken into account in the final version of the expert appraisal report. In total, more than 500 comments were submitted *via* an online form available on the Agency's website. Each one was analysed by several expert rapporteurs and a response was prepared, which required several sub-group meetings. Each response was then validated by the entire Working Group (see table of responses to online comments on the ANSES website). Almost 150 comments resulted in an amendment to, addition to or reformulation of the expert appraisal report.

Validation of the final report

The final expert appraisal report was validated by the Working Group on 23 October 2017.

broadcasters, local and regional authorities and institutions and elected officials, to establish a balance between the various interest groups.

3. ANALYSIS AND CONCLUSIONS OF THE CES

What is EHS? (This question is addressed in Section 3 of the expert appraisal report)

The Working Group adopted the definition of the WHO, which uses three criteria to characterise “Idiopathic environmental intolerance to electromagnetic fields (IEI-EMF)”, also called EHS, i.e.

- 1) the perception by the subjects of a variety of non-specific⁵ functional symptoms (sleep disorders, headaches, dermatological symptoms, etc.);
- 2) a lack of clinical and biological evidence to explain these symptoms;
- 3) the attribution of these symptoms, by the subjects themselves, to exposure to electromagnetic fields, which themselves are diverse.

It should be noted that, for the WHO, “IEI is a descriptor without any implication of chemical etiology, immunological sensitivity or EMF susceptibility. IEI incorporates a number of disorders sharing similar non-specific medically unexplained symptoms that adversely affect people”.

Regarding the symptoms, those most commonly reported in most descriptive studies, and through testimonials, are fatigue and sleep disorders. However, multiple heterogeneous symptoms have been described, common to many other conditions, with varying descriptions (the questionnaires used and recruitment of subjects are not comparable from one study to the next, etc.). The various testimonials reported during the hearings and the public consultation were also heterogeneous (see the WHO's first criterion). In any event, the complaints (pain, suffering⁶) formulated by EHS individuals are a reality.

Regarding research into clinical, biological and/or physiological bases, the few studies attempting to describe the characteristics of EHS have been unable to establish diagnostic criteria that could be used for clinical studies or classification criteria for research with a sufficient degree of consensus to be proposed in practice (see the WHO's second criterion). The result is a high level of imprecision in the organisation of research and the interpretation of its results.

Lastly, exposure to the electromagnetic fields described in studies or through testimonials is also highly heterogeneous (see the WHO's third criterion): radiofrequencies are those most commonly mentioned (mobile telephones, Wi-Fi, base stations), although extremely low frequencies (electrical lines and facilities) are also sometimes evoked, with the two types of fields interacting very differently with the human body.

Currently, the only way to define EHS is on the basis of self-reporting by people. This can cause a lack of sensitivity in all the studies on the topic, since very different EHS individuals can be recruited without distinction.

It thus remains very difficult to assess the prevalence of EHS; the scientific data on the percentage of EHS individuals in France and abroad are not very reliable, ranging from 0.7% to 13.3%. However, the most recent data (seven articles published between 2008 and 2013) give narrower results, with a percentage of around 5% (between 1.2% and 8.8%), and do not seem to confirm the

⁵ A clinical sign is “non-specific” when it can be the clinical expression of several different diseases. Conversely, a clinical sign is “specific” when it can guide the diagnosis to a disease or a group of diseases.

⁶ “By mutual agreement, psychiatry and phenomenology refer to signs and thus semiotics to justify the distinction between the words pain and suffering: the word pain is thus reserved for sensations perceived as located in specific organs of the body or in the whole body, while the word suffering refers to reflexivity, language, relations with oneself, relations with others, relations with meaning, questioning, etc. But pure, purely physical pain remains an extreme case, as is perhaps purely mental suffering, which seldom occurs without some degree of somatisation. This overlap explains the hesitations of ordinary language” (Ricœur, 1994).

prospect of a gradual increase in EHS prevalence that had been suggested by some earlier studies.

