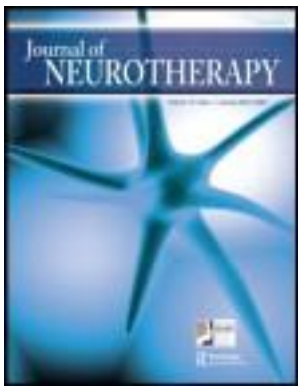


Journal of Neurotherapy: Investigations in Neuromodulation, Neurofeedback and Applied Neuroscience

Cranial Electrotherapy Stimulation Review: A Safer Alternative to Psychopharmaceuticals in the Treatment of Depression

Marshall F. Gilula MD [a] & Daniel L. Kirsch PhD [b]

[a] Center for Patient Safety, Department of Anesthesiology , University of Miami, Jackson Memorial Hospital

[b] Electromedical Products International, Inc.

Published online: 08 Sep 2008.

To cite this article: Marshall F. Gilula MD & Daniel L. Kirsch PhD (2005) Cranial Electrotherapy Stimulation Review: A Safer Alternative to Psychopharmaceuticals in the Treatment of Depression, Journal of Neurotherapy: Investigations in Neuromodulation, Neurofeedback and Applied Neuroscience, 9:2, 7-26, DOI: 10.1300/J184v09n02_02

To link to this article: http://dx.doi.org/10.1300/J184v09n02_02

SCIENTIFIC ARTICLES

Cranial Electrotherapy Stimulation Review: A Safer Alternative to Psychopharmaceuticals in the Treatment of Depression

Marshall F. Gilula, MD
Daniel L. Kirsch, PhD

ABSTRACT. The use of Cranial Electrotherapy Stimulation (CES) to treat depression and anxiety is reviewed. The data submitted to the Federal Drug Administration (FDA) for approval of medication in the treatment of depression are compared with CES data. Proposed method of action, side-effects, safety factors, and treatment efficacy are discussed. The results suggest there is sufficient data to show that CES technology

Marshall F. Gilula is Senior Patient Safety Fellow, Center for Patient Safety, Department of Anesthesiology, University of Miami, Jackson Memorial Hospital.

Daniel L. Kirsch is Chairman, Electromedical Products International, Inc., a medical device manufacturing firm with a product line that includes CES devices, the subject matter of this paper.

Address correspondence to: Marshall F. Gilula, Center for Patient Safety, Jackson Memorial Hospital, The Institute–Fourth Floor, 1611 NW 12th Avenue, Miami, FL 33136 (E-mail: mgilula@mindspring.com).

Journal of Neurotherapy, Vol. 9(2) 2005

doi:10.1300/J184v09n02_02

has equal or greater efficacy for the treatment of depression compared to antidepressant medications, with fewer side effects. A prospective research study should be undertaken to directly compare CES with antidepressant medications and to compare the different CES technologies with each other.

KEYWORDS. Cranial electrotherapy stimulation, CES, depression and patient safety, efficacy comparisons, treatment effectiveness

Cranial Electrotherapy Stimulation (CES) is in the Federal Drug Administration's (FDA) recognized category for medical devices using microcurrent levels of electrical stimulation applied across the head via transcutaneous electrodes for the treatment of depression, anxiety and insomnia. The treatment of depression with CES began in the United States in the early 1960s and is prescribed routinely by a few thousand physicians and mental health practitioners, but has yet to achieve full acceptance. That is possibly because sufficient information has not been made available to practitioners regarding the safety and efficacy of CES as a treatment for depression. Using an electromedical device requires an additional learning curve for both practitioners and patients who are accustomed to the pharmaceutical model of intervention. Ingesting a capsule or a tablet does not require the attention to detail demanded by choosing the correct device, waveform parameters, electrode locations and placement techniques. Ideally, both modalities require patient education, consistent follow-up, and determinations of compliance. The goal of this review is to compare the treatment efficacy of CES and medication in published studies.

HISTORY AND GENERAL REVIEW

Drs. Leduc and Rouxeau of France were the first to experiment with low intensity electrical stimulation of the brain in 1902 (Appel, 1972). Initially, this method was called electrosleep as brain stimulation was considered a sleep inducer. There were other names such as transcranial electrotherapy (TCET) and neuroelectric therapy (NET), but research on

CES began in the Soviet Union during the 1950s and was introduced in the US about a decade later (Iwanovsky & Dodge, 1968).

During the first half of the twentieth century many different methods were used in clinical settings to put patients to sleep for varying periods of time in order to restore more normal mental functioning. Various medications or combinations of medications were applied with different degrees of success. While many patients responded to such early medications rather dramatically, up to 3% died in the process (Badmaeva, 1956).

Electroconvulsive therapy (ECT) for depression and psychosis was introduced in 1933 by Cerletti and Bibi (1938). ECT typically involved the application of 120 volts with 500 milliamperes at 60 Hz for 0.2 seconds. ECT caused convulsions and a loss of consciousness rather than sleep, for a limited time. Subsequently, the electrical current was reduced to around 30 milliamperes, using 2 volts at 700 Hz. This less intense form of transcranial stimulation was called electroanaesthesia (National Research Council, 1974). Patients remained asleep as long as the current was on, but tended to wake up immediately when the current was turned off.

Finally, the current was turned down to a much lower intensity of 1 volt, with 5 milliamperes at 700 Hz. This modality was applied over many hours in some cases and was called "electrosleep" (Pozos, Richardson, & Kaplan, 1971; Pozos, Strack, White, & Richardson, 1971). The first articles in American medical journals written on the treatment referred to it as electrosleep and CES is still called electrosleep in some areas of the world outside the U.S. (Forster, Post, & Benton, 1963). Presently, most CES devices limit the stimulus intensity to less than 1.0 milliampere at 0.5 or 100 Hz from a 9 volt source.

American scientists discovered that CES did not reliably put patients to sleep but positive effects were obtained from the modality whether the patient slept or not. At the time CES was developed as a treatment for psychiatric disorders, psychopharmaceuticals began to emerge. One example is chlorpromazine, which was often used in combination with various narcotics for the induction of sleep. It was also found to be effective in the treatment of some psychoses, even when sleep was not induced (Williams & Webb, 1966).

