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Sleep Studies of Summer Members in Antarctica: Cardiovascular Responses

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Abstract

Six summer and four wintering members of Indian Antarctic expedition underwent heart rate (HR) and galvanic skin resistance (GSR) recordings during sleep. A total of three night recordings were performed on each subject at three different sessions during the period of four months of austral summer. As the subjects slept in the laboratory, they showed disturbance in sleep pattern. In all the subjects during summer, the sleep bradycardia increased with absence of periodic fluctuations of HR indicative of temporary loss of REM sleep. The subjects tended to show increase in slow wave sleep during summer. The winterover subjects showed disturbed sleep variables which was not related to HR and GSR changes during sleep. However, due to the limited number of subjects no affirmative answer could be made to prove relationship of sleep disturbance with prolonged daylight or psychological reaction with prolonged isolation.

Introduction

Stable temporal organization of human physiology and psychology is achieved through synchronization of underlying circadian pacemakers to a 24 h period primarily by appropriate light - dark cycle. The polar region provides an excellent laboratory for studying the human circadian rhythms. There is evidence that Antarctic expedition members frequently complain of "insomnia", and this has been linked to polar nights and homesickness (Bogolovaskii,1974 and Natani et al.,1970). The Antarctic sleep studies have been conducted by various workers like Bogolovaskii (1974), Gander et al.(1991) and Natani et al.(1970), particularly on subjects overwintering, indicating sleep disruption, suppression of delta sleep and diminution of paradoxical sleep during polar night by polysomnographic recordings (Joren et al.,1970 and Buguetetal.,1987).

The cardiovascular modifications take place during the whole of sleep-wake cycle and have multi-disciplinary importance. These modifications provide evidence for qualitative changes in the central mechanisms which control physiological functions between awake and sleep states. This evidence shows the need to perform experiments during sleep if one wants to define fully the haemodynamic profile during everyday life.

The cardiovascular regulations during sleep have been studied under variety of laboratory conditions (Coote,1982, Mancia and Zanchetti,1980 and Parmeggiani,1982). This study has been extended in Antarctic field conditions during XI Indian expedition to Antarctica to examine cardiovascular regulation during prolonged summer days by monitoring the heart rate (HR) and galvanic skin resistance (GSR) throughout the sleep phase. This knowledge is clearly needed to explain the adaptations ofpmembers to Antarctic environment.

Material and Methods

The study took place at the Indian Antarctic station "Maitri" during austral summer period (Dec, 1991 to March, 1992) on summer members of XI expedition team. Out of 50 summer members, six volunteers (mean age 35 years) were chosen for their usually good sleeping habits. A total of three night recordings were performed on each subject. Due to logistic constraints, selection of subjects could be made only on board ship in December, 1991. The first recording session was in the ship, the second was after reaching Antarctica - at Maitri station after 8 weeks of stay i.e. in February, 1992 and third and final session was during the return journey on board ship. In four winterover subjects (mean age 29.5 years) one sleep session recording was conducted during return journey to determine whether the alteration in sleep pattern is related to prolonged daylight or to prolonged isolation.

Each recording session of one subject was for one night. The subject slept in the bed of the study room which was in the medical room of the ship, and inside the laboratory at Maitri. A two channel polygraph (Biorite manufactured by Medicare systems, India) was placed away from the subject with a partition in between subject and the machine. The recording consisted of ECG (Standard Limb lead II) and galvanic skin resistance. Two basal records were obtained at half hourly intervals from 2130 hrs onward when the subject was put on the bed. The subjects were instructed to have their dinner by 2030 hrs and abstain from consumption of alcohol for that evening. On an average, the lights were switched off at 2230 hrs and the waking time was 0600 hrs ±15 min. The night watch was kept by the scientist monitoring the ECG. Hourly ECG and GSR records were obtained.The HR calculation was done by determining the R-R interval.