The descriptive studies show that EHS individuals have a lower level of well-being and are, on average, more anxious and depressed than controls. However, this observation is difficult to interpret since, as the studies were designed, it is not possible to determine whether this anxiety and/or depression are the causes or the consequences of the symptoms experienced by these people. Indeed, anxiety and depression are common reactions to most serious and rare diseases. In the case of EHS individuals, difficulties with medical care and the persistence of symptoms could contribute to generating anxiety and/or depression. It cannot be concluded that this mental component is more or less common in EHS individuals than in those presenting a serious or rare disease.

Note that there are associations between EHS and several syndromes and disorders, namely multiple chemical sensitivity, fibromyalgia, migraines and tinnitus.

Are human beings capable of perceiving electromagnetic fields? (This question is addressed in Section 5 of the expert appraisal report)

No studies have demonstrated the ability of EHS individuals to perceive radiofrequency electromagnetic fields in conditions of environmental exposure.

However, some highly disparate studies (whether in terms of exposure techniques or assessment criteria) of widely varying scientific quality have enabled the following to be observed:

- event-related potentials⁷ in electroencephalogram (EEG) recordings for non-EHS individuals during exposure to a 60 Hz magnetic signal (two studies undertaken by the same team);
- differences between EHS individuals and controls exposed to 50 Hz low-frequency electromagnetic fields in terms of their ability to distinguish between real exposure and artificial exposure (two studies undertaken by the same team);
- lowering of perception thresholds for low-frequency electric currents in certain EHS individuals (three studies undertaken by the same team). In this case, it makes sense to speak of electrosensitivity or hypersensitivity to electric current.

However, the results of these studies should be interpreted with caution and would need to be confirmed by replication studies, provided however that special attention is granted to the inclusion criteria for the participants and to the individual results. In addition, considering that the participants' functional symptoms were not collected, no connection between these observations and EHS can be established on the basis of these studies.

Is there a causal relationship between exposure to electromagnetic fields and the symptoms of EHS individuals? (This question is addressed primarily in Section 6 of the expert appraisal report)

⁷ Event-related potentials (ERPs) are defined as changes in the electrical activity of the nervous system in response to external (visual, auditory, sensory or motor) or internal (cognitive ERP) stimulation. Stimulation must be repeated a large number of times to extract, by averaging basic electrical activity, a specific response of the stimulated neural pathway.

Provocation studies are often considered as the best way to demonstrate, in laboratories, causal relationships between exposure to electromagnetic fields on the one hand and the occurrence and persistence of symptoms on the other hand.

The analysed provocation studies (around 40) were unable to demonstrate, in a reliable and reproducible manner, the development of biological or physiological symptoms or abnormalities specific to EHS during or after exposure (to low frequencies or radiofrequencies). This implies two assumptions:

- either the symptoms experienced by EHS individuals are not caused by exposure to electromagnetic fields and there are no quantifiable biological and/or physiological abnormalities when they are exposed to electromagnetic fields (assumption 1);
- or the absence of results is due to the methodological limitations of the provocation studies (subject selection, sample size, exposure type, etc.) (assumption 2). These methodological limitations would thus prevent the following possibilities from being ruled out with certainty:
 - certain people who are sensitive to electromagnetic fields and who experience biological and/or physiological effects in conditions of exposure have not been detected thus far due to the imprecision of the inclusion and exclusion criteria for the participants in these provocation studies;
 - there are biological and/or physiological effects that only occur in certain conditions of exposure (not yet tested);
 - electromagnetic fields have certain biological and/or physiological effects not yet analysed in provocation studies (see effects on sleep electroencephalograms (EEGs) described in the report on radiofrequencies and health published by ANSES in 2013).