Over the past three decades, at least eight medical device companies have applied for and received FDA clearance to market CES devices. A bibliography by Kirsch (2002) listed 126 scientific studies of CES involving human subjects and 29 animal studies. Most of the studies were

completed in the U.S. over the past 30 years. The majority of the studies were double-blind and conducted at American universities. In total, there were 6,007 patients treated under varying research conditions, with 4,541 actually receiving CES treatment.

PROPOSED MECHANISMS OF ACTION

It is generally believed that the effects are primarily mediated through a direct action on the brain at the level of the limbic system, the reticular activating system (RAS) and/or the hypothalamus (Gibson & O'Hair, 1987; Brotman, 1989; Madden & Kirsch, 1987). The primary role of the RAS is in the regulation of electrocortical activity. The RAS, hypothalamus, and limbic system are primitive brain structures. The functions of these areas and their influence on our emotional states were originally mapped and investigated by using electrical stimulation. Electrical stimulation of the periaqueductal gray matter has been shown to activate descending inhibitory pathways from the medial brainstem to the dorsal horn of the spinal cord, in a manner similar to the actions of β-endorphins (Salar & Job, 1981; Pert, Dionne, & Ng, 1981; Ng & Douthitt, 1975). Cortical inhibition which may be augmented by CES is a factor in the Melzack-Wall Gate Control Theory (Melzack, 1975). Toriyama (1975) suggested CES produces its effects through parasympathetic autonomic nervous system dominance via stimulation of the vagus nerve. Taylor (1991) added consideration of parasympathetic dominance by other cranial nerves such as the trigeminal, facial, and glossopharyngeal. Fields, Tacke, and Savana (1975) showed electrocortical activity produced by stimulation of the trigeminal nerve is implicated in the function of the limbic region of the midbrain that mediates emotion. Substance P and enkephalin have been found in the trigeminal nucleus, and are postulated to be involved in the regulation of emotions within the limbic system (Jarzembski, Larson, & Sances, 1970). The auditory nerve might also be affected by CES, which would account for the dizziness one experiences when the current is too high. Ideally, CES electrodes are placed on the ear lobes because it is a convenient way to direct current through the midbrain and brain stem structures. Recent research indicates CES increases posterior alpha power and it increases the amplitude and symmetry of the alpha produced in raw EEG (Kennerly, 2005).

From studies of CES in monkeys, Jarzembski, Larson, and Sances (1970) measured 42% to 46% of the original current entering the brain,

with the highest concentration demonstrated in the limbic region. Rat studies by Krupisky, Burakov, and Karandashova (1991) showed a threefold increase in β-endorphin concentration after just one CES treatment. Canine research by Pozos et al. (1971) suggested CES releases dopamine in the basal ganglia and the physiological effects of CES appear to be anticholinergic and catecholamine-like in action. Richter, Zouhar, and Tatsuno (1972) found the size, location, and distributions of synaptic vesicles were all within normal limits after a series of 10, one-hour stimulations of Rhesus monkeys.

DESCRIPTION OF THE TREATMENT PROCESS

Cranial electrotherapy stimulation (CES) is a simple treatment that can be easily learned in the office or clinic and administered by patients at home. The current is applied by clip-on electrodes attached to the ear lobes. In the 1960s and early 1970s, electrodes were placed directly on the closed eyes because it was thought that the low level of current used in CES could not otherwise penetrate the cranium. This electrode placement was abandoned over 20 years ago. Research by Ferdjallah, Bostick, and Barr (1996) has shown one milliampere of current applied to the head will result in about 5 microamperes/cm^2 of CES reaching the thalamic area. The authors considered this amount of current sufficient to affect the synthesis and release of various neurotransmitters.

Cranial electrotherapy stimulation devices are generally similar in size and appearance to transcutaneous electrical nerve stimulators (TENS), but produce very different waveforms at a much lower current level. Standard milliampere current TENS devices are of questionable value and possibly dangerous when applied transcranially. FDA regulations contraindicate their use on the head. Standard protocol for CES treatment of depression was for patient use 20 minutes to one hour a day for the first three weeks, at a comfortable level of current. The treatment time may be increased as the current level is lowered. This is generally followed by treatments every other day or on an as-needed basis for as long as necessary. In each treatment, the patient attaches the electrodes, moistened with a few drops of conducting solution, to the ear lobes via ear clip electrodes, turns the current up to a comfortable or subsensory level and leaves it at that level for 20 minutes to one hour for the treatment. The patient does not need to lie down in a dark, quiet room for it to have its effect, although there is some literature suggesting the concomitant use of re-

laxed settings or adjunctive devices such as comfortable seating can enhance the effects of CES (Gilula & Markovich 1977; Gilula, Markovich, & Beal, 1977; Gilula, 1978). It is not unusual for people to work on their computers, watch television, or read during a CES treatment period.

Following CES treatment, most patients feel less anxious, less distressed, and more focused on mental tasks. Patients with positive outcomes generally sleep better and report improved concentration, increased learning abilities, enhanced recall, and a heightened state of well-being after one or a series of CES treatments. Most people can resume normal activities immediately after treatment. Some people may experience a euphoric feeling, or a state of deep relaxation that may temporarily and minimally impair their mental and/or physical abilities for the performance of potentially hazardous tasks, such as operating a motor vehicle or heavy machinery. This may last for up to several hours after treatment.

EVIDENCE FOR CES EFFICACY

The 160-plus research studies of CES revealed significant changes associated with relaxation responses, such as lowered readings on electromyograms (Forster et al., 1963; Gibson & O'Hair, 1987; Heffernan, 1995; Overcash & Siebenthall, 1989; Voris, 1995), various improvements seen in electroencephalograms (Weiss, 1973; Cox & Heath, 1975; Heffernan, 1996, 1997; Hozumi, Hori, Okawa, Hishikawa, & Sato, 1996; Itil, Gannon, Akpinar, & Hsu, 1971; Schroeder & Barr, 2001; McKenzie, Rosenthal, & Driessner, 1971; Singh, Chhina, Anand, 1971), reduced anxiety (Klawansky et al., 1995; Bianco, 1994; Gibson & O'Hair, 1987; Heffernan, 1995; Krupitsky et al., 1991, Overcash, 1999; Philip, Demotes-Mainard, Bourgeois, & Vincent, 1991; Ryan & Souheaver, 1977; Schmitt, Capo, & Boyd, 1986; Smith & Shiromoto, 1992; Voris & Good, 1996; Winick, 1999), increased peripheral temperature (an indicator of vasodilatation; Heffernan, 1995; Brotman, 1989), reductions in gastric acid output (Kotter, Henschel, Hogan, & Kalbfleisch, 1975), and reductions in blood pressure, pulse, respiration, and heart rate (Heffernan, 1995; Taylor, 1991).

