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ELECTRIC SLEEP-PRODUCING DEVICES: AN EVALUATION USING EEG MONITORING

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Although Kerbikov(5) first reported the use of electric sleep in the English literature in 1955, little interest was shown in this form of treatment until the appearance in this country of several foreign-made instruments. Recently there have been indications that the sleep-producing devices are effective in normal subjects, in psychiatric patients and in patients with muscle-tension syndromes(1, 2, 4). More extravagant claims without documentation have appeared in newspaper and magazine articles(7), and it has been said that the Russian space scientists were experimenting with the use of such devices for producing long periods of sleep in astronauts on interstellar flights.

Our own interest in these devices concerned two rather practical questions: 1) Are they capable of producing sleep with such facility that they would be useful in conjunction with EEG recordings as part of the clinical test? 2) Is the phenomenon of electrically induced sleep of sufficient intensity that it would be useful in the treatment of various psychiatric disorders associated with sleeplessness or disturbance of the sleep cycle?

In studying the changes in such a subtle function as the onset of sleep there is necessarily a formidable problem of controlling factors of internal and external conditioning. Consequently, in the experiments to be described our interest was essentially confined to validating the contention that sleep onset could be controlled and manipulated reliably by the apparatus at our disposal. We leave to others the formidable task of excluding factors of suggestion when the positive effects are of a low order of magnitude.

Because electroencephalographic monitoring has allowed a more precise definition of the states of alertness and of sleep, it was used to determine the existence of sleep before and after treatment. Furthermore, EEG monitoring was considered desirable as a means of detecting any possible damage resulting from the passage of electric current through the head. Apart from the possibility that damage-induced EEG slow-wave activity might occur, there was also a question as to whether electric sleep would produce disturbances of fast activity such as frequently accompany sleep initiated by hypnotic drugs.

PROCEDURE

The observations were carried out on two groups of subjects: one of normal volunteers and one of psychiatric patients. The normal subjects (Table 1) ranged in age from 24 to 55 years, and the majority of them were technicians or physicians interested in the possibility of obtaining sleep by this method. Their attitudes toward these devices ranged from mildly skeptical to openminded. Observations on the normal subjects were carried out in the morning or afternoon.

Psychiatric patients (Table 2) who were under treatment at the Rochester State Hospital formed the patient group. Observations were carried out in the morning or afternoon. The patients were told that this instrumentation was part of their diagnosis and treatment, and they were assured that this was not a form of electroshock treatment. They were not told that the device was meant to put them to sleep.

Conventional, bilateral, frontal, parietal, occipital and ear electrodes were secured by collodion and filled with electrode jelly. The appropriate eye and mastoid electrodes of the sleep machines were applied with head straps after the interpolation of sa-

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TABLE 1
Normal Subjects Participating in Evaluation of Russian Electrosleep Machine

CASE	AGE	TRIAL	CYCLES PER SECOND	VOLTAGE	SUBJECTIVE EFFECT	ELECTROENCEPHALOGRAM
1	24	1	5.5	10	Drowsy	Reduced alpha amplitude
2	37	1	10	10	Drowsy	Reduced alpha amplitude
3	28	1	5.5	12.5	Drowsy	No change
4	32	1	7.5	12.5	Alert	No change
5	32	1	5.5	10	Very drowsy; sleep (?)	No change
6	28	1	10	11	Drowsy	No record
7	33	1	7.5	15	Intermittent: drowsiness and sleep (?)	Sleep changes
8	33	1	7.5	9	Alert	No change
		2	25	10	Alert	No change
		3	14	15	Alert	No change
9	33	1	10	14	Alert	Reduced alpha amplitude
10	34	1	7.5	15	Drowsy	Reduced alpha amplitude
11	32	1	14	13	Sleep	No record
12	55	1	15	5	Alert	No record

line-soaked pads over the eyes and mastoid processes. The subject then relaxed comfortably in a quiet room with low illumination.