GSR was recorded by measuring the electrical resistance with a model ME digital multimeter (MECO, India). Silver chloride button electrodes were fixed with velcro straps around the distal phalanx of the index and middle fingers of the left hand. The hand was cleaned properly by applying soap to remove the grease before placing the electrodes. The data was statistically analysed with analysis of variance (ANOVA) for repeated measures between each time interval and between the basal presleep records.

Results

Our sleep *HR* recordings indicate that there is a gradual bradycardia with onset of sleep. Under pre-Antarctic condition there are bursts of increased HR which follow a cycle of 2 to 2 1/2 hrs. The GSR shows a gradual increase during sleep.

The HR changes during the first sleep session showed a gradual slowing till 0430 hrs, when it was lowest. During awake phase the subjects had a mean HR 74±9.98 per minute which persisted in the same level till they were awake. By next two hours of sleep the heart rate significantly (p) reduced with fluctuations for next two hours. The lowest heart rate achieved was at 0430 hrs in the early morning (59.83±7.84/min). Thereafter HR rose significantly at 0530 and 0630 hrs to an average of 61.33±7.8/min and 65±8.98/min respectively (Fig 1). The change in pattern of sleep HR was observed during second recording session in Antarctica after subjects had 8 weeks of stay through prolonged day. The awake HR did not show any significant change but the sleep bradycardia was more. The initial HR of 73.71±5.0/min significantly reduced to 69.16±7.12/min at 2330 hrs. The lowest HR of 59±4.4/min was achieved comparatively earlier at 0230 hrs against lowest HR recorded at 0430 hrs in the first session. Then for the next two hours there was no significant change in HR even when the subjects were awake. The reduction of HR at 0230 hrs is statistically significant (p).

A change in the sleep HR pattern was noted in the post- Antarctic recording session when compared with the recordings of earlier two sessions. Apart from the fact that they were disturbed, there were erratic fluctuations in HR during sleep. To start with, the heart rate was 76.66±7.6/min. This was significantly high compared to the values in two previous sessions 74±9.9 and 73±4.8/min, respectively.The HR showed a fall initially lasting for next two hours (62±5.4 and 61.16±4.7) followed by a slight increase in the third hour and again a

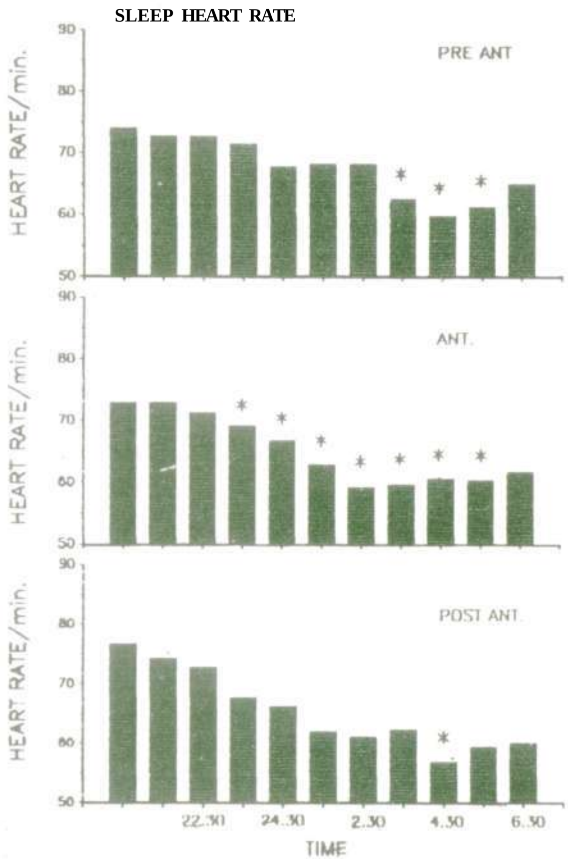

Fig 1 : *One hourly heart rate recorded during sleep from 2130 hrs to 0600 hrs in six subjects. Pre-Antarctic (PRE ANT), at Antarctica (ANT) and on return (POST ANT) phase.*
** = P<0.01 (mean±SD)*

significant fall (56.83±5.3) at 0430 hrs. Thus the maximum fall in HR coincided with pre-Antarctic record (Fig 1).