CES research also found significant reductions in clinical depression (Cox & Heath, l975; Bianco, 1994; Philip et al. 1991; Rosenthal, 1972; Feighner, Brown, & Olivier, 1973; McKenzie et al., 1971; Matteson & Ivancevich 1986; Rosenthal & Wulfsohn, 1970a, 1970b; Shealy et al., 1989; Smith & O'Neill, 1975; Smith, 1999). The effectiveness of CES

for treating anxiety has been reconfirmed through meta-analyses conducted by Klawansky et al. (1995) and O'Connor, Bianco, and Nicholson (1991). Gender does not influence the outcome of CES treatment (Kirsch & Smith, 2004) and in a survey of 500 patients with anxiety, the age ranged from 3 to 89 (Kirsch & Smith, 2004).

Longitudinal data from 17 studies of CES conducted follow-up investigations from one week to two years after treatment (Kirsch, 2002). These studies encompassed various populations including depressed patients unresponsive to medications. Sixteen of the studies reported that at least some of the subjects had continued improvement after a single CES treatment, or a series of CES treatments. The other follow-up report only commented on safety (Forster et al., 1963). None of the 17 studies mentioned any enduring adverse effects.

CES RESEARCH IN DEPRESSION

There are 26 published studies of patients with depression and measured physiological and/or psychological changes after CES treatment. Twenty-one of the 26 (81%) studies reported efficacious results in the treatment of depression. The five CES studies which reported negative or indeterminate results were conducted in the 1970s with CES devices that are no longer commercially available. Three studies showed both actual treatment and sham treated groups to improve significantly, most likely because both groups were also taking medications (Levitt, James, & Flavell, 1975; Marshall & Izard, 1974; Passini, Watson, & Herder, 1976). One study reported no significant change on anxiety or depression scales, but subjective insomnia improved ($P < .05$) during active treatment (Moore, Mellor, Standage, & Strong, 1975). Only one early CES study published over 30 years ago conducted on a population of insomniacs with an average duration of symptoms of nearly 20 years did not show any significant change at all in any parameters (Frankel, Buchbinder, & Snyder, 1973).

COMPARISON DATA OF ANTIDEPRESSANTS AND CES EFFICACY

A recent study evaluated clinical trial data from the nine antidepressant medications approved by the FDA between 1985 and 2000 (Khan,

Khan, & Brown, 2002). These trials comprised 10,030 depressed patients in 52 studies and less than half (48%, 45/93) showed superiority to placebo. Kirsch, Moore, Scorboria, and Nicholls (2002) utilized the freedom of information process to obtain all the data submitted by pharmaceutical companies to the FDA in order to gain approval for their medications for the treatment of depression. The authors analyzed the data to determine the treatment effect of each medication over and above the recovery rate (equivalent to the treatment effect) of the placebo controls. Table 1 shows a summary of the mean improvement (weighted for sample size) in both medication and placebo conditions for the six antidepressant medications studied. As can be seen in this table, the medication treatment effectiveness above the placebo controls ranged from a low of 11% in fluoxetine (Prozac) to a high of 32% in paroxetine (Paxil). The average treatment effectiveness was 21.17% beyond the recovery achieved among the placebo controls. The FDA accepted all of these medications as safe, effective treatments of depression.

Table 2 shows similar results from eight CES studies submitted to the FDA as part of a 515(i) application by Electromedical Products International, Inc. to reclassify CES from class III to class II for the existing applications of depression, anxiety and insomnia. The results included 22

TABLE 1. Mean Improvement (Weighted for Sample Size) in Medication and Placebo Conditions, and Proportion of Placebo/Medication Response (Adapted from Kirsch & Moore, 2002)

Medication	Trials	N	Medication Effect	Placebo Effect	Proportion Placebo/Medication
Fluoxetine	5	1,132	8.30	7.34	.89
Paroxetine	12	1,289	9.88	6.67	.68
Sertraline	3	779	9.96	7.93	.80
Venlafaxine	6	1,148	11.54	8.38	.73
Nefazodone	8	1,428	10.71	8.87	.83
Citalopram	4	1,168	9.69	7.71	.80
			Mean placebo contribution to effect size		79%
			Mean medication treatment contribution beyond placebo		21%

CES studies from a meta-analyzes of 1,075 patients. The treatment effect size was 57±.08% improvement when corrected for sample size (Kirsch & Smith, 2004). The eight studies in Table 2 utilized a reporting format similar to those in the medication studies so that they could be compared (N weighting yielded no substantial change). These were not prospective controlled studies of the efficacy of medications and CES under identical conditions and the results need to be interpreted cautiously. Table 2 shows the mean effectiveness of CES above that of the placebo controls in the CES studies is 63%, or three times the mean effectiveness of the psychoactive medications shown in Table 1. Figure 1 summarizes the improvement over placebo effect of five antidepressants from Table 1 and of CES from the studies in Table 2.

The researchers who analyzed the medication studies noted that the FDA never asked for or measured the percentage of overall effectiveness or the percent of improvement obtained by any of the medications it evaluated and approved (Kirsch, 2002). In fact, the authors commented that compared with the placebo controls the medications only managed a 1 to 3 point drop in the depression measures used in the study and concluded, "The range was from a 3-point medication/placebo difference for venlafaxine (Effexor) to a 1-point difference for fluoxetine (Prozac),

TABLE 2. Mean Improvement in CES and Placebo Conditions, and Proportion of the CES/Placebo Response for Each Study

Author	Scale	N	CES Effect	Placebo Effect	Proportion Placebo/CES
Bianco (1994)	HDS	29	19.45	2.89	.15
Krupitsky (1991)	ZUNG	20	25.90	−5.90	.19
Smith (1975)	POMS	72	7.80	6.00	.77
Smith (1994)	POMS	21	5.05	2.73	.54
Matteson (1986)	POMS	54	4.16	1.00	.24
Rosenthal (1972b)	ZUNG	22	8.10	2.70	.33
Rosenthal (1970b)	ZUNG	12	21.10	9.00	.43
Lichtbroun (2001)	POMS	60	32.00	10.00	.31
			Mean Placebo contribution to effect size		37%
			Mean CES treatment contribution beyond placebo		63%

both of which were on the 21-item (64-point) version of the ZUNG depression scale (American Psychiatric Association, 2000, pp. 534-537). The clinical significance of these differences is questionable (Kirsch, 2002).

