

# A Systematic Review of Treatments for Electromagnetic Hypersensitivity

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## Key Words

Electromagnetic fields · Environmental illness · Hypersensitivity, electromagnetic · Systematic review

## Abstract

**Background:** Electromagnetic hypersensitivity (EHS) is a poorly understood condition in which patients report symptoms following perceived exposure to weak electromagnetic fields (EMFs) such as those produced by mobile phones or visual display units. Little is known about the aetiology of the condition although experimental data suggest that EMFs are an unlikely causal agent. In this systematic review we assessed the efficacy of any treatment for people reporting EHS. **Methods:** Twelve literature databases were examined to identify relevant studies. We also hand-searched conference proceedings and examined the reference sections of reviews and other papers. Only clinical trials that compared the efficacy of a potential treatment for EHS against a control condition were included in the review. **Results:** Nine controlled clinical trials were identified, examining the effects of cognitive behavioural therapy (4 studies), visual display unit screen filters (2 studies), 'shielding' EMF emitters (1 study), supplementary antioxidant therapy (1 study) and acupuncture (1 study). The quality of these studies was limited. Nevertheless, their results suggest that cognitive behavioural therapy is more effective than providing no treatment. None of the other

therapies have had their efficacy adequately demonstrated. **Conclusions:** The evidence base concerning treatment options for EHS is limited and more research is needed before any definitive clinical recommendations can be made. However, the best evidence currently available suggests that cognitive behavioural therapy is effective for patients who report being hypersensitive to weak EMFs.

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## Introduction

Electromagnetic hypersensitivity (EHS) is a poorly understood condition in which people report non-specific symptoms following perceived exposure to weak electromagnetic fields (EMFs) [1, 2]. These symptoms can be associated with the presence of a wide range of electrical devices including visual display units (VDUs), mobile phones and domestic appliances: devices which do not cause illness in the large majority of those who use them and which produce EMF levels far below those believed to cause adverse physiological effects [2]. At least two subcategories may exist within the broader definition of EHS; patients who report acute symptoms resulting from contact with one or two specific electrical devices and those who subsequently develop more severe symptoms that are associated with a wider range of electromagnetic stimuli [1, 3]. A large degree of heterogeneity exists with-

in the condition, however, and as yet no cohesive syndrome of symptoms has been identified in either generalised EHS or in any of the more specific sensitivities to individual electrical devices [4, 5].

To date, the main focus of research into EHS has been to establish the role of EMFs in causing or exacerbating these symptoms. In a recent systematic review we identified 31 experimental provocation studies that have tested this by exposing EHS volunteers to real or sham EMF stimuli under blind or double-blind conditions [6]. Although some studies did observe an association between EMF presence and symptom reporting, these tended to be either unreplicated or statistically unreliable. The majority of studies found no such association, suggesting that EMFs play little, if any, role in the pathogenesis of the condition. EHS is thus similar to other 'modern' illnesses in which non-specific symptoms are attributed to supposedly toxic exposures despite a lack of scientific evidence to support this attribution. For instance, patients who report multiple chemical sensitivity, dental amalgam intolerance and sick building syndrome all describe a similarly broad range of non-specific symptoms to EHS patients and display similar patterns of 'overvalued' ideas regarding their aetiology [7].

It therefore seems appropriate to ask whether treatments that are effective for other forms of medically unexplained syndromes are also effective for treating EHS. In particular, given that the use of cognitive behavioural therapy (CBT) is helpful in many modern medically unexplained syndromes [8, 9], is CBT also helpful in this condition? Alternatively, a more EMF-oriented approach to EHS management has been advocated by some, who have suggested that 'electromagnetic sanitation' of patients' homes and offices is the best way to reduce their symptoms [10]. In this systematic review we have attempted to collate the evidence concerning what treatment works best for EHS by identifying all controlled clinical trials for the illness.

## Methods

### *Search Strategy for the Identification of Studies*

The search strategy used to identify relevant controlled clinical trials has been described in detail elsewhere [6]. In brief, 12 literature databases were searched from inception to January 2004 using a wide range of EHS-related free-text keywords such as electrosmog, electromagnetic hypersensitivity and terminal dermatitis. The databases were also searched using combinations of relevant stimulus MeSH terms (i.e. 'electricity', 'cellular phone', 'lighting', 'computers', 'radiation') or free-text keywords (e.g. 'mobile phone', 'computer', 'power line') and hypersensitivity MeSH terms (i.e. 'hy-

persensitivity') or free-text keywords (e.g. 'allergy', 'hypersensitivity', 'intolerance'). The Bioelectromagnetics Society conference proceedings for 1996–2003 were also hand searched for further studies and the reference sections of relevant studies and reviews were examined for other potentially relevant papers.