The EEG instrument was usually operated in the same room but was not in use during the electrosleep period. Six channel recordings were made on a Grass type IIIC (time constant 0.18 second) standard electroencephalograph before and immediately after the use of the sleep machine. Recording during the application of electrosleep was not possible due to artifact caused by the stimulus current. After the patient had become relaxed and after adjustment of eye and mastoid sleep electrodes for maximum comfort, the initial five- to ten-minute EEG record was taken. After com-

TABLE 2
Psychiatric Patients Participating in Evaluation of Japanese Electrosleep Machine: Fixed Frequency 10 Cycles Per Second; Voltage 10 to 15 Volts

CASE	PSYCHIATRIC PROBLEM	AGE	TRIAL	SUBJECTIVE EFFECT	ELECTROENCEPHALOGRAM
1	Reactive depression; hypochondriasis	57	1	Drowsy	No effect
			2	Drowsy	No effect
2	Reactive depression; insomnia	40	1	Drowsy; Sleep (?)	Sleep
			2	Alert	No effect
3	Phobic reaction; insomnia	62	1	Drowsy	Reduced alpha amplitude
			2	Sleep	Sleep
4	Anxiety	43	1	Alert	No effect
			2	Alert	No effect
5	Anxiety; depression	53	1	Increased anxiety	No effect
			2	Alert	No effect
6	Reactive depression; insomnia	37	1	Alert	No effect
			2	Alert	No effect
7	Reactive depression	21	1	Drowsy; sleep (?)	No effect
			2	Sleep	Sleep
8	Chronic anxiety; hypochondriasis	42	1	Restless	No effect
			2	Drowsy	No effect

pletion of a satisfactory EEG recording, the electrosleep session was commenced with application of the current at a low value unfelt by the subject or patient. The current was then adjusted to a strength producing mild but undisturbing flicker in the field of vision. This was continued until the subject or patient went to sleep or suggested that he did not feel drowsy and did not wish to continue longer with the procedure. Periods of electrosleep stimulation ranged from 20 to 45 minutes.

APPARATUS

Russian instrument. The Russian sleep instrument (Figure 1) was imported by the Waters Corporation, Rochester, Minn. It consisted essentially of a mains-operated vacuum-tube multivibrator circuit giving frequency control from 1.5 to 60 cycles and a voltage range (with a load of 2000 ohms) of 0 to 19 volts. A square wave output was produced. The voltage range actually employed in these observations was between 10 and 15 volts. There were four metal electrodes attached to a rubber headband. Contact with the eyelids and with skin over the mastoid processes was ensured by soaking cotton wadding in normal saline for placement under the electrode. The negative electrodes were placed anteriorly and the positive, posteriorly. The Russian instrument was used on normal subjects only, since serious accidental damage of the electronic mechanism prevented its use in the second part of the study.

FIGURE 1

Eye electrodes, head strap and connecting lead of Russian mains-operated vacuum-tube electrosleep device are in place. Bilateral mastoid electrodes are not in view.

Japanese instrument. The Japanese sleep instrument used is known as "Good Sleep" and is manufactured by the Kawasaki Electric Company (Figure 2). This instrument differs from the Russian model in that it is entirely battery-operated from a 22.5-volt dry cell. When tested on a load of 10,000 ohms, it produced an output voltage ranging from 3 to 22 volts, square pulses of 1.5 milliseconds duration during a repetition frequency of 10 cycles per second. This frequency cannot be altered on the "Good Sleep" model. After the Russian model was damaged, the Japanese sleep instrument was used to complete the study on the normal and patient subjects.

FIGURE 2

Eye electrodes, head bands and bilateral mastoid electrodes of Japanese transistorized battery-operated "Good Sleep" electrosleep device are attached to subject.