By comparison, Table 2 shows the drop in the measuring scales in CES treatment group above the controls group ranged from 2 to 32 with an average of 13. That suggests that CES, in those studies at least, was more than four times as effective as the most effective of the six medications analyzed and 13 times more effective than fluoxetine (Prozac) compared with placebo controls. That is an inexact comparison because different scales were used as most of the fluoxetine (Prozac) research utilized the Hamilton Depression Scale (HAM-D), three of the CES studies employed the ZUNG Depression scale which correlates well with the HAM-D scale (American Psychiatric Association, 2000; pp. 534-537; pp. 526-529).

SIDE-EFFECTS AND ADVERSE EFFECT COMPARISONS

There has been a continual search for the safest most effective medication for treating depression among the pharmaceutical companies. Today's Internet-amplified concern with adverse medication effects suggests that consumers are better informed and seeking out a variety of alternative modalities perhaps to obtain less severe side effects. There are many cautionary statements regarding side effects of medication (Physician's Desk Reference, 2004) for each of the medications listed in Table 1. The increased risk of suicidal thoughts and behavior ("suicidality") in children and adolescents caused the FDA to issue a severe "black box" warning in a Public Health Advisory for all selective serotonin reuptake inhibitors (SSRI) medications (FDA, 2004). Nearly all antidepressant medications are in some way involved with one or more of the hepatic P450 system of isoenzymes (Levy, Mattson, Meldrum, & Perucca, 2002). This type of hepatic metabolism can produce complications with various classes of medications including anticonvulsants, antibiotics, and birth control medications because one medication can induce or inhibit the metabolism of other medications. Medication interactions and/or side effects can actively interfere with treatment.

In contrast, there are no reports suggesting that CES interacts with the metabolic systems of the liver. Labeling of CES contains precautions seen in all electromedical devices against the use by pregnant women and persons with implanted devices such as cardiac pacemakers. Most CES

manufacturers suggest that a CES device not be used while operating dangerous equipment due to a calming effect. There is no literature to date indicating any danger of using CES while taking MAO (monoamine oxidase) inhibitors, drinking alcohol, or while taking any prescribed psychoactive medication. There has never been a report of "current dependence" from patients using CES or any other electromedical modality. One survey found no significant negative side effects of CES (Kirsch, 2002) and there are no known cases of a patient using a CES unit as part of a completed suicide. Patents diagnosed with a seizure have not had a seizure due to the sudden cessation of CES use (Smith, Tiberi, & Marshall, 1994). Several studies describe how adjunctive CES was used to withdraw patients from psychoactive medications and may potentiate medications early in the withdrawal process (Gomez & Mikhai, 1978; Stanley & Cazalaa, 1982).

COST-EFFECTIVENESS AND OTHER ECONOMIC COMPARISONS

Figures 2 through 5 show cost comparisons between antidepressant medications and the Alpha-Stim Stress Control System (Electromedical Products International, Inc.). These figures show the cost effectiveness of CES compared to medication. The medication cost comparisons are from a recent media article that investigated medication pricing and do not include ongoing physician visits to change prescriptions, adjust dosages, or treat the side effects of the medications (Brink, 2003). The estimates also do not account for increasing medication costs over a five-year period.

Both modalities may not receive equal status in terms of insurance reimbursement as medication is usually covered, while a CES device may or may not be covered as durable medical equipment and out-of-pocket costs to individual patients will vary according to insurance coverage. These figures show that while the initial outlay for a CES device is greater than the first few months of medication, the break even point is generally within four to six months, resulting in a substantial savings in the first year and in five-year cumulative savings.

FIGURE 1. Efficacy of medication and CES over the placebo response from data in Tables 1 and 2.

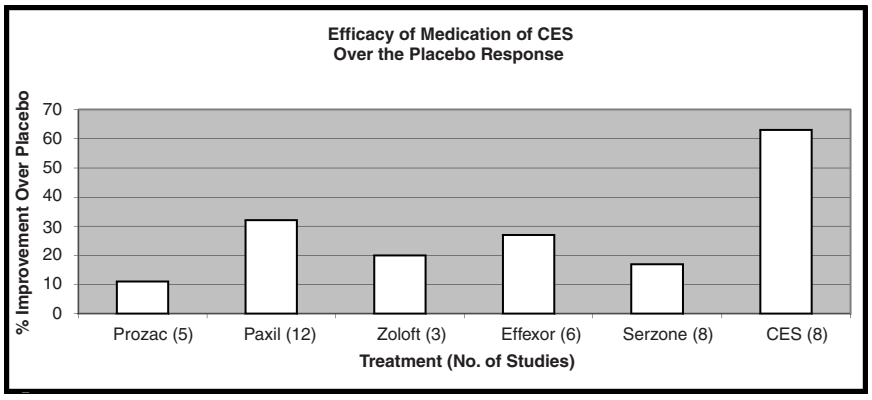


FIGURE 2. Cost comparison of medication and CES by month.

