

# BLOOD CHANGES DURING ELECTRICALLY INDUCED SLEEP

M. I. Ul'yanov and G. P. Kolupaev

Pathophysiological Laboratory of the N. N. Burdenko Main Military Hospital, Moscow

(Presented by Active Member AMN SSSR V. N. Chernigovskii)

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Recent years have seen the introduction of electrical sleep therapy into clinical practice in the Soviet Union, induced by the action of a weak, pulsed, low-frequency current on the brain. Depending on the intensity and the extent of the sleep inhibition, in the overwhelming majority of patients a state of drowsiness or of sleep only slightly different from natural sleep is produced under these conditions.

It is of great interest to study the vegetative changes taking place in the body during electrically induced sleep. The character of the hematological changes arising in these conditions has been almost completely neglected in the Soviet literature, and even more so in the foreign literature.

## EXPERIMENTAL METHOD

Studies of the blood picture during a course of electrically induced sleep were made in the psychoneurological division of the hospital. In all, 30 observations were made on 19 patients aged from 30 to 54 years. The diagnosis of a neurasthenic syndrome was established in all the patients; in addition two suffered from hypertension and one from cerebral arteriosclerosis.

Electrical sleep was induced in a specially equipped ward, by means of the apparatus devised by the Research Institute of Experimental Surgical Apparatus and Instruments. A constant current of low power (of the order of 0.1-1.5 ma, at a frequency of 60-70 cps) caused no unpleasant sensations in the patients, who were subjected to it for about 1½ hr. The majority fell asleep, on the average, after 20 min. Sleep lasted for about an hour.

Blood for examination was taken three times from each patient: before the current was switched on, 20-30 min after the patient had been put to bed, and then approximately one hour later, when the state of drowsiness had passed into a deeper sleep, and lastly when the current had been switched off and the patient was awake. Taking the blood lasted 4-5 min and was done with as little disturbance of the patient as possible. When taking the first sample of blood we made a deeper puncture of the pulp of the finger than usual. For this purpose we used a Frank's needle with a finely pointed stylet. Immediately after taking the blood, we applied cotton wool soaked in heparin solution to the site of puncture and fixed it to

the finger with a strip of adhesive plaster. By this means we avoided the necessity for further puncture of the finger in taking the subsequent samples of blood. The depth of sleep varied from a slightly drowsy state to a profound sleep with a corresponding general relaxation of the skeletal musculature, snoring and so on. When blood was taken in deep sleep, in some cases the sleep was disturbed to some degree. The reaction of the sleeping subject to the taking of blood, in conjunction with other signs of the depth of sleep and the results of interrogation of the subjects at the end of the session, enabled the depth of sleep to be estimated.

## EXPERIMENTAL RESULTS

The results of our observations on the general condition of the patients during electrically induced sleep corresponded to those reported in the literature. The respiration as a rule became slower and deeper, the pulse was slowed by several beats per minute and the arterial pressure fell on the average from 128/81 to 117/75 mm Hg. The body temperature fell on the average by 0.2°. After the procedure the patients volunteered that they felt better, more wide-awake and tranquil.

The dynamic investigation of the blood revealed a definite relationship between the changes in certain indices. It was found in the first place that the character and degree of the hematological changes were closely connected with the function of sleep itself and with its qualitative features. This can be seen from a comparison of the results of investigation of the blood during tranquil, deep sleep (16 observations) with those of cases in which the patients were not asleep at the time of the procedure, but were in a drowsy state (14 observations). Assuming that the mean error of the method when counting the leukocytes to be  $\pm 7\%$ , and the red cells  $\pm 2.5\%$ , we found that during deeper sleep the leukocyte count progressively fell, on the average, by 25%. The fall in the leukocyte count was mainly at the expense of the neutrophils and lymphocytes (see Table and Figure). As a result of the sleep the red cell count and the hematocrit index rose, thus showing some degree of hemoconcentration.

In the patients who were in a state of light sleep at the time of the procedure, the total leukocyte count not only did not fall but, in isolated cases, even increased.

Change in Absolute Values of Hematological Indices During Electrically Induced Sleep  
(in %) (Mean results of all observations)

Level of sleep	Time of examination of blood	Red cells	Hematocrit	Leukocytes	Leukocyte formula			
					eosinophils	neutrophils	lymphocytes	monocytes
Deep	During sleep	+10	+13	-25	-33	-25	-25	-25
	When awake	-6	-2	+23	-2	+20	+56	+51
Superficial	During sleep	+5	+5	+3	-30	+1	+10	+2
	When awake	-6	+4	+9	+63	+10	+5	-7

The red cell count and hematocrit index rose, but to a lesser degree than during deep sleep.

