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TIME COURSE OF THE HEART RATE AND GALVANIC SKIN REFLEX DURING NIGHT SLEEP IN PATIENTS WITH CHRONIC OCCUPATIONAL INTOXICATION BY VINYL CHLORIDE

E. A. Gnesina and A. I. Pshenitsyna

P. 39 During various stages of sleep the heart rate (HR) and galvanic skin reflex (GSR), like other vegetative functions, undergo a number of regular changes (A. M. Vein). Thus, in the superficial stages of slow-wave sleep (SS) the HR, when compared with this index during the waking stage, decreases and disordered GSR appear; in the deep stages of SS the HR increases and the GSR reach their maximum expression (L. F. Latash and coworkers; Coccagna and coworkers). With the start of fast-wave sleep (FS) the pulse becomes more frequent and arrhythmic and extrasystoles arise. Here a variable rhythm is more characteristic for the FS than an increase in the HR; the GSR are usually absent in FS. It is usually assumed that the HR and GSR reflect the state of the emotional sphere (Bloch). From this standpoint the lability of the HR and FS correlates with experiencing emotionally colored dreams in this stage, but the greatest expression of the GSR in the deep stages of SS, or specifically delta sleep (DS), in the absence of dreams, represents a certain paradox. A study of the dynamics of the GSR during sleep disclosed that the maximum number of GSR is observed in the second and third cycles of DS, decreasing toward the end of the night, where the emotional nature of the dreams usually increases (V. P. Danilin

and L. P. Latash; V. S. Rotenberg and coworkers). These data enabled L. P. Latash to express the theory that DS, and the GSR accompanying it, has a damping role as regards the frequency and emotional nature of the dreams in subsequent episodes of FS. From the standpoint of the information theories (Gaardner), sleep represents a process that is characterized by continuous psychic activity, which proceeds either consciously, as dreams in FS, or unconsciously, as dreams in SS. In the opinion of L. P. Latash, the GSR are the stigma of the unconscious activity in SS. L. P. Latash explains the practical absence of GSR in FS by the vegetative blockade mechanism, by analogy with the decrease in the muscle tone in this stage. Despite the fact that the presented data require further experimental and clinical confirmation, they can serve as a starting point when studying vegetative regulation in patients with sleep disturbances.

We studied the HR and GSR during the night sleep of patients with insomnia, which accompanies chronic occupational intoxication by vinyl chloride (VC), a volatile narcotic that is widely used at the present time by the chemical industry in the production of synthetic polymers (E. A. Gnesina and V. A. Antonyuzhenko). Clinically, the intoxication is distinguished as two stages: the early stage, which proceeds with functionally dynamic shifts in the nervous system, and the later stage, where organic symptoms of damage to the trunk sections of the brain and trunk-hypothalamic paroxysms appear (V. A. Antonyuzhenko). We studied a total of 20 patients (9 in the early stage of intoxication, and 11 in the later stage), ranging in age from 30 to 50 years, and 5 healthy persons of the same age (control). The overall clinical study included a continuous polygraphic recording of night sleep by

P. 39 the standard Rechtschaffen - Kales method, with recording of the EKG and GSR from a palmar surface by the I. R. Tarkhanov method. The stages of sleep were determined visually using the classification of
P. 40 the same authors. The HR in the episodes of the separate stages were calculated from the average indices of the number of R—R intervals on the EKG in three 20-second sections taken from the portions of the recording without motive artifacts. The difference between the maximum and minimum values of the HR in this stage was taken as the lability index in the FS. The absolute number and frequency of the GSR per minute in all of the episodes of the various stages of sleep were calculated during the entire polygraphic recording. The obtained data were processed statistically using the Wilcoxon - Mann - Whitney nonparametric criterion (E. V. Gubler and A. A. Genkin). The dynamics of the GSR and HR were compared with the answers of the patients regarding dreams during the time of the experimental night.