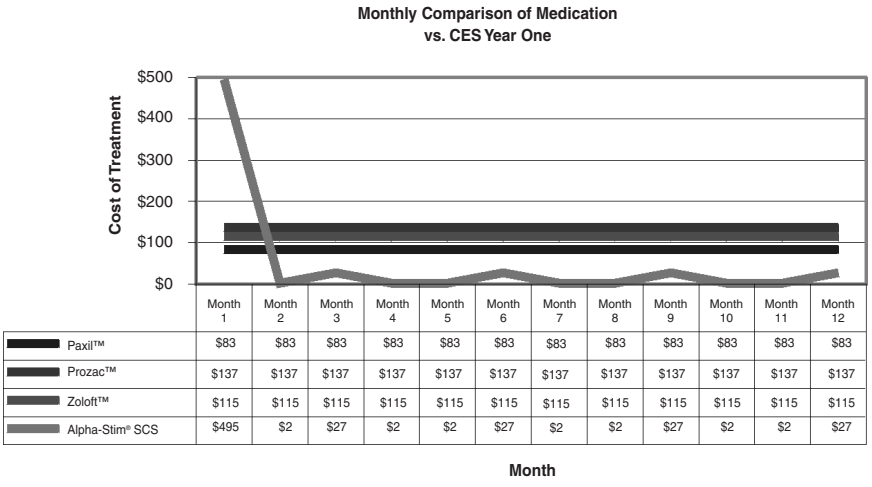
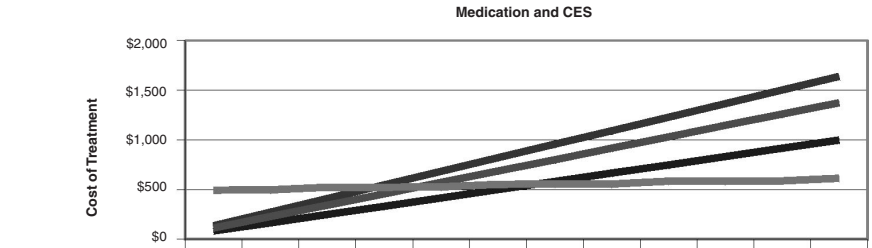


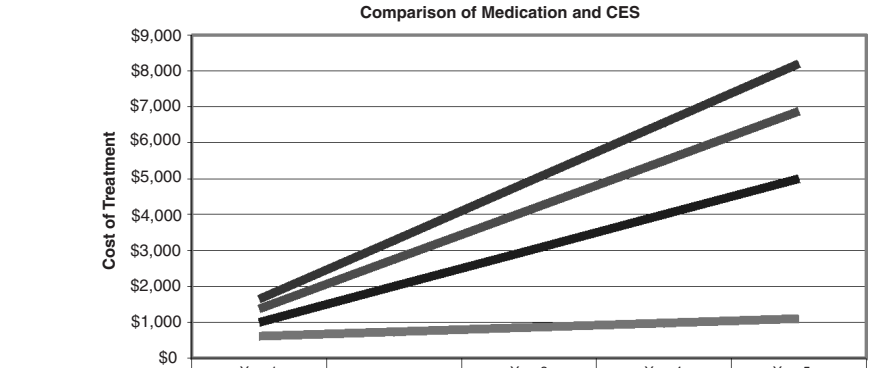
FIGURE 3. Cost comparison of medication and CES over one year.



	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Paxil™	$83	$167	$250	$333	$416	$500	$583	$666	$750	$833	$916	$999
Prozac™	$137	$273	$410	$546	$683	$820	$956	$1,093	$1,230	$1,366	$1,503	$1,639
Zoloft™	$115	$229	$344	$458	$573	$687	$802	$916	$1,031	$1,146	$1,260	$1,375
Alpha-Stim® SCS	$495	$497	$524	$525	$527	$554	$556	$557	$584	$586	$588	$614

Month

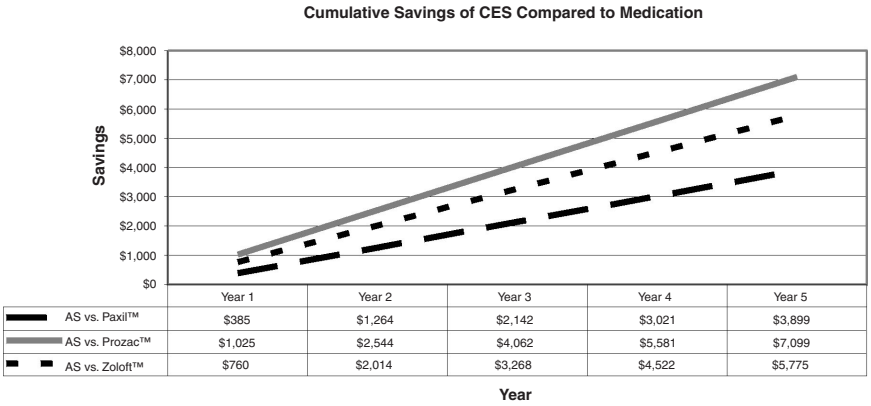
FIGURE 4. Cost comparison of medication and CES over five-year period.



	Year 1	Year 2	Year 3	Year 4	Year 5
Paxil™	$999	$1,999	$2,998	$3,998	$4,997
Prozac™	$1,639	$3,279	$4,918	$6,558	$8,197
Zoloft™	$1,375	$2,749	$4,124	$5,499	$6,874
Alpha-Stim® SCS	$614	$735	$856	$977	$1,098

Year

FIGURE 5. Cumulative savings of CES over medication during five-year period.



	Year 1	Year 2	Year 3	Year 4	Year 5
AS vs. Paxil™	$385	$1,264	$2,142	$3,021	$3,899
AS vs. Prozac™	$1,025	$2,544	$4,062	$5,581	$7,099
AS vs. Zoloft™	$760	$2,014	$3,268	$4,522	$5,775

DISCUSSION

This review cannot clearly state that one treatment is better than another due to differences in study methodologies, diagnosis and patient characteristics. A study utilizing both modalities in a randomized double blind design with similar patients would directly compare the effectiveness of the treatments. However, the data presented in this review for medication and CES provides direction to physicians and other mental health professionals when confronted with patients who fail to respond to medication or are concerned about potential adverse side effects.

A problem with the research on the efficacy of treatment for depression is that treatment in the medication studies occurred over a four- to six-week period while the treatment period in the CES studies occurred in three weeks or less. From a clinical perspective, both treatment paradigms may not be representative of real world treatment intervention. Usually, the situational or reactive depression is never treated within a six-week period of time. It is more realistic to conceptualize the treatment of most depressions within a time frame of months to years and rarely is a significant clinical depression fully resolved in such a brief treatment time as that described in the studies of treatment efficacy. It is possible there were different types of depression measured in the two groups of studies, but both used similar inclusion criteria for obtaining psychometric assessment of depression on intake.