Moreover, the results of several provocation studies led their authors to put forth the assumption of a role of the nocebo effect⁸ in the occurrence and/or persistence of EHS (compatible with both assumptions 1 and 2 above). However, these provocation studies were undertaken with people who had been experiencing EHS for some time and thus did not provide information about the conditions under which the first symptoms occurred or their attribution to exposure to electromagnetic fields. The fact remains, however, that around 15 articles give consistent results showing that, subject to artificial exposure, EHS individuals express many more false recognitions and symptoms than controls, which can only be due to a nocebo effect. Therefore, the nocebo effect undoubtedly plays a non-negligible role in the persistence of EHS. While some of the mechanisms that underlie this effect are still poorly understood, it is well established that this phenomenon, like the placebo effect, is often involved in provider-patient relationships and is a normal cognitive-emotional response. In addition, its occurrence does not rule out a possible unidentified organic condition.

In the end, there is currently no solid experimental evidence enabling a causal relationship to be established between exposure to electromagnetic fields and the symptoms described by EHS individuals.

⁸ The nocebo effect is defined as all of the “negative” symptoms experienced by a person exposed to medication, non-medicated therapy or environmental factors. It is caused by the suggestion, belief or fear that this exposure is harmful. It will be shown below that this is a normal psychophysiological phenomenon.

What assumptions have been made to interpret the symptoms of EHS individuals? (This question is addressed primarily in Section 7 of the expert appraisal report)

To try to explain the various symptoms of EHS individuals, the experts in ANSES's Working Group identified various assumptions through their analysis of the scientific literature. Moreover, given the limitations of many scientific articles and the lack of studies on certain issues, the Working Group also considered field experience and the assumptions made by various doctors and associations. It then studied all of these assumptions.

At first, the Working Group sought to determine whether there are characteristic biomarkers of EHS (biological differences or physico-chemical modifications, chronic oxidative stress or chemical poisoning). The roles of genetics and the immune system were also examined to try to explain EHS. However, there are no conclusive scientific data supporting these assumptions.

The Working Group then focused on the activity of the autonomic nervous system (ANS) in EHS individuals. Some studies seem to show different phenotypes in terms of ANS activity at baseline (i.e. in the absence of exposure) between EHS individuals and controls. The origin of this difference is thought to be an ortho-/para-sympathetic imbalance which, depending on the study, results in an increase in the orthosympathetic component, tachycardia and/or an increase in skin conductance. However, these changes could also be the result of stress related to the experimental conditions. The heterogeneity of the results can be explained by several limitations, found in most of these studies: small sample sizes, unsuitable methodologies, etc. Thus, the available data do not indicate that electromagnetic fields impact the autonomic nervous system of EHS individuals (or that of controls). In the current state of knowledge, the assumption that EHS individuals may have baseline autonomic nervous system dysfunction cannot be confirmed or ruled out.

The Working Group also investigated several assumptions regarding the central nervous system (CNS) to fully or partly explain the occurrence of EHS. According to the first such assumption, exposure to electromagnetic fields could amplify changes in the blood-brain barrier (BBB) caused by other factors and cause molecules to be leaked from the blood to the cerebrospinal fluid. The leakage of molecules may then cause neurological disorders in EHS individuals. The Working Group studied the available scientific articles on the topic and concluded that this assumption cannot currently be validated.

Another assumption regarding the central nervous system was analysed, under which disruptions in the production of neurotransmitters (catecholamines, serotonin) may explain the occurrence of EHS. However, there are not enough scientific data to draw any conclusions on the topic.

The assumption of predisposition to migraines in EHS individuals received greater attention from the Working Group. Indeed, headaches are one of the symptoms most commonly reported by these individuals and the results obtained by a doctor for some of them, whom he treated as migraine sufferers, appeared to be of interest. The data from the scientific literature, while too sparse and disparate to enable a conclusion to be drawn on the topic, nonetheless indicate that research should be undertaken into this issue.

Other assumptions, explored in articles involving the central nervous system, were analysed by the Working Group. They focused on the possible impairment of brain electrical activity, metabolism and cerebral blood flow. In the current state of knowledge, it is not possible to demonstrate any such impairment specific to EHS individuals. Moreover, based on the available data, it is not possible to know whether or not the effects of exposure to radiofrequencies on brain electrical activity observed in non-EHS individuals (see ANSES, 2013) are within the limits of physiological variation or if they could have positive or negative health effects in the long term.

