TABLE

Effect of Milking on the Erythrocyte Count and Hemoglobin Content of Cows

When experiment performed	Name of cow							
	Mol		Gazel		Zenitka		Volzhanka	
	erythrocytes, millions	Hb, %	erythrocytes, millions	Hb %	erythrocytes, millions	Hb %	erythrocytes, millions	Hb %
Before milking	7.50	50	5.91	56	6.09	50	5.92	60
During Milking	8.59	60	7.20	60	7.89	60	8.67	69
30 minutes after milking	—	—	—	—	7.08	51	7.91	66
40 minutes after milking	7.86	51	6.72	52	—	—	—	—
1 hour 30 minutes after milking	6.77	—	6.24	51	6.01	53	6.18	54
During 2nd milking	8.62	60	7.19	61	7.08	59	7.36	68
25 minutes after milking	8.04	62	7.75	61	—	—	—	—
40 minutes after milking	—	—	—	—	—	—	8.50	59
1 hour after milking	—	—	—	—	6.28	50	—	—

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BLOOD CHANGES DURING PHYSIOLOGICAL SLEEP

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Nocturnal sleep causes alterations in a number of the vegetative functions of the body. Variations in the cytomorphology of peripheral blood during sleep have been little investigated, although the study of hematological and other functional shifts taking place in the organism during sleep is necessary in the application of sleep therapy. The results of a study of the cytomorphology of peripheral blood during nocturnal physiological sleep will be reported in the present paper.

EXPERIMENTAL METHODS

The observations were carried out on 32 healthy men, aged from 21 to 23 years. In 22 of them two blood samples were taken: one before sleep, at about midnight, and one during sleep, at about 6 a.m. Four blood samples were taken from the remaining subjects: one before sleep, and three during the night, at 2-hourly

* In Russian.

intervals. The first sample was taken 30 minutes after the subject had gone to bed, but before he was asleep. Supper was taken 5-6 hours before taking the first sample. Sampling of sleeping subjects was done in such a way as to cause the least disturbance of sleep. Sleep was profound in most of the subjects, which was to be expected in view of their age and good physical condition. The sleep of 13 of the subjects was interrupted by the second sampling, while the other 19 were not fully roused by this operation. Our estimate of the depth of sleep was based chiefly on the general reaction of the subject to the sampling operation. Some indication of the depth of sleep was also derived from interrogation of the subject on the following day.

We applied the usual techniques of hematological investigation, slightly modifying the method for supravital staining of reticulocytes. A drop of blood was mixed in a paraffined watch-glass with an equal volume of physiological saline, and a small drop of a saturated alcoholic solution of brilliant cresol blue was added from a Pasteur pipette. The mixture wasmixed thoroughly, and kept in a damp chamber for 15-20 minutes, after which a smear was made. The granuloreticulo-filamentous substance of erythrocytes is stained sharply by this procedure. The smears were counterstained according to Romanovsky, for greater constrast.

EXPERIMENTAL RESULTS

A number of changes in the blood picture were found after 5-6 hours of nocturnal sleep. Taking the mean error of counting formed elements of blood as ±7% for leucocytes, ±2.5% for erythrocytes, and ±5% for thrombocytes, we observed a definite fall in leucocyte count in most of the subjects, on the average from 9,800 to 8,000per cu. mm. An analysis of the absolute hemogram values showed that this decrease involved all of the white cells, with the exception of the eosinophils, both the proportion and the absolute number of which rose in most cases.

In the majority of subjects the erythrocyte count rose, by 3-26%of the waking value. The reticulocyte count rose parallel with this, and there was a shift to the left in the reticulocyte index. Hemoglobin content did not vary beyond the limits of accuracy of the method. The color index fell noticeably in most cases.

Hematocrit readings were taken for 17 subjects, and the mean erythrocyte volume was calculated. Both of these values rose during sleep (Table 1). It appeared from the experiments in which 4 blood samples were taken that these values may vary widely during sleep.

We also found qualitative and quantitative differences in the thrombocyte fraction. There was a slight thrombocytosis, together with an increase in the number of large forms of thrombocytes, diminished specific granulosity, and increase in the size of the hyaloplasm.

