Revista da Escola de Enfermagem da USP
ISSN: 0080-6234
reeusp@usp.br
Universidade de São Paulo
Brasil

The architecture of day sleeping and the sleep-wake cycle in nurses in their working shifts*

ARQUITETURA DO SONO DIURNO E CICLO VIGÍLIA-SONO EM ENFERMEIROS NOS TURNOS DE TRABALHO

LA ARQUITECTURA DEL SUEÑO DIURNO Y DEL CICLO DE VIGILIA EN LOS ENFERMEROS DURANTE LOS TURNOS DE TRABAJO

Milva Maria Figueiredo de Martino[1]

ABSTRACT

This study aimed to observe the architecture of day sleeping after a night of work, and the characteristics of the sleep-wake cycle in nurses working in different shifts. The study was performed at the Hospital de Clínicas da Faculdade de Medicina de Ribeirão Preto, USP. The sleep-wake cycle was evaluated through the sleep diary in (n=36) subjects, with an average age of 30 years. Of these, only five performed polysomnography measurements at the Sleep Laboratory. Subjects presented better night sleep and the polysomnography recordings identified short periods of day sleep with incomplete cycles. Subjects woke up many times, which characterizes poor sleep efficiency.

KEY WORDS

Chronobiology.
Sleep.
Shift work.
Nurses.

RESUMO

Este estudo teve como objetivos verificar a arquitetura do sono diurno após o trabalho noturno, e as características do ciclo vigília-sono em enfermeiras de diferentes turnos. Foi realizado no Hospital de Clínicas da Faculdade de Medicina de Ribeirão Preto, USP. Através do diário de sono avaliou-se o ciclo vigília-sono em (n=36) sujeitos, com média de idade de 30. Destes apenas cinco fizeram medidas da polissonografia no Laboratório de Sono. Apresentaram qualidade de sono noturno melhor, os registros polissonográficos identificaram sono diurno com períodos curtos e incompletos quanto aos ciclos, muitos despertares que caracterizaram pouca eficácia de sono.

DESCRITORES

Cronobiologia.
Sono.
Trabalho em turnos.
Enfermeiras.

RESUMEN

Este estudio tuvo como objetivos verificar la arquitectura del sueño diurno después del trabajo nocturno, y las características del ciclo de vigilia-sueño en enfermeras de diferentes turnos. El estudio fue realizado en el Hospital de Clínicas de la Facultad de Medicina en la ciudad de Ribeirao Preto, USP. A través del diario de sueño se evaluó el ciclo de vigilia-sueño en 36 sujetos, que tuvieron un promedio de edad de 30 años. Entre estos, apenas cinco realizaron medidas de la polisonografía en el Laboratorio de Sueño; los que presentaron una mejoría en la calidad de sueño nocturno; los registros polisonográficos en lo que se refiere a los ciclos, identificaron un sueño diurno con períodos cortos e incompletos; también se constató muchos despertares lo que caracteriza la poca eficacia de sueño.

DESCRIPTORES

Cronobiología.
Sueño.
Trabajo por turnos.
Enfermeras.

* Extracted from the Free Lecturer dissertation: "Estudo da arquitetura do sono e ciclo vigília sono em enfermeiros de diferentes turnos de trabalho", Department of Nursing at School of Medical Sciences, State University of Campinas, 2002. [1] Associate Professor of the Department of Nursing at School of Medical Sciences, State University of Campinas. Campinas. SP, Brazil.milva@unicamp.br

Received: 06/25/2007
Approved: 06/06/2008

Portuguese / English: www.scielo.br/reeusp

INTRODUCTION

Sleep, one of the physiological states that are characteristic of people, has two distinct behavioral patterns, and differs from wake by the readily-reversible loss of responsiveness to environmental events[(1)]. Both oneiric states are characterized by profound, although different, alterations of functional brain patterns. In the first, named slow-wave sleep (SWS), the brain waves have low frequencies and high amplitude (synchronous activity) in comparison with the wake state.