Similar study in a winterover group (n=4) showed an erratic pattern. Although the maximum bradycardia was recorded at 0430 hrs, the fall in HR was less than that of summer members (Fig 3).

Galvanic skin resistance

The time course of GSR changes throughout the sleep is shown in Fig 2. In all subjects the GSR in the first recording showed a gradual increase till 0430 hrs*. The basal GSR of 907 kohms increased to 2114 kohms and then reduced to 1413 kohms after 0430 hrs.

The GSR studied during the second session showed overall low values. Also, the rise during sleep diminished in comparison to first session. The basal GSR was significantly lower (p <0.05 679±300.8 kohms) as compared to the first session (907.8±364 kohms). The increase in GSR also took place earlier, at 2200 hrs (Fig 2).

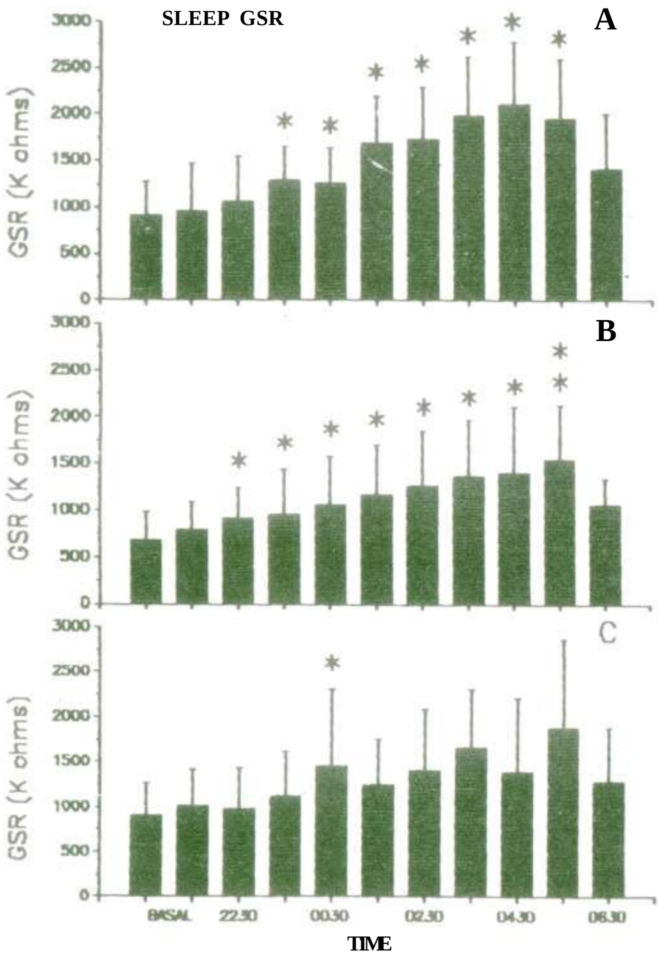

Fig 2 : Galvanic skin resistance (GSR) during sleep of six subjects recorded in pre Antarctic (A), during stay in Antarctica (B) and on return voyage (C) phases.