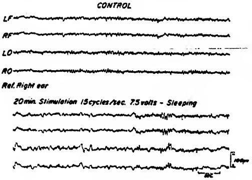
RESULTS

Normal subjects (Russian device). Eleven men ranging in age from 24 to 55 years and one woman, aged 50 years, were tested with the Russian device during single trials of one-half hour each. (One subject was tested on three successive occasions.) An attempt was made to use the frequency and voltage range which was detectable to the patient but produced no particular discomfort. The frequency usually ranged from 5 to 15 cycles per second, and the voltage ranged from 10 to 15 volts. Sensations of prickling, burning, tapping and flickering were perceived most frequently, often causing some discomfort which disappeared as the voltage was reduced. The eyes and the jaw were the common sites of discomfort. Nine of the subjects had EEG recordings before, during (with the current turned off) and after each trial.

Many subjects complained of discomfort due to the harness or to sensations produced by the electricity. Definite sleep occurred in only two subjects. This was confirmed by EEG changes as shown in Figure 3. The subject in Figure 3 showed rather sparse alpha rhythm in the control recording seen in the upper part of the tracing before the stimulus had been applied. After stimulation for 20 minutes at 15 cycles per second and 7.5 volts, the subject was noted to be sleeping. Sleep continued after removal of the stimulus as indicated in the second part of the tracing which shows slow waves and spindle activity.

FIGURE 3

EEG recordings on normal subject before and after use of Russian electrosleep device reveal changes in sleep record which show slow waves, spindles and occipital "lambdoid waves" associated with sleep presumed to have been induced artificially.



In the few subjects in which sleep occurred, it was light and intermittent. Slight drowsiness occurred in four subjects as indicated by some diminution in alpha amplitude. Most sleep or drowsiness occurred in four subjects including the subject on whom several trials were performed. No person slept for long intervals or for the duration of the complete test, and all subjects were easily aroused by external stimuli such as noise. Some persons volunteered the information that they would have slept more easily without the apparatus.

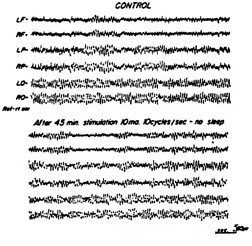
It was concluded that sleep effects from this technique, if present, were so minimal that they would be of no consequence in helping to solve the problem of sleep recordings in electroencephalography.

Normal subjects and patients (Japanese device). Three normal male subjects were tested for 40-minute test intervals before the Japanese "Good Sleep" instrument was used on patients (data not included in Table 1). As in the case of the Russian instrument, sensations consisting of vibration and flicker were usually felt around the eyes. Of these subjects, one fell into a deep sleep within 10 minutes, but the other two were restless and showed no evidence of sleep.

The instrument was then tested on eight female patients for two consecutive trials of 45 minutes each (see Table 2). The patients were told to go to sleep if they felt like it but were not told that this was a sleep machine. The psychiatric problems of these patients consisted largely of anxiety, phobias, hypochondriasis and depression, usually of the reactive type to situational problems and accompanied by insomnia. The tests were monitored by taking an EEG recording before and after each trial, and, if the subject appeared to be asleep during the trial, the electrosleep machine was turned off and EEG recordings taken.

FIGURE 4

EEG of patient having reactive anxiety and depression shows failure of 45-minute stimulation with Japanese sleep device to produce changes characteristic of sleep. Notice widespread alpha rhythm in control and post-stimulation records.



Of these eight subjects, only three showed definite sleep and then on only one of the trials. In other instances, some slight drowsiness was indicated by reduced alpha amplitude in the EEG.

An example of failure to produce sleep is shown in Figure 4. It shows a patient with an active anxiety depression whose control recording shows widespread and persistent alpha activity. In a second series of tracings taken 45 minutes after stimulation at 10 milliamps and 10 cycles, there was still widespread alpha rhythm but no sleep had occurred.

On the other hand, Figure 5 shows an example of a patient with depressive reaction who failed to sleep during the first test, but who showed moderate to deep sleep, with spindles, on a second test carried out two days later. The parameters of stimulation were the same in both instances. In other cases there was moderate restlessness or increased anxiety during the trial.