Sleep architecture herein means the distribution of the phases in relation to time, and the temporal structure of the sleep-wake cycle (SWC), the moment when sleep and wake occur within a spectrum of frequencies that make up these shifts. Once the structure and architecture are established, it is possible to detect and quantify the alterations that may occur[(2)].

Repercussions of the sleep-wake cycle in nurses

Several studies on the sleep-wake cycle, comparing it with other variables, identified similar sleep patterns among nurses and the nursing team[(3-5)].

The authors verified that the repercussions of the sleep-wake cycle in the work shifts of nurses working in different schedules resulted in physiological changes, especially when interfering in the sleep necessities, causing changes in the circadian cycle[(2-3)].

Chronobiologic studies of the sleep-wake cycle were preceded by rigorous studies of sleep phenomenology and physiology. The sleep-wake cycle is an important biological marker for the human species, with a particular ability to establish social norms. The lack of sleep entails not only social consequences, due to maladjustments to cultural standards, but could also bring about other serious physiological and emotional consequences[(5)].

Chronobiology added a new dimension to classic studies about the sleep-wake cycle, as it shows that some of the phenomenological characteristics and all incidence levels and average duration of states and stages or phases should be defined according to the moment of the circadian cycle they are studied in[(6)].

In human beings, individual differences are noteworthy regarding the allocation of the 24 hours of the day for the periods of sleep and wake. The human population can be divided in three basic types. The first, individuals named *morning people*, who rise early in the day, between 5:00 and 7:00 AM, are perfectly capable of working at this time, and at a very good level of alertness. Overall, these are individuals who prefer to go to bed earlier, around 11:00 PM. These individuals are characterized by early phases of a large part of their endogenous rhythms when compared with the general population[(5)].

Another example refers to individuals who naturally tend to awaken late, between 12:00 AM and 2 PM, especially during their vacations or weekends. If they can choose their sleeping hours, they prefer to go to bed between 2:00 and 3:00 AM. For these individuals, the subjective feeling of alertness, as well as their performance, is more marked during the afternoon or night time. The maximum values of their endogenous rhythms are late when compared with the general population. They are usually called *night people*. Finally, there are those individuals who are indifferent to awaking earlier or later, appropriately named *the indifferent type*. These three types respond differently to sleep manipulation, such as deprivation for example[(6)].

Two other types can be defined, characterized by sleep hours. These are called the short-sleepers, individuals who need 5h30 to 6 hours of sleep at most. Those who biologically need between 8h30 to 9 hours of sleep, named long-sleepers. These types have a different distribution of the several sleep stages during the night[(5-7)].

> The sleep-wake cycle is an important biological marker for the human species, with a particular ability to establish social norms.

Disorders in the sleep-wake cycle pattern can be explained by alterations in the circadian rhythm patterns. In human beings, in particular, in addition to the light cycle, cyclical factors that result from the social organization of work and leisure act as powerful *Zeitgeber*[(a)]. Some transitory sleep and wake disorders could be associated to sudden changes in the *Zeitbeger* exogenous synchronizers, such as a transmeridian trip, commonly named *jet lag*; or a transitory change of the work shifts (night and occasional shifts), or even when daylight saving time is activated or deactivated, leading to a state named transitory internal desynchronization, where the phase relation between the many circadian rhythms is altered, transitorily disrupting the internal temporal order[(5)].

These situations are characterized by sleepiness during the day, insomnia with difficulties to fall asleep at the new social *Zeitgeber* time, occasional gastrointestinal disorders, asthenia or feelings of hunger at inadequate times and reduced performance on several physical and mental tasks. When these phase changes of the environmental *Zeitgebers* occur in a systematic way, like what happens in situations of regular night shift work, work in alternating shifts and constant transmeridional flights for crews of international airplanes, the symptoms aggravate to the extent that the afflicted population is at risk of several diseases, from a medical perspective. These situations characterize exogenously produced alterations of the circadian rhythms[(5-6)].

[(a)]Zeitgeber – German word whose meaning is *time marker*.