Medication studies are easily double-blinded and placebo controlled by making pills containing a non-therapeutic substance such as sugar and not informing the researchers or subjects which pills are allegedly therapeutic. Modern studies of CES use an equally effective method. Sham CES devices are created for the placebo treatment by using non-conductive wires. To insure blinding of both researchers and subjects current is limited to a subsensory level of only 100 microamperes. To compensate for this low current the treatments need to be administered for a longer time, usually one hour.

CONCLUSIONS

As an increasing number of patients seek alternatives to the side effects of medications, CES offers a viable alternative. With proper education of health care professionals, it is easy enough to offer CES in a clinic, hospital, or doctor's office. Some patients are enthusiastic about a non-chemical treatment alternative, but there are always some patients who either find CES unacceptable or who are unable to adhere to a regular self-treatment schedule. The practitioner can educate the patient in how to apply the electrodes and in the general use of the device. Proper utilization of this electromedical modality will nearly always require short-term daily usage, and chronically depressed patients will find it cost effective to own their own CES device for use on a scheduled or as-needed basis.

The CES approach can be used to help soften the initial transitory adverse effects of pharmaceuticals, such as the "activation" and jitteriness experienced with some of the selective serotonin reuptake inhibitors (SSRIs). Other patients will be happy to find out that they do not build up a tolerance to the small battery operated device so the amount of current need not be increased, nor is there any indication that it becomes less effective over time. If CES is selected as a treatment modality, physicians who fear legal repercussions for failure to use an antidepressant at the beginning of treatment will need to present the patient with risk-benefit equations, educate themselves, and/or use CES in a place where they can observe the immediate effects. There is no typical pattern in antidepressant medication use so each patient should ideally have individualized treatment, and the same principle applies to using CES as a stand alone or add-on therapy.

Cranial electrotherapy stimulation is available to health care professionals as a safe, effective treatment for depression. For many depressed or anxious patients, this modality can be quite efficacious as either a stand

alone (i.e., as "monotherapy") or as an add-on therapy. When used as an add-on, CES can enable the physician to reduce the dosage of SSRIs or other potent antidepressant medications thereby reducing the potential for severe long-term adverse effects from the medication (Gilula & Barach, 2004).

REFERENCES

American Psychiatric Association. (2000). *Handbook of psychiatric measures*. Task Force for the Handbook of Psychiatric Measures. Washington, DC: Author.

Appel, C. P. (1972). Effect of electrosleep: Review of research. *Goteborg Psychology Report*, *2*, 1-24.

Badmaeva, V. V. (1956). Death during narcotic therapeutic sleep. *Archives Pakistan*, *18*, 104-107.

Bianco, F., Jr. (1994). The efficacy of cranial electrotherapy stimulation (CES) for the relief of anxiety and depression among polysubstance abusers in chemical dependency treatment. Unpublished doctoral dissertation, The University of Tulsa.

Brink, S. (2003). Health on the border. *US News and World Report*, *134*, 20, 54-56.

Brotman, P. (1989). Low-intensity transcranial electrostimulation improves the efficacy of thermal biofeedback and quieting reflex training in the treatment of classical migraine headache. *American Journal of Electromedicine*, *6* (5), 120-123.

Cerletti, U., & Bibi, L. (1938). L'Elettroshock. *Archives, General Neurological Psychiatric Psychoanalysis*, *19*, 266.

Cox, A., & Heath, R. G. (1975). Neurotone therapy: A preliminary report of its effect on electrical activity of forebrain structures. *Diseases of the Nervous System*, *36*, 245-247.

FDA Public Health Advisory. (2004, October 15). Suicidality in children and adolescents being treated with antidepressant medications. Retrieved March 28, 2005, from *http://www.fda.gov/cder/drug/antidepressants/SSRIPHA200410.htm*

Feighner, J. P., Brown, S. L., & Olivier, J. E. (1973). Electrosleep therapy: A controlled double-blind study. *Journal of Nervous and Mental Disorders*, *157*, 121.

Ferdjallah, M., Bostick, F. X., Jr., & Barr, R. E. (1996). Potential and current density distributions of cranial electrotherapy stimulation (CES) in a four-concentric-spheres model. *IEEE Transactions on Biomedical Engineering*, *43* (9), 939-943.

Fields, W. R., Tacke, R. B., & Savana, B. S. (1975). Pulpal anodal blockade of trigeminal field potentials elicited by tooth stimulation in the cat. *Experimental Neurology*, *47*, 229-239.

Forster, S., Post, B. S., & Benton, J. G. (1963). Preliminary observations on electrosleep. *Archives of Physical Medicine and Rehabilitation*, *44*, 481-489.

Frankel, B. L., Buchbinder, R., & Snyder, F. (1973). Ineffectiveness of electrosleep in chronic primary insomnia. *Archives of General Psychiatry*, *29*, 563-568.

Gibson, T. H., & O'Hair, D. E. (1987). Cranial application of low level transcranial electrotherapy vs. relaxation instruction in anxious patients. *American Journal of Electromedicine*, *4* (1), 18-21.

Gilula, M. F. (1978, November). Elektroson v kachestvye metoda vozgeystviya na soznaniye dlya sozdaniya aktivnoy relaksatzii [Electrosleep as a methodology for influencing consciousness to produce active relaxation]. (Translated by L. A. Zarakhovich) Presented at the P. K. Anokhin Institute of Normal Physiology, Academy of Medical Sciences, Moscow, USSR.

Gilula, M. F., & Markovich, S. E. (1977). Holistic electrosleep: An electrophysiologic equivalent of meditation or deep muscular relaxation. *Neuroelectric News*, *6* (4), 7-18.

Gilula, M. F., Markovich, S. E., & Beal, J. B. (1977, May). Electrophysiological aspects of the pain response; relating TNS to skin resistance and bioelectric impedance measurements. Paper presented at the Pain and Health Rehabilitation Institute conference, Chicago, IL.

Gilula, M. F., & Barach, P. R. (2004). Cranial electrotherapy stimulation: A safe neuromedical treatment for anxiety, depression, or insomnia. *Southern Medical Journal*, *97* (12), 1269-1270.