** = P<0.01 (mean ± SD)*

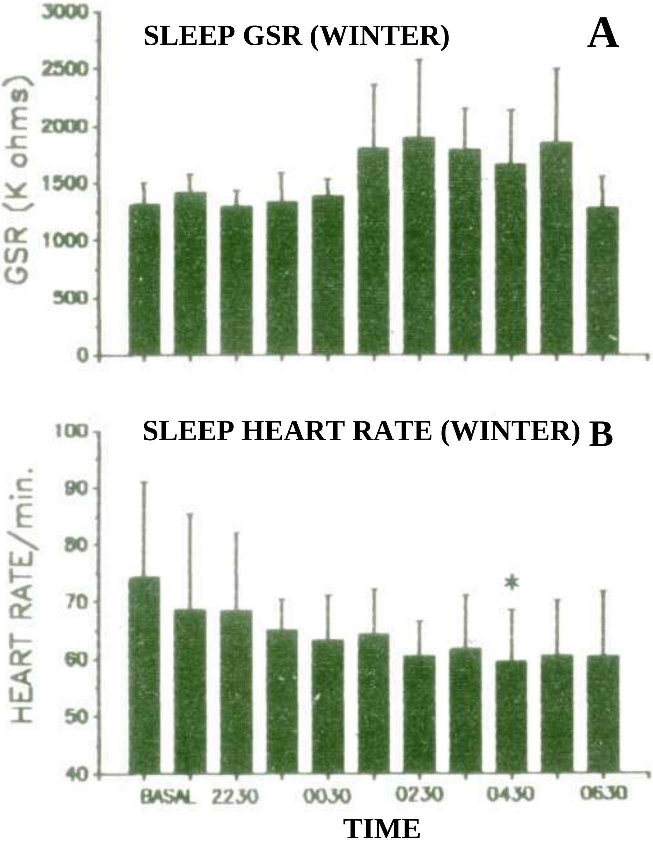

*Fig 3 : Galvanic skin resistance (GSR) and heart rate (mean ±SD) recorded during sleep of four winterover persons during their return voyage from Antarctica. * = P<0.01.*

The GSR values indicated multiple fluctuations throughout the night sleep in the third session. The initial GSR of 953.5 kohms increased to 1458 (0030 hrs), 1664 kohms at 0130 hrs and peaked to 1886 kohms at 0530 hrs.

The GSR in the wintering personnel (n=4) showed similar multiple fluctuations with peaks at 0230 hrs and 0530 hrs (Fig 3). The initial value of GSR was raised (1311 kohms) to start with in these subjects (Fig 3).

Discussion

The sleep study performed on 10 volunteers over a period of four months during Antarctic summer is one of the first field studies in Antarctica to record the sleep cardiovascular responses. According to studies of Coote (1982), during synchronised (non-REM) sleep blood pressure, cardiac output, total

peripheral resistance and heart rate have been found to decrease, and during REM (desynchronised) sleep stage there is short lasting marked increase in sympathetic activity (Coote, 1982). This study was, therefore, conducted, taking cardiovascular criteria to identify the sleep stages. Due to limited facilities at Antarctica, sleep EEG could not be recorded to study the sleep pattern. The REM sleep disappeared temporarily in present subjects after 8 weeks of stay only to reappear during the return voyage. The REM period as indicated by short lasting increase in heart rate was recorded only in first session. The winter persons continued to show a longer period of non-REM. However, the hourly heart rate recording is not conclusive to determine the exact time of non-REM and REM sleep but it approximates with normal ranges (Clausen et al.,1974). It will be worthwhile to obtain continuous recording in future on a polygraph with a paper speed of 5 mm/sec. The higher drop in HR and GSR during Antarctic summer indicate more of slow wave sleep (Mancia and Zanchetti,1980). Absence of fluctuation in HR during summer sleep in Antarctica indirectly points to an increase in deep slow wave sleep (Lacombe et al.,1988).

The increase in GSR may be due to decrease in peripheral vascular resistance and decreased sweat gland activity which is unrelated to cold environmental temperature (Coote,l982). The significant increase in GSR indicates peripheral vasodilation characteristic of slow wave sleep (Gellborn,1967 and Parmeggiani,1982).

Change in the pattern of GSR increase with multiple fluctuations during sleep phase of winterover subjects in Antarctica fails to prove any relation with HR changes in sleep. This may be attributed to emotional and psychological reactions as the subjects were in isolation for 14months.

In conclusion, the summer members living in field conditions during expedition show some degree of sleep disturbance in the form of reduced REM phase which was linked with the cardiovascular recordings and this can be attributed to prolonged daylight. However, this relationship cannot be affirmed on the basis of our studies which were earned out in three different sleeping laboratory set-ups and on small number of subjects. The interrupted HR recording further adds to the variability in our study. We, therefore, need to confirm these findings by recording all parameters before and after the expedition in a well constructed sleep laboratory, by continuously monitoring the cardiovascular parameters.

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