Sleep plays a fundamental part in replenishing energy for the next day, metabolic balance and physical and mental development, while the lack of sleep causes irritability, lack of memory and of concentration[8]. Sleep deprivation caused by night shift work leads to physical and mental fatigue, apathy, negligence and insensitiveness. As an example, human beings who are totally deprived of sleep recover a good amount of deep sleep after the first night of sleep, and they only recover lost desynchronized sleep in the second night of sleep after deprivation. If the individuals attempt to sleep during the day, the sleep structure does not allow them to recover the deep periods of sleep and the desynchronization of the lost periods[5].

Another author found that one night of sleep deprivation would certainly cause symptoms like insomnia and excessive sleepiness during the day. In addition to these symptoms, the night shift worker is at higher risk of cardiovascular and gastrointestinal disorders, among others[9].

The night shift nurses sleep during the morning. Since this sleep pattern is characterized by disturbances in both internal structure and length, which is shorter than night sleep, it is also named polyphasic, since it has fractioned periods of sleep. The observation of a hypnogram characteristic of normal night sleep shows that there is a higher sleep percentage for slow-wave sleep for the early periods of sleep and longer paradoxal sleep at the end of the night. In the case of night shift workers, the pattern is inverted, because sleep starts in the morning (a period with longer paradoxal sleep), with a dissociation of the functional principles of paradoxal and slow-wave sleep between the biological rhythms and the new environmental synchronizer[9-11].

From a chronobiological viewpoint, the damages caused by night shift work are interpreted as consequences of a temporal disorder in the organism. Therefore, it could be said that, as a result of the temporal forms of work organization that do not consider the circadian rhythmic variability of the individuals, tasks and workers during the day will have great problems.

Overall, the night shift work performed by nurses in hospitals is important, as they are responsible for continuous patient care delivery. This activity does not receive its due credit, especially regarding the nurses' own health. As part of this investigation, the electroencephalographic records of a subgroup of the total sample were used in this investigation.

OBJECTIVE

The main objective of this study was to analyze the architecture of daytime sleep after the night shift, as well as the circadian rhythm structure of nurses, by studying the characteristics of the sleep-wake cycle.

METHOD

Subjects

Nurses (n=36) working the night shift at Hospital de Clínicas da Faculdade de Medicina de Ribeirão Preto-USP-SP (HCFMRP - USP) took part in this study. Only five of these had polysomnography exams in the sleep laboratory. The morning shift was from 6:10 AM to 1:00 PM; the afternoon shift was from 2:00 PM to 8:00 PM and the night shift was from 7:00 PM to 7:00 AM. The age range of the participants comprised the 22-47-year interval, with an average age of 30, with 84% females and 15% males.

Criteria for sample selection

Nurses of HC-FMRP-USP working for the surgery and medical clinic inpatient units in the morning, afternoon and night shifts were invited to take part in the study, which comprised the application of a questionnaire covering personal and professional information, as well as data related to the general state of health. Nurses of both genders took part in the study. They should neither have sleep disorders nor other diseases and should have been working night shifts for at least two years. All of them signed the term of consent according to the Review Board approval, file HCRP- #9434/2001.

Material

Two questionnaires were used in this study – one for collecting personal and professional information, as well as data related to the general state of health, and another for evaluating the sleep-wake cycle (sleep journal).

Equipment

A polygraph (Nihon-kohden, 18 channels, Vanguard digital integrated circuit system for polysomnography) from the sleep laboratory of the HCFMRP-USP was used in the study, capable of recording electroencephalograms (EEG), electrooculograms (EOG) and electromyographies (EMG) .

Procedures

The 36 subjects filled out the sleep journal daily in the morning after the nighttime sleep, for a period of 15 days. The researcher asked the subject to fill out, firstly, the questionnaire about personal and professional information, as well as data related to the general state of health, before proceeding to taking notes about the sleep habits. Five voluntary subjects of the studied sample were invited to have electroencephalographic examinations. These measurements of the physiological daytime variables were performed at the electroencephalographic laboratory of HCRP-USP. The EEG measurements of the daytime sleep were taken immediately after night shift work with a duration of between 7 and 12 hours.

Data treatment

The following results were analyzed to assess the measurements of the sleep-wake cycle: time of going to bed, of waking up, of falling asleep, sleep latency, total hours of nighttime and daytime sleep, naps, quality of daytime and nighttime sleep, ways of awakening and comparing sleep on the collection days with usual sleep. Kruskal-Walis' test, with a significance level of p =< 0.05 and Spearman's correlation coefficient were used.