The absolute number of GSR varied widely for the persons in the control group, and on the average was 1578. The frequency of the GSR in the first cycle predominated in the superficial stages of the SS (I, II), decreased toward the end of the cycle in the DS, and even more so in the SS; on the whole, the frequency of the GSR in the first cycle was lower than in the subsequent 3 - 4 cycles (Fig. 1). Beginning with the second cycle, a definite regularity appeared in the distribution of the GSR: the lowest indices were observed in the superficial stages of the SS of all of the cycles, the highest were observed in DS, while the transition from DS to FS was accompanied by a sharp drop in the frequency of the GSR. The frequency of the GSR in DS continued to

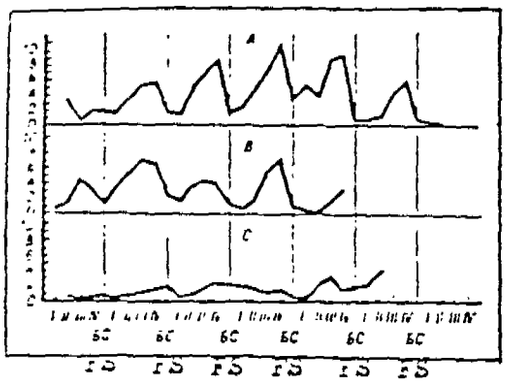

Fig. 1. Distribution of GSR during night sleep.

Ordinate) frequency (number per minute) of GSR; abscissa) stage of slow-wave sleep (SS); FS) phase of fast sleep; A) line connecting average indices of GSR frequency in SS (I, II, III, and IV stages) and FS for persons in control group; B) the same for the patients in the early stage of chronic occupational intoxication by vinyl chloride; C) in the later stage of intoxication.

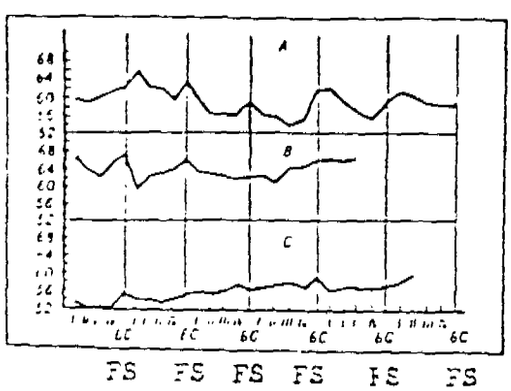

Fig. 2. Dynamics of HR during night sleep.

Ordinate) HR (number of R—R intervals on EKG per minute; abscissa) the same as in Fig. 1; A) line connecting average indices of HR in SS (I, II, III, and IV stages) and FS for persons in control group; B) the same for patients in early stage of chronic occupational intoxication by vinyl chloride; C) in the later stage of intoxication.

increase from the second to the fourth cycle, and then it decreased, although the character of the distribution of the GSR was retained in the 5th and 6th cycles (see Fig. 1).

The HR for the awake persons in the control group immediately before placing the electrodes was 68 per minute. The transition to sleep was accompanied by a decrease in the HR. In the first cycle the lowest HR (59) was observed in the superficial stages (I and II) of SS, while in the deep stages of SS and FS the HR increased somewhat. Like the GSR, the dynamics of the HR in the first cycle differed from the dynamics of the HR in the subsequent cycles (Fig. 2). Beginning with the second cycle a high HR was observed in stage I of SS; the HR was lower in stages II - IV of SS. The frequency of the rhythm of the heart contractions increased again on going to FS, while extrasystoles appeared in the individual persons. The lability in FS increased toward the end of night up to 10.3 number/sec, and on the average reaching 9.8 number/sec. The range in the fluctuations of the HR, the difference between the extremes during the time of recording all of the HR values, was 12.0. After waking, when compared with being awake before sleep, the HR was observed to drop to 10.5 number/sec.

The results obtained in studying the healthy persons testified to the complex multistep reorganization of the vegetative regulation during sleep, with a variable coupling of the vagal (decrease in HR and GSR) and sympathicotonic (increase in HR and GSR) effects, and depicting the reciprocal relationship that exists between the DS and GSR when night starts and the constantly increasing decrease in the frequency and emotional nature of the dreams in the premorning cycles.

For the patients in the early stage of intoxication the total number of GSR was 1076, which is somewhat lower than for the persons
P. 41 in the control group, but the differences in the distribution of the GSR did not reach the confidence level ($P > 0.05$). The GSR distribution by cycles was similar to the distribution in the control group: minimum values in FS, and maximum values in DS. The highest GSR frequency was reached in the DS of the fourth cycle. The difference in the GSR distribution from the control group was related to the structure characteristics of sleep, by a reduction in its duration and a decrease in the number of cycles down to 4, and less frequently to 5. Judging by the GSR distribution (see Fig. 1), cycles were absent in which a decrease in the frequency of the GSR in DS and the arising of FS, accompanied by remembered emotional dreams, could be expected.