Gomez, E., & Mikhail, A. R. (1978). Treatment of methadone withdrawal with cerebral electrotherapy (electrosleep). *British Journal of Psychiatry*, *134*, 111-113.

Heffernan, M. (1995). The effect of a single cranial electrotherapy stimulation on multiple stress measures. *The Townsend Letter for Doctors and Patients*, *147*, 60-64.

Heffernan, M. (1996). Comparative effects of microcurrent stimulation on EEG spectrum and correlation dimension. *Integrative Physiological and Behavioral Science*, *31* (3), 202-209.

Heffernan, M. (1997). The effect of variable microcurrents on EEG spectrum and pain control. *Canadian Journal of Clinical Medicine*, *4* (10), 4-11.

Hozumi, S., Hori, H., Okawa, M., Hishikawa, Y., & Sato, K. (1996). Favorable effect of transcranial electrostimulation on behavior disorders in elderly patients with dementia: A double-blind study. *International Journal of Neuroscience*, *88*, 1-10.

Itil, T., Gannon, P., Akpinar, S., & Hsu, W. (1971). Quantitative EEG analysis of electrosleep using frequency analyzer and digital computer methods. *Electroencephalography and Clinical Neurophysiology*, *31*, 294.

Iwanovsky, A., & Dodge, C. H. (1968). Electrosleep and electroanesthesia–theory and clinical experience. *Foreign Science Bulletin*, *4* (2), 1-64.

Jarzembski, W. B., Larson, S. J., & Sances, A. (1970). Evaluation of specific cerebral impedance and cerebral current density. *Annals of the New York Academy of Sciences*, *170*, 476-490.

Kennerly, R. C. (2005). Clinical and quantitative EEG changes following cranial electrical stimulation. Doctoral dissertation, University of North Texas. In process.

Khan, A., Khan, S., & Brown, W. A. (2002). Are placebo controls necessary to test new antidepressants and anxiolytics? *International Journal of Neuropsychopharmacology*, *5* (3), 193-197.

Kirsch, D. L. (2002). *The science behind cranial electrotherapy stimulation*. Edmonton, Alberta: Medical Scope Publishing.

Kirsch, D. L., & Smith, R. B. (2004). Cranial electrotherapy stimulation for anxiety, depression, insomnia, cognitive dysfunction, and pain. In Paul Rosch (Ed.), *Bioelectromagnetic medicine* (pp. 727-740). New York: Marcel Dekker, Inc.

Kirsch, I., Moore, T. J., Scorboria, A., & Nicholls, S. S. (2002). The emperor's new drugs: An analysis of antidepressant medication data submitted to the FDA. *Pre-*

vention and Treatment, *5*, 1-11. Available online at: www.journals.apa.org/prevention/volume5/pre0050023a.html

Klawansky, S., Yeung, A., Berkey, C., Shah, N., Phan, H., & Chalmers, T. C. (1995). Meta-analysis of randomized controlled trials of cranial electrostimulation: Efficacy in treating selected psychological and physiological conditions. *Journal of Nervous and Mental Disease*, *183*, 478-485.

Kotter, G. S., Henschel, E. O., Hogan, W. J., & Kalbfleisch, J. H. (1975). Inhibition of gastric acid secretion in man by the transcranial application of low intensity pulsed current. *Gastroenterology*, *69*, 359-363.

Krupitsky, E. M., Burakov, G. B., & Karandashova, J. S. (1991). The administration of transcranial electric treatment for affective disturbances therapy in alcoholic patients. *Drug and Alcohol Dependence*, *27*, 1-6.

Levitt, E. A., James, N., & Flavell, P. (1975). A clinical trial of electrosleep therapy with a psychiatric inpatient sample. *Australia and New Zealand Journal of Psychiatry*, *9*, 287-290.

Levy, R. H., Mattson, R. H., Meldrum, B. S., & Perucca, E. (Eds.) (2002). Antiepileptic drugs (5th ed., p. 54). Philadelphia: Lippincott Williams & Wilkins.

Lichtbroun, A. S., Raicer, M. C., & Smith, R. B. (2001). The treatment of fibromyalgia with cranial electrotherapy stimulation. *Journal of Clinical Rheumatology*, *7*, 72-78.

Madden, R. E., & Kirsch, D. L. (1987). Low intensity transcranial electrostimulation improves human learning of a psychomotor task. *American Journal of Electromedicine*, *2* (2/3), 41-45.

Marshall, A. G., & Izard, C. E. (1974). Cerebral electrotherapeutic treatment of depression. *Journal of Consulting and Clinical Psychology*, *42* (1), 93-97.

Matteson, M. T., & Ivancevich, J. M. (1986). An exploratory investigation of CES as an employee stress management technique. *Journal of Health and Human Resource Administration*, *9*, 93-109.

McKenzie, R. E., Rosenthal, S. H., & Driessner, J. S. (1976). Some psychophysiologic effects of electrical transcranial stimulation (electrosleep). In N. L. Wulfsohn & A. Sances (Eds.), *The nervous system and electric currents* (pp. 163-167). New York: Plenum.

Melzack, R. (1975). Prolonged pain relief by brief, intense transcutaneous somatic stimulation. *Pain*, *1*, 373-375.

Moore, J. A., Mellor, C. S, Standage, K. F., & Strong, H. (1975). A double-blind study of electrosleep for anxiety and insomnia. *Biological Psychiatry*, *10* (1), 59-63.

National Research Council, Division of Medical Sciences (1974). *An evaluation of electroanesthesia and electrosleep*. FDA Contract 70-72, Task Order No. 20 (NTIS PB 241305), 1-54.

Ng, L. K. Y., & Douthitt, T. (1975). Modification of morphine-withdrawal syndrome in rats following transauricular electrostimulation: An experimental paradigm for auricular electroacupuncture. *Biological Psychiatry*, *10*, 575-580.

O'Connor, M. E., Bianco, F., & Nicholson, R. (1991, June). Meta-analysis of cranial electrostimulation in relation to the primary and secondary symptoms of substance withdrawal. Presented at the 12th annual meeting of the Bioelectromagnetics Society, Tulsa, OK.

Overcash, S. J. (1999). A retrospective study to determine the effect of cranial electrotherapy stimulation (CES) on patients suffering from anxiety disorders. *American Journal of Electromedicine*, *16* (1), 49-51.