RESULTS AND DISCUSSION

The analysis of the nurses' sleep patterns yielded the average time of 11:27 PM for bedtime, 11:54 PM as the time of falling asleep, 6:32 AM for waking up and average sleep latency of 30 minutes. The subjects' maximum time after graduation was 24 years, and the time since they started working was 26 years. Regarding the habit of drinking coffee to fight off nighttime sleepiness, 85.1% of the subjects answered affirmatively.

Regarding the data on health, we obtained the following percentages of *yes* answers in the questionnaire: 50% (n=14) for weight gain, 44.83% (n=13) for headaches, 42.86% (n=12) for appetite disorders and 34.48% (n=10) for irritability, which was not statistically significant.

For the neurologic disorders, such as difficulties for reasoning, 53.7% of the sample answered *sometimes*. In another study[7], the results showed decreased alertness and memory of nurses who worked the night shift when specific tests for these findings were applied. However, the data were similar to those found in the present study.

The polysomnographic exams were used to analyze the sleep architecture, i.e. how the stages of sleep occurred. Changes can be observed, showing incomplete stages and periods when the subjects were awake for daytime sleep.

Table 1 shows the time in bed, total time of sleep during the exam and the periods when the subjects were awake. Overall, the subjects had the impression of not having slept. The average duration of total sleep time was 1h56.

Table 1 - Sleep parameters evaluated with polysomnography - Ribeirão Preto, SP - 2002

Variables	Subject 1	Subject 2	Subject 3	Subject 4	Subject 6*
Time in bed	02:07:10	02:16:46	01:43:46	01:47:39	01:42:00
Total sleep time	01:41:24	02:10:45	01:37:10	01:32:01	01:05:50
Sleep efficiency*	79.74%	95.60%	93.6%	85.48%	76.72%
Time spent awake during sleep	00:17:13	00:03:00	00:06:34	00:10:35	00:27:01
Number of awakenings	10	01	02	03	07
Number of micro-awakenings	0	02	09	02	0

(n=5)
*levels of good sleep efficiency (over 90%)

Table 2 shows the stages of daytime sleep during polysomnography. It is observed that there were no records of REM sleep for all subjects. This occurred because their daytime sleep period was very short.

Table 2 – Distributions of sleep stages of the subgroup – Ribeirão Preto, SP - 2002

Variables	Subject 1	Subject 2	Subject 3	Subject 4	Subject 6
Awake	00:25:46	00:06:01	00:06:34	00:15:38	00:05:33
Stage I	00:22:12 21.9%	00:10:12 7.8%	00:13:05 13.5%	00:09:36 10.4%	17,5
Stage II	01:19:12 78.1%	01:39:52 76.4%	01:11:27 73.5%	00:49:34 53.9%	57,5
Stage III	--	00:18:40 14.3%	00:12:38 13.0%	00:09:06 9.9%	2,0

(n=5)

Stage I is characterized by episodes of light sleep, also present in Stage II. Stages II and IV are marked by slow, deep slumber. Subjects 1 and 3 showed absence of Stage IV, or deep slumber, which confirms the reports of the subjects after the exam about the feeling of not having slept.

Data in table 3 show the average values and standard deviations of the variables analyzed by polysomnography. It is observed that the average time in bed was 2h15 for a total sleeping time of 1h56; there are differences when the results obtained from the sleep journals are compared with the polysomnography. It was observed that the times of the sleep stages were shorter, probably due do the short period of daytime sleep, even though they were present. Nonetheless, the percentage of sleep efficacy (78.49%) is below 90%, which is considered a normal standard.