When the subjects were awake, which usually coincided with switching the current off, in spite of the fact that not more than 5-10 minutes elapsed between the discontinuation of the electrically induced sleep and the taking of the blood, the blood picture was greatly altered. In cases of deep sleep, on waking the leukocyte count rose sharply, sometimes exceeding the initial level. The rise in the leukocyte count took place mainly on account of neutrophils and lymphocytes. In contrast to the leukocytes, the red cell count fell on the average. During the awakening of those subjects who, in the course of the session were in a state of light sleep or drowsiness, no rise in the total leukocyte count was observed. The red cell count showed a general tendency to fall.

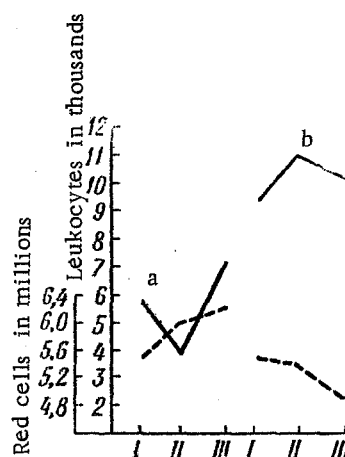
Analogous changes in the blood picture also take place during natural sleep. One of the authors of the present article [1, 2] observed that, as a result of tranquil, deep sleep, the leukocyte count in healthy persons regularly falls, on the average, by 30%. Restless, superficial natural sleep is characterized by the absence of fall of the leukocyte count and, in individual cases, even by a rise in the number of leukocytes. In this case the red cell count rises, but to a lesser degree than during deep sleep. The hematocrit index is also increased as a result of natural sleep.

All the changes mentioned above are, of course, within physiologically normal limits of variation. In deep sleep they reflect the general tendency of the hematological indices to even themselves out and to approximate themselves to normal, which ultimately bestows on sleep the character of a restorative process.

The identical nature of the hematological changes is evidence that what has been said applies equally to electrically induced sleep, which has no negative influence whatever on the blood system, but, on the contrary, causes changes analogous to those which develop during natural sleep. This affords further proof of the

close relationship between the two types of sleep and, consequently, justifies the wider use of electrically-induced sleep for clinical purposes.

The fact that the blood picture changes during electrically induced sleep, by comparison with the initial data, the converse nature of the changes on waking, and the relationship between the hematological changes and the quality of the sleep all suggest that the changes observed are connected with the function of sleep itself. We are thus correct in assuming that the changes in the blood picture during electrical sleep are due to changes in the functional state of the central nervous system. The direction and degree of the hematological changes are evidently dependent on the intensity and the extent



Changes in the total leukocyte and red cell counts during electrically induced sleep (observation on May 14, 1958). a) Deep sleep; b) state of drowsiness. Time of investigation of blood: I) Before session of electrical sleep; II) during session; III) at conclusion of session. —) leukocytes; -----) red cells.

of development of the process of inhibition and of those functional dynamic relationships which are formed under these circumstances between the cerebral cortex and the subcortical structures directly concerned with the change in the morphological composition of the peripheral blood.

#### SUMMARY

The change in the blood picture during electrically-induced sleep is associated with the function of the sleep as such. In deep sleep the number of leukocytes falls progressively at the expense of all the white blood cells. There is a rise in the number of erythrocytes and the hematocrit index. In a state of drowsiness the number of leukocytes does not drop and in individual instances it even rises; the erythrocyte count and hematocrit index are

not increased so much as in deep sleep. On awaking, the leukocytic shift assumes a character which is just the opposite of that noted during profound sleep. In general, the fluctuations in hematological indices are within physiologically normal limits and analogous to those observed in natural sleep.

#### LITERATURE CITED

1. M. I. Ul'yanov, Transactions of the Third All-Union Conference of Laboratory Physicians [in Russian] (Moscow, 1955) p. 251.
2. M. I. Ul'yanov, Byull. Éksp. Biol. Med. No. 1 (Supplement), 45 (1957).\*

\* Original Russian pagination. See C.B. Translation.