For the patients in the early stage of intoxication the HR prior to sleep was higher (70) than for the persons in the control group. The same as in the control group, a retardation of the HR was observed on going to sleep, but it began more gradually (see Fig. 2). In contrast to the control group, a tendency for reduction in the HR in the 4th and 5th cycles was not observed. When compared with the control group, the lability in FS (4.2 number/sec) was lower ($P < 0.05$). The differences between the HR before and after sleep (5.0 number/sec; $P < 0.01$) and the range in the fluctuations of the HR (8 number/sec; $P < 0.01$) were smaller than for the healthy persons.

Dreams were mentioned by 6 of the 9 patients in the early stage of intoxication. However, 3 of them after waking could not remember the contents of the dreams. The description of the dreams was fragmentary, included details of the scene, but not the entire picture. From the

standpoint of the clearness and remembrance of the dreams as a reciprcal function of DS saturation the GSR is high, while the depiction of the GSR in DS, which did not decrease up to the end of sleep, correlated with some impoverishment of the dream activity for the patients in the early stage of intoxication. It is obvious that a more uniform distribution of the HR, and a decrease in the lability of the HR in FS when compared with the control group, both reflected a decrease in the emotional nature of the dreams experienced by these patients during sleep.

For the patients in the later stage of intoxication the absolute number of GSR in the polygrams was lower than for the control group and for the patients in the early stage, and on the average was 459.5 ($P < 0.05$). A definite distribution of the GSR by stages within the cycles was absent; when compared with the control group the GSR frequency in SS was lower ($P < 0.01$), and higher in SS ($P < 0.05$); a tendency to establish a GSR maximum in the DS of the third and fourth cycles, like for the patients in the early stage, was not observed (see Fig. 1).

The starting HR prior to sleep for the patients in the later stage of intoxication was reduced to 58. When compared with the control group, a reliable decrease was observed in the range of the HR fluctuations (5.3 number/sec; $P < 0.05$) and the lability of the HR in FS (3 number/sec; $P < 0.01$). Here the HR, after an initial retardation in the first cycle, tended to show a steady increase in subsequent cycles. To sum up, the HR after awaking exceeded the HR before sleep by 7.2 number/sec ($P < 0.01$).

The dream activity for the patients in the later stage of intoxication was characterized by a scantiness, and the dreams were rare (for 4 of 11 patients) and simple in content. It must be assumed that in the later stage of intoxication one of the factors, present in the general

41 pathogenetic chain with an impoverishment of the dream activity, can be the low and monotonic, not differentiated by stages and cycles, depiction of the HR and GSR.

As a result, an analysis of the distribution of the GSR and HR during sleep for patients with chronic occupational intoxication by VC disclosed characteristic differences in the distribution of the vegetative indices in different stages of intoxication.

Based on our previously obtained data, the insomnia syndrome, arising during chronic occupational intoxication by VC, is related to an enhancement of the physical activation shifts in the early stage of intoxication and a predominance of the tonic activation in the later stage (E. A. Gnesina and V. A. Antonyuzhenko). This gives reason to believe that the change in dream activity and the picture of the vegetative ornamentation of sleep for the patients studied by us reflects a

P. 42 nonoptimum course of the information processes and disturbance of the vegetative regulation on a background of the activation shifts.

The results of our studies permit an approach to understanding the pathogenesis of the emotional and vegetative disturbances that accompany the insomnia syndrome during intoxication by VC, and also by other narcotic poisons, and, in addition, they give basis for solving the problem of the pathogenetically based therapy of these disturbances.

SUMMARY

1. A change in the number and distribution of the HR and GSR during sleep is observed in the insomnia syndrome that accompanies chronic occupational intoxication by VC.

2. In the early stage of intoxication the differences in depicting

42 the GSR in the DS episodes during the night are counterbalanced; the lability of the HR and FS is reduced.

3. In the later stage of intoxication the number of GSR decreases and a definite distribution of the GSR by phases and cycles disappears; the lability of the HR in FS is low, and the differences in the HR in SS and FS are smoothed out.

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