The possible disruption of the sleep-wake cycle or circadian clock in EHS individuals was also investigated by the Working Group. Two studies including polysomnography recordings after long-

term exposure to a GSM signal in EHS individuals confirmed⁹ that this exposure increased EEG spectral power in the spindle frequency range¹⁰. However, since these two studies did not compare the results obtained for EHS individuals with those of controls, no conclusion can be drawn regarding a potential disruption specific to EHS individuals. On the other hand, another study demonstrated an increase in the energy of the high-frequency (HF)¹¹ band of EEGs, significantly smaller in EHS individuals than in controls, both during sleep induction and during the night. This observation should be compared with those made regarding the effects of exposure to radiofrequencies on sleep EEGs in non-EHS individuals. Even though the consequences of these sleep changes on the body were not characterised according to specific criteria¹² and remain unknown, these observations suggest that the assumption of disruption of the circadian clock remains credible and should be studied to attempt to explain the symptoms of these people (frequent sleep, concentration and memory disorders according to the questionnaire-based descriptive studies).

Lastly, the concept of “hypersensitivity” as a character trait drew the Working Group’s attention. “Hypersensitivity” refers to temporary or permanent higher-than-average sensitivity that can be difficult for the person experiencing it and perceived as “exaggerated” and even “extreme” by others. “Hypersensitive” individuals are thought to perceive their environment with particular acuity and sensitivity. This concept first emerged in psychology and was then confirmed by ethological (in over 100 animal species), neurobiological and genetic studies. It is a line of approach to a possible factor common to several syndromes (multiple chemical sensitivity and fibromyalgia in particular) that should be further explored.

Recommendations of the collective expert appraisal

1. Recommendations for the public authorities

Considering:

- the uncertainties related to the available (or unavailable) scientific data on EHS;
- the lack of a suitable animal model to study EHS;
- that despite numerous testimonials from EHS individuals linking the end of their symptoms to the end of exposure to waves, the scientific data currently available are neither in favour of nor against an improvement in their health condition after the lowering of exposure levels;
- that the French Act No 2015-136 of 9 February 2015 on restraint (the “Abeille Act”) entrusted the French National Frequency Agency (ANFR) with “methods for the management and correction of atypical points¹³” in order to reduce the level of fields emitted in the places in question while guaranteeing service coverage and quality;

⁹ Result already described by several authors and underlined in the report on the effects of radiofrequencies published by ANSES in 2013.

¹⁰ The fact that spindles are a marker of sleep stabilisation seems inconsistent with the sleep disorders described by EHS individuals. This apparent contradiction raises the issue of the major difference between subjective analyses of perceptions of sleep quality and those using polysomnography with an EEG recording enabling various sleep diseases and disorders to be diagnosed (sleep apnoea, narcolepsy, restless leg syndrome, insomnia, etc.).

¹¹ The HF band evaluates parasympathetic activity. During sleep and its induction, the energy of the HF band of the heart signal increases.

¹² According to the criteria defined by the American Academy of Sleep Medicine.

¹³ Atypical points are defined as places where the level of public exposure to electromagnetic fields significantly exceeds that generally observed at national level, in accordance with the criteria determined by the ANFR and regularly revised

- that no scientific data have demonstrated the efficacy of white zones or “safe” buildings, or of specific hospital rooms, in reducing the symptoms reported by EHS individuals;

the CES advises the public authorities to:

- continue financing research work, in particular fundamental research, on the health effects of radiofrequencies and especially EHS;
- support, among other things, the creation of research infrastructures suitable for investigating EHS (for undertaking provocation studies, etc.);

In addition, the CES renews¹⁴ its recommendations on reducing exposure levels for the general public and underlines the importance of the following in particular:

- carefully considering the potential consequences of lowering exposure levels induced by mobile telephone base stations;
- studying the link between the increase in the number of antennas and the possible concomitant increase in average exposure;

Lastly, in the event that white zones are created, the CES recommends rigorously assessing their potential benefits for the symptoms of EHS individuals.