Overcash, S. J., & Siebenthall, A. (1989). The effects of cranial electrotherapy stimulation and multisensory cognitive therapy on the personality and anxiety levels of substance abuse patients. *American Journal of Electromedicine*, *6* (2), 105-111.

Passini, F. G., Watson, C. G., & Herder, J. (1976). The effects of cerebral electric therapy (electrosleep) on anxiety, depression, and hostility in psychiatric patients. *Journal of Nervous and Mental Disease*, *163* (4), 263-266.

Pert, A., Dionne, R., & Ng, L. K. Y. (1981). Alterations in rat central nervous system endorphins following transauricular electroacupuncture. *Brain Research*, *224*, 83-94.

Philip, P., Demotes-Mainard, J., Bourgeois, M., & Vincent, J. D. (1991). Efficiency of transcranial electrostimulation on anxiety and insomnia symptoms during a washout period in depressed patients: A double-blind study. *Biological Psychiatry*, *29*, 451-456.

Physician's Desk Reference. (2004). (58th ed.). Montvale, NJ: Thompson PDR.

Pozos, R. S., Richardson, A. W., & Kaplan, H. M. (1971). Electroanesthesia: A proposed physiologic mechanism. In D. V. Reynolds & A. E. Sjoberg (Eds.), *Neuroelectric research* (pp. 110-113). Springfield, MO: Charles C. Thomas.

Pozos, R. S., Strack, I. E., White, R. K., & Richardson, A. W. (1971). Electrosleep versus electroconvulsive therapy. In: D. V. Reynolds & A. E. Sjoberg (Eds.), *Neuroelectic research* (pp. 221-225). Springfield, MO: Charles C. Thomas.

Richter, W. R., Zouhar, R. L., Tatsuno, J. (1972). Electron microscopy of the macaca mulatta brain after repeated applications of electric current. *Anesthesiology*, *36* (4), 374-377.

Rosenthal, S. H. (1972). Electrosleep: A double-blind clinical study. *Biological Psychiatry*, *4*, 179-185.

Rosenthal, S. H., & Wulfsohn, N. L. (1970a). Studies of electrosleep with active and simulated treatment. *Current Therapeutic Research*, *12* (3), 126-130.

Rosenthal, S. H., & Wulfsohn, N. L. (1970b). Electrosleep: A preliminary communication. *Journal of Nervous and Mental Disease*, *151*, 146-151.

Ryan, J. J., & Souheaver, G. T. (1977). The role of sleep in electrosleep therapy for anxiety. *Diseases of the Nervous System*, *38* (7), 515-517.

Salar, G., & Job, I. (1981). Effect of transcutaneous electrotherapy on CSF β-endorphin content in patients without pain problems. *Pain*, *10*, 169-172.

Schmitt, R., Capo, T., & Boyd, E. (1986). Cranial electrotherapy stimulation as a treatment for anxiety in chemically dependent persons. *Alcoholism: Clinical and Experimental Research*, *10* (2), 158-160.

Schroeder, M. J., & Barr, R. E. (2001). Quantitative analyses of the electroencephalogram during cranial electrotherapy stimulation. *Clinical Neurophysiology*, *112* (11), 2075-2083.

Shealy, C. N., Cady, R. K., Wilkie, R. G., Cox, R., Liss, S., & Clossen, W. (1989). Depression: A diagnostic, neurochemical profile and therapy with cranial electrical stimulation (CES). *Journal of Neurological and Orthopaedic Medicine and Surgery*, *10* (4), 319-321.

Singh, B., Chhina, G. S., Anand, B. K., Bopari, M. S., & Neki, J. S. (1971). Sleep and consciousness mechanism with special reference to electrosleep. *Armed Forces Medical Journal* (New Delhi), *27* (3), 292-297.

Smith, R. B. (1999). Cranial electrotherapy stimulation in the treatment of stress related cognitive dysfunction with an eighteen month follow-up. *Journal of Cognitive Rehabilitation*, *17* (6), 14-18.

Smith, R. B., & O'Neill, L. (1975). Electrosleep in the management of alcoholism. *Biological Psychiatry*, *10* (6), 675-680.

Smith, R. B., & Shiromoto, F. N. (1992). The use of cranial electrotherapy stimulation to block fear perception in phobic patients. *Current Therapeutic Research*, *51* (2), 249-253.

Smith, R. B., Tiberi, A., & Marshall, J. (1994). The use of cranial electrotherapy stimulation in the treatment of closed-head-injured patients. *Brain Injury*, *8*, 357-361.

Stanley, T. H., Cazalaa, J. A., Atinault, A., Coeytaux, R., Limoge, A., & Louville, Y. (1982). Transcutaneous cranial electrical stimulation decreases narcotic requirements during neurolept anesthesia and operation in man. *Anesthesia and Analgesia*, *61* (10), 863-866.

Taylor, D. N. (1991). Effects of cranial transcutaneous electrical nerve stimulation in normal subjects at rest and during stress. Unpublished doctoral dissertation, Brooklyn College of the City University of New York.

Toriyama, M. (1975). Ear acupuncture anesthesia. *Ear and Throat*, *47*, 497-501.

Voris, M. D. (1995). An investigation of the effectiveness of cranial electrotherapy stimulation in the treatment of anxiety disorders among outpatient psychiatric patients, impulse control parolees and pedophiles (pp. 1-19). Dallas & Corpus Christi, TX: Delos Mind/Body Institute Newsletter.

Voris, M. D., & Good, S. (1996). Treating sexual offenders using cranial electrotherapy stimulation. *Medical Scope Monthly*, *3* (11), 14-18.

Weiss, M. F. (1973). The treatment of insomnia through the use of electrosleep: An EEG study. *Journal of Nervous and Mental Disease*, *157*, 108-120.

Williams, R. L., & Webb, W. B. (1966). *Sleep therapy* (p. 20). Springfield, MO: Charles C. Thomas.

Winick, R. L. (1999). Cranial electrotherapy stimulation (CES): A safe and effective low cost means of anxiety control in dental practice. *General Dentistry*, *47* (1), 50-55.

RECEIVED: 07/12/04
REVISED: 01/13/05
ACCEPTED: 01/25/05