### *Inclusion Criteria*

Studies were only included in the review if they examined a discrete group of participants who reported symptoms which they attributed to the presence of weak EMFs, tested an intervention which was intended to improve the well-being of these participants and compared this intervention to a control condition intended to provide no effect or a placebo-only effect.

### *Data Extraction and Analysis*

For each study, data concerning the sample, design, treatment allocation, blinding, active and control conditions, outcomes and results were extracted and tabulated. Due to the likely qualitative differences between the studies, no meta-analyses were planned.

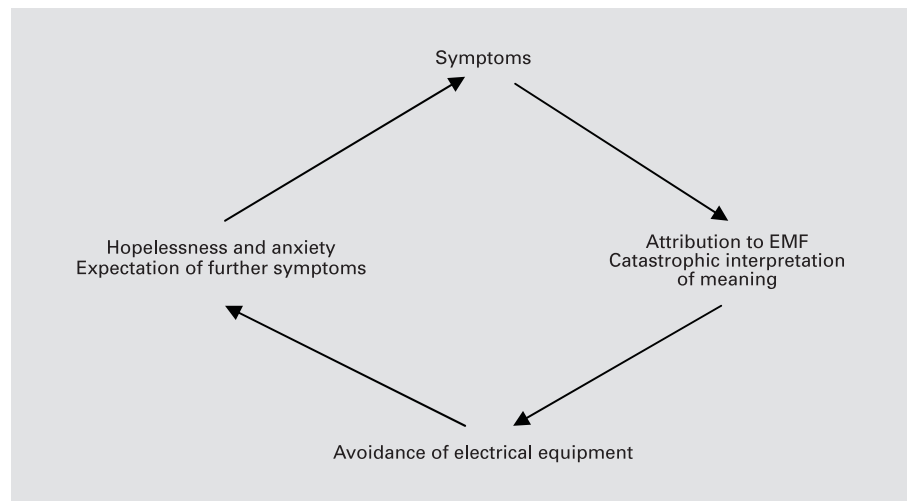
## Results

### *Search Results*

In total, over 8,600 titles or abstracts were examined, from which 497 papers were selected as potentially relevant. Of these, the majority (71%) were subsequently excluded because they were review papers, editorials, or did not include a sample of patients whose symptoms were explicitly attributed to EMFs. Only nine papers (2%) reported data relating to a controlled clinical trial for EHS. The interventions tested in these trials were based on CBT (4 studies) [11–14], reducing the EMF emissions of workplace VDUs (2 studies) [15, 16], wearing a device designed to emit 'shielding' EMFs (1 study) [17], administering antioxidant therapy in the form of vitamin supplements (1 study) [18] and providing acupuncture (1 study) [19]. Only partial information was available regarding two of these studies, consisting of an English abstract from a Swedish dissertation in the case of one CBT study [13] and a brief report from a manufacturer's brochure in the case of the shielding EMF study [17]. The majority of the included studies were Swedish in origin, reflecting the much wider reporting of EHS in that country than in any other [1].

### *Cognitive Behavioural Therapy*

The 4 studies which tested CBT are summarised in table 1 [11–14]. The theoretical rationale given for the use of this intervention was fundamentally the same for each study. Typically, a vicious circle model (fig. 1) was used to explain how automatic assumptions made by EHS patients regarding the causes and implications of their