2. Recommendations for research institutions and organisations

2.1. Improving knowledge of EHS

2.1.1. Provocation studies

Considering that:

- provocation studies are those that have the best level of evidence to demonstrate a potential causal relationship between exposure to electromagnetic fields and the symptoms reported by EHS individuals but have thus far shown methodological limitations (see § 6.2.3 of the report) and have not led to scientific consensus (see § 6.2.4);
- EHS individuals report being more sensitive to certain types of signals (or signal variations) than others¹⁵;

the CES recommends undertaking provocation studies (with clearly characterised groups of people in terms of age, gender, types of symptoms, etc.) on the effects of:

- signals as close as possible to those encountered in the environment;
- exposure to electromagnetic fields by designing new protocols (various exposure conditions, deferred effects, etc.).

based on the results of the measurements it receives. A national inventory of atypical points in France is established annually by the ANFR.

¹⁴ See § 13.3, p 346 of the report published by ANSES in 2013.

¹⁵ Recent research undertaken in the Netherlands (Van Moorselaar *et al.*, 2016) showed the feasibility and relevance of conducting a rigorous provocation study while being specific to each EHS participant.

2.1.2. Characterising the symptoms of EHS

Sleep and circadian rhythm disorders

Considering that:

- sleep disorders are among the symptoms most commonly reported by EHS individuals but remain poorly quantified;
- sleep EEG abnormalities have been described in non-EHS individuals after exposure to radiofrequencies (see ANSES, 2013), and that these abnormalities seem to have been found in EHS individuals but without being compared to those observed in non-EHS individuals (see § 6.2.1.2.5);
- very recent experimental research showed, for the first time, that rats were capable of choosing an environment where their exposure to radiofrequencies was lowest during the rest period (daytime) and that this choice was associated with an increase in the duration of REM sleep (see § 5.3.1);
- the symptoms of EHS individuals (sleep disorders in particular) make the assumption of circadian clock disruption possible;

the CES recommends:

- studying the prevalence, intensity and characteristics of subjective and self-reported sleep disorders (with intensity scales in particular) and circadian rhythms in EHS individuals and in controls;
- studying the disorders associated with sleep disturbances in EHS individuals, such as daytime sleepiness, memory, attention, concentration and mood disorders, and changes in physical activity compared to those of a control population;
- undertaking provocation studies using polysomnography, to objectively analyse sleep quality during exposure to electromagnetic fields in EHS individuals.

Migraines and headaches

Considering that:

- headaches are one of the symptoms most commonly reported by EHS individuals but that, thus far, research into this theme has seldom been undertaken using the International Classification of Headache Disorders;
- the very few studies that have distinguished between migraines and other headaches showed a non-negligible frequency of migraine attacks or history in EHS individuals, without being able to say whether this frequency is higher than in the general population;
- one doctor's experience (see § 7.5.3.2) with the use of migration medications in EHS individuals raised interesting assumptions, whose verification could lead to EHS individuals being effectively treated with migraine medications;

the CES recommends:

- studying the various types of headaches experienced by EHS individuals based on the international classification, to clarify the link between migraines and EHS. The aim is to determine whether all or some of these people's headaches are migraines and whether these people have more migraines than non-EHS individuals;
- based on the results of the above research, undertaking clinical trials in order to study the efficacy of migraine treatments in EHS individuals.

Hypersensitivity as a character trait

Considering that:

- hypersensitivity (see § 3.8.4) has been described as a character and behavioural trait that is starting to be documented, from psychological as well as neurobiological standpoints;
- until now, the examination of the psychological profiles of EHS individuals has only used tests exploring a small number of components (anxiety, depression, somatisation);

the CES recommends studying:

- potential connections between hypersensitivity as a character trait and EHS, for exploratory purposes, to assess the relevance of continuing investigations with cerebral functional imaging markers;
- the psychological profiles of EHS individuals with tests¹⁶ more broadly exploring the various components.