TABLE 1

Effect of Sleep on the Basic Red Blood Cell Indices (mean values for 17 subjects)

When samples taken	Hemoglobin		Erythrocytes, millions	Color index	Hematocrite, %	Mean corpuscular volume, cu. μ	Reticulocytes, %
	%	g per 100 ml					
Before sleep	78.4	12.5	4.77	0.86	36	75	5.5
During sleep	78.6	12.6	5.03	0.79	40	80	8.1

It thus appears that natural night sleep causes a number of quantitative and qualitative changes, involving all of the formed elements of peripheral blood. These alterations are apparently due not only to redistribution processes, but also to changes in the functional state of the blood-forming organs, at least in the sense of release of cells into the circulation (reticulocytosis). Bearing in mind the general tendency of hematological changes, it should be noted that some form of deviation from the normal basic indices was found in a number of individuals before sleep.

Thus, 9 subjects had a leucocyte count amounting to 11,000-12,000 per cu. mm., and 13 individuals showed thrombocytopenia, of the order of 90,000-100,000 blood platelets per cu. mm. A slight erythrocytopenia was seen in some cases. The result of sleep appeared to be to bring the hematological indices closer to the normal values.

This normalization of the blood morphology is most clearly evident in profound sleep.

There are sufficient grounds for believing that these hematological alterations taking place during sleep are to a considerable extent a result of changes in the functional state of the higher levels of the central nervous system, inasmuch as the physiological basis of sleep lies in an inhibitory process arising in the cerebral cortex, and spreading to the lower levels. In connection with this, we thought it would be instructive to compare the nature of the hematological changes found in persons whose sleep was calm and profound (19 subjects) with those of a group of 13 whose sleep was superficial and uneasy. The mean values found in these two groups are presented in Table 2. It appears that the total leucocyte count in individuals whose sleep was peaceful and deep fell, as a result of a diminution in the numbers of all the species of white cells, with the exception of eosinophils, the absolute number of which rose in the great majority of cases. A fall in the neutrophil count was seen, with a decrease in the nuclear index of the neutrophil shift of 0.1 to 0.08, on the average. This fall in leucocyte count was not observed in the group of 13 whose sleep was shallow and uneasy, and in 4 of these subjects the leucocyte count even rose by 9-28%. The neutrophil count was raised, with an increase in the nuclear index of the neutrophil shift of 0.06 to 0.09, and the eosinophil count tended to fall. The erythrocyte and thrombocyte counts rose, although to a smaller extent than during profound sleep. The reticulocyte reaction was also somewhat more pronounced.

The findings for the 10 subjects whose blood was sampled 4 times during the night were in conformity with those presented above.

TABLE 2

Effect of the Type of Nocturnal Sleep on the Alterations in the Absolute Values of the Hematological Indices (as percentages of the initial values)

Type of sleep	Number of persons in group	Erythrocytes	Reticulocytes	Thrombocytes	Leucocytes	Leucocyte formula				
						eosinophiles	juvenile + mast cells	polymorphonuclear	lymphocytes	monocytes
Calm, profound	19	+7	+45	+26	—30	+34	—19	—27	—38	—33
Uneasy, shallow	13	+5	+91	+8	+1	—6	+62	+6	—12	—9

It thus appears that the changes in the cytomorphological composition of the peripheral blood taking place during sleep are closely bound up with the nervous processes which control sleep, as a definite functional state of the organism. The lowering of a number of hematological indices during profound sleep may be explained as being a consequence of irradiation of the inhbitory process to subcortical formations, which are concerned in the regulation of the composition of the blood. In persons whose sleep is shallow the excitability of the subcortical formations is enhanced, owing to the weakening of the regulating effect of the cerebral cortex, and also because of positive induction; as a result certain hematological indices increase. The absence of parallellism in the variations in esosinophil count and of other kinds of leucocytes during sleep, and the opposite direction of the variations in erythrocyte and leucocyte counts, are evidence of the complex nature of the processes taking place in the subcortical formations concerned in the regulation of blood composition.