**Fig. 1.** Cognitive behavioural model of electromagnetic hypersensitivity.

**Table 1.** Cognitive behavioural studies

	Hillert et al. [14], 2002	Hillert et al. [11], 1998	Andersson et al. [12], 1996	Harlacher [13], 1998
Quality	Non-random non-blind	Randomised non-blind	Randomised non-blind	Non-random non-blind
Design	Parallel groups	Parallel groups	Parallel groups	Parallel groups
Sample size	22	22	17	Unknown
Age, years	Mean = 42 (29–58)	Mean = 40 (26–58)	Mean = 42 (26–53)	Unknown
% male	36	27	29	Unknown
Sensitivity and illness duration	Mainly generalised EHS. Mean duration of 3 years (<1–10)	Generalised EHS of unknown duration	Mainly generalised EHS. More than 6 months duration	‘Electricity hypersensitivity’
Active intervention	Eight 3-hour group CBT and physiotherapy sessions over 2 months (n = 12)	Up to 16 one-to-one CBT sessions over 6 months (n = 10)	Four to ten 1-hour one-to-one CBT sessions over 20 weeks (n = 9)	‘Psychological treatment... according to cognitive-behavioural principles’
Control	Waiting list controls (n = 10)	Waiting list controls (n = 12)	Waiting list controls (n = 8)	Waiting list controls
Assessment time-points	End of therapy	End of therapy and 6-month follow-up	End of therapy	Unknown
Effects of active condition compared to control condition	No significant changes in self-reported symptoms, discomfort from triggers or avoidance behaviours following active or control condition	Significantly reduced self-ratings of hypersensitivity. No differences in symptoms, discomfort, avoidance behaviours, biochemical measures, psychological traits, or absences from work	Significantly reduced self-ratings of disability and symptoms. No differences in post-provocation symptom reporting or self-rated ability to detect EMF. No differences in most blood measures	‘Significant reduction in the degree of [EHS]-suffering’ 50% of those treated reported reduced symptoms or reduced perception of EHS

symptoms might lead to feelings of anxiety and helplessness, maladaptive attempts to avoid situations in which EMFs are likely to be encountered, and self-fulfilling expectations of additional symptoms when such avoidance is not possible. CBT was used as a way of encouraging patients to challenge these assumptions and to test non-EMF-related interpretations and ways of coping with their symptoms. Where necessary, patients were also

taught techniques for handling psychosocial stress. One study [14] also incorporated a package of physiotherapy and exercise designed to improve levels of physical fitness and to educate patients about the connections between their physiological and subjective states.

All four CBT studies used patients placed on a treatment waiting list as the control group. None was blind and only two [11, 12] were described as randomised.

**Table 2.** VDU Filter studies

	Oftedal et al. [16], 1995	Oftedal et al. [15], 1999
Quality	Randomised double-blind	Randomised double-blind
Design	Cross-over	Cross-over
Sample size	20	42
Age, years	Mean = 40 (26–57)	Mean = 41 (24–62)
% male	40	21
Sensitivity and illness duration	Skin symptoms apparently associated with VDU use. Illness duration not reported	Skin symptoms apparently associated with VDU use. Illness duration not reported
Active intervention	Activated electric-conducting screen filters fitted to VDUs at work for 2 weeks	Activated electric-conducting screen filters fitted to VDUs at work for 3 months
Control	Deactivated electric-conducting screen filters fitted to VDUs at work for 2 weeks	Deactivated electric-conducting screen filters fitted to VDUs at work for 3 months
Assessment time-points	Comparison made between symptoms experienced during the 2nd week of work with each filter	Comparison made between symptoms experienced during 4th week and final week with each filter
Effects of active condition compared to control condition	Small but significant reduction in 1 of 7 self-reported symptoms. No differences in objective dermatological evaluation	No significant differences in self-reported symptoms

Three of the studies reported that CBT resulted in a significantly better outcome than the control condition [11–13] while one reported no significant differences [14]. Improvements associated with CBT included reductions in the degree of EHS suffering [13], reduced symptom severity [12], reduced disability [12] and a reduction in the number of patients describing themselves as sensitive to EMFs [11, 13]. Not all studies reported improvements in each of these areas, however, and neither of the two studies which measured the variable identified any reduction in self-reported avoidance of EMF following treatment [11, 14]. Furthermore, in the only study to have tested patient responses to experimental provocation with an EMF source following treatment, CBT was found to have had no effect on increases in post-provocation symptom severity or on patient beliefs concerning their ability to detect EMF [12].

#### *VDU Screen Filters*

Two randomised double-blind studies [15, 16] used cross-over designs to test the efficacy of attaching electric-conducting filters to the VDUs of office workers who reported hypersensitivity to their computer monitors (table 2). In both studies an inactive placebo filter was used as the control condition. The first experiment identified no differences between the two conditions in terms of objective dermatological signs, although participants did report significantly greater reductions in skin tingling

with the active filter than with the placebo [16]. Six other symptoms were unaffected. The second study tested a larger sample over a longer period of time but observed no significant differences between the two conditions in terms of any symptom [15]. Both studies also made non-blind assessments of the effects of using either type of filter in comparison to a baseline period with no filter attached. In both studies, the use of either filter, whether active or placebo, was associated with reduced symptom reporting.