EHS and related syndromes and disorders

Considering that:

- there are many associations between EHS and several syndromes and/or disorders (usually multiple chemical sensitivity - MCS, fibromyalgia, tinnitus, etc.);
- dermatological disorders are common during EHS and that abnormalities in the small nerve fibres of the skin have been found in fibromyalgia;

the CES recommends:

- comparing the clinical and possibly pathophysiological aspects of EHS on the one hand and of idiopathic MCS, fibromyalgia and tinnitus on the other hand;
- studying abnormalities in the small nerve fibres of the skin when comparing EHS and fibromyalgia.

2.1.3. Other research proposals

Considering that:

- up to now, the various attempts to develop a specific standardised questionnaire on EHS usable for research have not been successful;
- the very few long-term follow-up studies with EHS individuals have not exceeded one year;
- some studies, as well as the hearings and testimonials, emphasised the "doctor-shopping" of EHS individuals;
- the isolation (social, professional, familial) of EHS individuals is systematically underlined;
- the care and perceptions of EHS individuals can vary from one country to the next;

the CES recommends:

- developing and validating a specific standardised questionnaire on EHS like those available for most syndromes (MCS and fibromyalgia for example);
- undertaking prospective studies for the long-term monitoring of EHS individuals;

¹⁶ Such as the Minnesota Multiphasic Personality Inventory (MMPI).

- studying the complexity of provider-patient relations for EHS individuals;
- identifying the various factors that contribute to the psycho-social isolation of these people;
- carrying out comparative studies on the issue of EHS (patient realities, perceptions of EHS, care, etc.) in several countries.

2.2. Assessment of the empirical methods currently used to “diagnose” EHS or to “treat” EHS individuals

Considering that:

- no diagnostic criteria for EHS have been validated to date;
- some authors and practitioners have nonetheless proposed empirical methods for the “diagnosis” and/or “treatment” of EHS individuals;
- there are very few studies on their effectiveness;

the CES recommends assessing the effectiveness of the empirical “diagnostic” and/or “treatment” methods used, in particular:

- ortho-/para-sympathetic balance (dynamics of the autonomic nervous system), especially heart rate variability;
- leading three-dimensional methods¹⁷, blood flow and brain energy metabolism in EHS individuals, in order to verify the assumption of cerebral ischemia related to EHS;
- questionnaires on EHS;
- the various EHS treatments proposed empirically, for which clinical trials should be undertaken.

Lastly, in general, the CES underlines the importance of strengthening interactions between scientists and associations of EHS individuals.

3. Recommendations for health and social service professionals

Until there is a better understanding of EHS, especially of the physiological, psychological and/or biological components that may explain the described symptoms, it is clear that many EHS individuals demonstrate a state of (physical and/or mental) suffering that varies in intensity. This requires and justifies the provision of suitable care by the healthcare system. Moreover, such care is a prerequisite for the implementation of high-quality research work.

To improve the care of EHS individuals, it is first and foremost essential to establish and maintain a climate of trust between EHS individuals on the one hand and health and social service professionals on the other hand. For this to happen, the CES advises the health authority, as a priority, to:

- develop training for doctors on the health effects of radiofrequencies and provide them with information enabling them to meet the expectations of EHS individuals;

¹⁷ PET (positron-emission tomography) scan for example.

- ask the French Society for Occupational Medicine to examine the feasibility of a good practice guide on the care of EHS individuals in the workplace¹⁸;
- ask the French National Authority for Health (HAS) to examine, as with the recommendations it formulated on fibromyalgia¹⁹, the relevance of formulating care recommendations tailored to EHS individuals;
- foster closer ties and promote collaboration among professionals involved in the care of EHS individuals (doctors, occupational and environmental disease clinics - CCPPs, departmental homes for disabled persons - MDPHs, etc.).