As in the case of the Russian device used on normal subjects, there was a failure to obtain a significantly greater incidence of sleep or an increased rate of onset than might have been expected in natural unassisted sleep in these subjects.

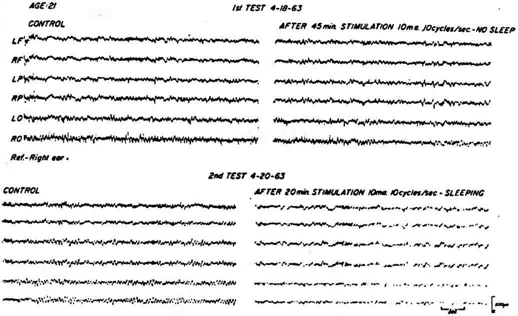
No EEG patterns attributed to cerebral injury were observed after stimulation with either the Russian or Japanese device.

COMMENT

Originally the Russians based this method of electrosleep on Pavlovian conditioning theory(1); that is, they invoked a phenomenon called "parabiosis" which is defined as a special condition of excitable tissue, a condition produced by the effect of stimuli unusual for the tissue and which represents a persistent state of changed excitability. Parabiosis is considered to be inhibitory. Pavlov postulated that three types of external stimuli give rise to inhibition; namely, the very weak, the very strong and the unusual. He believed that foreign stimuli, when repeated, led to the development of inhibitory conditions of the cerebral cortex. Prolonged stimulation leads to profound inhibition which encom-

FIGURE 5

Attempted sleep induction failed in patient having reactive depression on first test with Japanese instrument but succeeded in second test 2 days later. In lower right, note absence of alpha rhythm and presence of sleep spindles indicating EEG evidence of sleep.



passes the cerebral hemispheres and by irradiation descends to the lower brainstem centers. Hence, sleep is thought of as produced by cortical inhibition directly with secondary irradiation to subcortical centers.

In Russia, electrosleep appears to be used primarily by psychiatrists(3, 6, 7, 9). Various Americans touring the Soviet Union have described the use of electrosleep where it is given for two-hour intervals on consecutive days for approximately 15 to 20 treatments(8). Improvement is claimed for such conditions as reactive neuroses, asthenic states and psychoreactive forms of schizophrenia. Hypertension and rheumatic encephalitis (chorea) have also been benefited, but involutional melancholias are believed to be made worse.

The results reported in this investigation indicate that both Russian and Japanese sleep machines are relatively ineffectual instruments. However, as indicated previously, the design of these experiments was not such that would detect very minimal sleep-inducing properties. It is possible, for instance, that some of our subjects went to sleep more quickly than they would have done without the device. It would require extensive control observations and a much larger series of subjects and patients to settle this matter.

Apart from a practical failure to demonstrate effective sleep-inducing properties, it can indeed be doubted whether the relatively small currents produced by these instruments could have a significant neurophysiologic effect on the brainstem or cortex, as has been claimed by the Russian workers. It is more probable that the most significant part of this current travels in the skin and does not penetrate the cranium and that a more likely explanation of sleep-inducing effects, if they can be demonstrated, is the monotonous flicker sensation induced in the visual fields. Clinical experience with photic stimulation and observations originally reported by Pavlov indicate that at low intensities, and if long continued, flicker stimulation may produce a significant hypnotic effect.

SUMMARY

When tested on normal subjects and patients with various psychiatric disorders, the electric "sleep-inducing" devices have been found to be ineffective from a practical standpoint, although behavioral observations and EEG monitoring have indicated the onset of normal drowsiness and sleep patterns in some subjects and patients. No clinically evident EEG disturbances of a pattern attributed to injury have resulted from the use of the devices. There is some question whether currents of the magnitude employed would penetrate the cranium in sufficient intensity to produce the complex changes theorized in the Russian literature.

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