#### *'Shielding' EMF Emitters*

One study investigated the effects of the Synchroton<sup>®</sup> Scalar Synchronizer, a device described as emitting 'low intensity (6–60 mW average power consumption) electromagnetic potential waves pulsed at the Schuman fundamental frequency of 7.83 cycles per second' [17]. According to the manufacturers these emissions might act as 'neutralizing frequencies [preventing] in all sufferers the harmful effects of EM pollution'. Although the manufacturers provided several accounts of the effects of this device, only one study [17; p 24–25] met our inclusion criteria. This tested the effects of the Synchroton on 4 women described as having chronic fatigue syndrome and EHS (table 3). Participants used the device for 1 month with alternating periods of it switched on for 3 days and then switched off for 2 days. A variety of outcomes were assessed including symptoms, cognitive func-

**Table 3.** Other studies

	Abraham [17], 1998	Hillert et al. [18], 2001	Arnetz et al. [19], 1995
Quality	Non-random non-blind	Randomised double-blind	Randomised non-blind
Design	Cross-over	Cross-over	Parallel groups
Sample size	4	16	20
Age, years	35–42	Mean = 40 (21–59)	<29 (n = 2), 30–39 (n = 6), 40–49 (n = 6), >50 (n = 6)
% male	0	19	25
Sensitivity and illness duration	Unclear. All participants had ‘EM field sensitivity’ and met criteria for chronic fatigue syndrome	Mainly generalised EHS with a duration of 1 year or more	Generalised EHS. Mean duration of 3 years
Active intervention	Multiple 3-day periods over 1 month with Synchronon® Scalar Synchronizer switched on	180 mg vitamin C, 100 mg vitamin E and 120 µg selenium daily for 3 weeks	Classic deep acupuncture for ten 30-min sessions over 5 weeks (n = 13)
Control	Multiple 2-day periods over 1 month with Synchronon® Scalar Synchronizer switched off	Placebo tablets daily for 3 weeks	Superficial acupuncture at the same acupuncture points for ten 30-min sessions over 5 weeks (n = 7)
Assessment time-points	Assessments made during each on and off period	Daily questionnaires. Blood samples taken before and during last 3 days of each condition	After treatment and at 1-, 3- and 6-month follow-up
Effects of active condition compared to control condition	Improvements in symptoms, cognitive function and perceived hypersensitivity, as well as grip strength, balance and patella tendon reflexes. No statistical tests reported	No differences with respect to symptoms and stress, perceived hypersensitivity, avoidance behaviours, or blood biochemistry	No differences reported with respect to symptoms, perceived hypersensitivity, ability to relax or biochemical variables

tion and grip strength. ‘Consistent improvement in all parameters’ was reported during periods for which the device was switched on, compared to no improvements with it switched off. Unfortunately, the study was neither blind nor randomised and no statistical tests of these apparent differences were reported.

#### *Supplementary Antioxidant Therapy*

Noting that oxidative stress might be one mechanism underlying the type of symptoms experienced in EHS, one double-blind randomised controlled cross-over trial compared the effects of dietary supplementation with antioxidant vitamins and minerals (120 µg selenium, 180 mg vitamin C and 100 mg vitamin E daily for 3 weeks) versus placebo tablets in a group of 16 EHS sufferers [18] (table 3). No improvements were observed over time and no differences between the two treatments were found with respect to subjective health measures or biochemical indicators of the oxidative status of the participants’ blood.

#### *Acupuncture*

One non-blind randomised controlled trial [19] compared the efficacy of 5 weeks of deep acupuncture (the active treatment) against 5 weeks of superficial acupunc-

ture (the control treatment) in a group 20 EHS volunteers (table 3). Over a 6-month follow-up both treatments were associated with significant improvements in self-reported job satisfaction, ability to work with a VDU, ability to relax after work, perceived hypersensitivity to EMFs, symptom severity and use of analgesia, although no significant differences between the two types of intervention were reported. Thus, although the original rationale for using deep acupuncture was that it might serve to modulate sensory input, the authors therefore suggested that any physiological effects of acupuncture were probably not the key factors leading to these improvements. Instead, they suggested that the beneficial effects observed might have been mediated by a reduced sense of hopelessness in the patients and a diminished conviction that all their symptoms were caused by EMFs.