4. ANSES'S CONCLUSIONS AND RECOMMENDATIONS

First of all, regarding the exposure of individuals to electromagnetic fields, ANSES reiterates the recommendation it formulated in its Opinion of October 2013 on the exposure of individuals to electromagnetic fields: "Considering the current or future deployment of new mobile communication technologies [...], in parallel with the existing services, and the uncertainties concerning the long-term effects of exposure to radiofrequencies, the Agency emphasises the need for these technological developments to go hand in hand with limitation of individual exposure, whether exposure is environmental or related to devices".

Regarding the need to undertake a collective expertise appraisal on the topic of EHS, ANSES reiterates that in its Opinion of October 2013 it indicated that: "Considering on the one hand the number of recent publications and the expected publication of results from on-going studies, and on the other, the need to grant particular attention to the issue of hypersensitivity to electromagnetic waves, ANSES decided to postpone assessment of this issue, to be dealt with in a special report by the Working Group".

With regard to this expert appraisal, the Agency endorses the conclusions and recommendations of its Expert Committee on Physical agents, new technologies and development areas, set out above (see Section 3).

It reiterates that this expert appraisal was undertaken between 2014 and 2017 by a dedicated multidisciplinary working group, together with the Expert Committee on "Physical agents, new technologies and development areas". This expert appraisal work drew on all the available scientific literature, as well as on numerous hearings with hospital and general practitioners, researchers and associations, in connection with electrohypersensitive (EHS) individuals. The Agency underlines the fact that the expert appraisal report was available for public consultation between July and October 2016 and that it takes into account the numerous comments (more than 500) collected. This made it possible, among other things, to supplement the references and enhance several parts of the report (see Annex 17 on the review of the consultation and the main changes made to the report, as well as the table of responses to the comments in the electronic Annex).

The expert appraisal showed the great complexity of the issue of electrohypersensitivity. First of all, there are currently no validated diagnostic criteria for EHS, and the expert appraisal found that

¹⁸ This guide could rely on validated scientific data and a survey of occupational physicians caring for these people. It could define methods for measuring electromagnetic fields in the workplace when a source of electromagnetic fields is called into question by an EHS individual and, in collaboration with hospital structures dedicated to occupational diseases, the conditions for consulting these structures.

¹⁹ See the "Guidance report on fibromyalgia syndrome in adults" of July 2010 and the guide on "Fibromyalgia in adults: promoting early and graduated care" of June 2011.

it is only possible to define EHS on the basis of self-reporting by people. In the end, in the current state of knowledge, there is no solid experimental evidence enabling a causal relationship to be established between exposure to electromagnetic fields and the symptoms described by EHS individuals. However, the Agency emphasises that the complaints (pain, suffering) expressed by EHS individuals are a reality of life and that they have to adapt their daily lives to cope with it.

The symptoms experienced by EHS individuals, as well as the psycho-social isolation suffered by some of them, require and justify the provision of suitable care by health and social service professionals (see the CES's recommendations for health and social service professionals). As such, the Agency underlines the relevance of asking the French National Authority for Health to investigate guidelines on the care of EHS individuals intended for health professionals. In particular, the Agency recommends developing training for health and social service professionals in supporting and counselling EHS individuals, as well as taking their questions and expectations into account in their practices, especially in terms of quality of life.

In addition, the Agency stresses the need to continue research work on EHS, in accordance with the following recommendations:

- strengthen interactions between scientists and associations of EHS individuals (see recommendations for research institutions and organisations);
- support the establishment of research infrastructures suitable for investigating EHS, mainly in order to conduct long-term follow-up studies, while ensuring that the experimental conditions are controlled and take into account the circumstances of EHS individuals;
- continue financing research work, in particular fundamental research, on the health effects of radiofrequencies (see recommendations for the public authorities).

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KEYWORDS

Hypersensibilité électromagnétique (EHS), intolérance environnementale idiopathique attribuée aux champs électromagnétiques (IEI-CEM), champs électromagnétiques, radiofréquences, basses fréquences.

Electromagnetic hypersensitivity (EHS), Idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF), Electromagnetic fields, Radiofrequencies, Low frequencies.