## **Discussion**

### *Current Evidence*

Little good quality research has been conducted into possible treatments for EHS with only nine studies meeting our lenient criteria as to what constitutes an adequate clinical trial for this condition. Moreover, only three of

these trials were both double-blind and randomised [15, 16, 18]. Clearly more good-quality research is required, but in the meantime it is still necessary to provide some guidance as to how EHS might be treated. In this regard the best currently available evidence suggests that CBT is the most appropriate therapy, with three of the four studies which tested this intervention reporting beneficial effects in comparison to remaining untreated [11–13]. CBT also has the most convincing rationale of any of the treatments reviewed above. Given that increased EMF does not usually elicit increased symptom reporting in EHS patients, it seems probable that some form of cognitive mechanism is responsible for their misattribution of these symptoms [6]. Helping patients to consider alternative causes for the symptoms and to explore non-EMF-related strategies for coping with them is therefore a logical intervention and one which has proved effective across a range of related conditions [8, 9].

Having said this, the methodological limitations of the four CBT studies mean that several questions regarding efficacy remain unanswered. In particular, as no study has followed up patients for more than 6 months, it is unclear how long any beneficial effects last. It is also notable that the four studies all employed skilled and experienced therapists to conduct the CBT, so whether this treatment would be as effective outside a specialist setting is uncertain. Finally, the lack of any ‘placebo’ condition in these studies is also highly problematic. Three other studies included in this review have shown that placebo treatments can result in improvements in self-reported health in EHS patients [15, 16, 19]: it is therefore possible that the beneficial effects reported in the CBT studies were actually due to the non-specific effects of receiving CBT, such as having spent a large amount of time with a sympathetic therapist. Further studies using suitable non-CBT conditions which control for contact time are now required.

Although complementary and alternative treatments are popular among patients with EHS, we found no evidence that either acupuncture [19] or antioxidant vitamin supplements [18] have any specific therapeutic effects on the condition. Acupuncture did produce an impressive placebo effect however, although taking supplementary vitamins did not. Dismissing complementary therapies as inappropriate for EHS may therefore be premature. Given that CBT is not always well-received by patients, some of whom see it as implying that their symptoms are ‘all in the mind’, the use of a suitable complementary therapy involving social support and relaxation components may be justified in some cases both to provide short-

term relief from symptoms and to illustrate to patients that their symptoms can be managed without avoidance of electrical equipment.

Treatments focused on altering the electromagnetic environment of the patient received no support from this review, with two studies of electric-conducting VDU screen filters suggesting them to be no better than placebo [15, 16] and the poor quality of the Synchroton Scalar Synchronizer study making any proper assessment of its efficacy impossible [17]. Given that altering EMF levels in experimental provocation studies does not usually affect acute EHS symptom severity [6], this finding is perhaps unsurprising. Moreover, by reinforcing a patient’s belief that his/her symptoms are caused by EMF, in the long-term such electromagnetic sanitation might prove counterproductive. This is not to suggest that where patients report symptoms that they believe to be EMF-related, an environmental evaluation of their work-place or home should not be conducted. But where this evaluation does not reveal a clear cause for their illness, elaborate attempts to reduce EMFs in the patient’s vicinity currently have little to recommend them.

#### *Suggestions for Future Research*

Given the questions that still remain concerning the efficacy of CBT for EHS, more good-quality research into this should now be a priority. Future studies in this area should ideally ensure that a suitable ‘placebo’ condition is used to control for therapist contact time, that allocation to treatment conditions is performed randomly and that patients are followed up for more than 6 months. It would also be interesting if patient reactions to a double-blind provocation with an appropriate EMF source was used as one of the outcome measures, as this may provide an appropriate way of measuring acute responses to perceived EMF presence, in contrast to self-reported quality of life scales which may measure the more chronic aspects of EHS.

Studies to investigate whether CBT-based interventions can be used to help patients with less severe forms of EHS may also be worthwhile. For example, one study has previously reported that some EHS patients report improvement following only an initial short description of CBT principles [11]. Whether a brief CBT intervention for patients in the early stages of EHS would provide a useful and cost-effective way of improving quality of life and preventing the subsequent development of more severe forms of the illness should therefore be examined.

Further research into non-CBT-based treatments may also be useful. For example, it has been suggested that

classical conditioning may underlie the acute symptoms experienced in EHS [20]. Accordingly treatments based on systematic desensitization in which repeated exposure to an EMF stimulus is paired to, for example, relaxation techniques may serve to diminish this conditioned response. Such a treatment may be particularly suitable for patients who only experience symptoms associated with one or two specific electrical devices.

Finally, despite the occasional use of these techniques for treating EHS, we note that no controlled clinical trials were found relating to the use of antidepressants or ho-

meopathic techniques. Proponents of these treatments should now provide good quality evidence that they are effective and safe for EHS.

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