Table 3 - Analyses of sleep pattern parameters - Ribeirão Preto, SP - 2002

Variables	Average Values	Standard Deviation
Time in bed	02:15:43	0:29
Total sleep time	01:56:03	0:25
Sleep efficiency	78.49%	23.50
Time spent awake during sleep	00:10:45	0:06
Awake	02:27:30	5:19
Stage I	00:19:36	0:13
Stage II	02:08:43	2:21
Stage III	00:13:56	0:09
Stage IV	00:14:13	0:13
Sleep latency	00:35:12	0:52
Sleep latency III, IV	04:04:31	7:37

(n=5)

Daytime sleep suffered disorders, characterized by awakenings in all polysomnographies performed, which could be translated as poor quality of sleep.

In the healthcare area, the work plans are different for each person, and night shifts are less frequent than daytime shifts. At night, the activities are different from those determined for the morning or afternoon shifts[10]. In situations demanding continuous night shift work, the common nighttime sleep pattern is monophasic, and efficacy could often be compromised when there is an accumulated debt of sleep.

The analysis of the sleep patterns of nurses with rotating shifts in the morning, afternoon and night shifts reveal the existence of three different types related to sleep logistics. The most important characteristics in each group of this study were: 1.) Monophasic sleep: all nurses were shown to be capable of sleeping the usual nighttime sleep, as much as possible at the same time (23h24). However, there were differences in the time of awakening, with differences between the subjects according to their work shifts; 2.) Fractioned sleep – the group of nurses working alternated night shifts had fractioned or split daytime sleep patterns, especially after a night shift working day, occurring in the morning, between 8:00 AM and 12:00 AM. In theory, it could be said that this sleep strategy could benefit the health of the individual more – however, despite the proven effects of alternating sleep periods, the underlying effects of lack of sleep are still evident[11]. By adopting the *prophylactic sleep*, named short prophylactic sleep[11], the individual would have a better probability of being awake and alert when necessary, and would take advantage of any interval, short as it could be, between tasks to take a nap. This short episode of daytime sleep was present in other populations of nurses studied during work shifts[2,5,12]. 3.) Naps – these refer to restorative or compensatory sleep[13]. We call it nap or short-duration sleeping period. The study sample demonstrated a duration of around 2h09 for this period, which was predominant for some nurses.

For night shift nurses with fixed work hours, there were short-period sleep records more frequently, usually after the daily night shift, which was possibly characterized as sleep deficit instead of nap, since they remained awake during the night[6].

In comparison with the usual sleep, the nurses classified daytime sleep as equal in 82% of the cases, worse in 6.25% and better in 9.38%. These findings are similar to those in other studies[6,14], which analyzed the adaptation of night shift nurses to different arrangements of nighttime work. The results showed that the duration of the daytime sleep was shorter than that of the nighttime sleep. Values attributed to the quality of daytime sleep, according to a visual analogous scale, were lower when compared to nighttime sleep. Our findings are similar to that research.

The time of daytime sleep (morning and afternoon periods) was 4h41, and the time of nighttime sleep had higher average values due to the work shift. The verification of the fractioned sleep time adopted by the nurses showed that average total sleep time in this study was 3 hours, which is close to the value of 4h50 found by another author[14]. This author infers that the good quality of the nurses' daytime sleep may be a characteristic of good circadian adjustment to nighttime work, a pertinent observation that was also found in the present study. Daytime sleep was assessed by means of the following parameters: latency, duration and number of awakenings. The polysomnographic records were analyzed according to the stages of sleep, and the presence of paradoxal or REM sleep. The increased number of awakening episodes related to the increased total sleeping time suggests that sleep becomes more unstable as it is prolonged.

The polysomnographic results showed an average time in bed of 2h15min43s and total sleeping time of 01h56min03s. The estimated sleeping time in the sleep journal was of 2h09, and time spent awake during sleep was 00h10min45s.

Another characteristic observed was the high number of awakenings and micro-awakenings in the medical report, which somewhat influences the quality of sleep negatively. Stages I and II were less affected, present in the hypnogram of all subjects submitted to polysomnography. The NREM and REM sleep stages were not found due to the short duration of the daytime sleep.

The sleep latency time was estimated for a short period, 13 seconds, when compared to the sleep journal data, which pointed at 30 minutes. These figures are considered high in studies about this type of event[7].

We could observe that, during the polysomnographic exam, the subjects fell asleep soon after the lights were turned off and the computer registries began. This may have occurred because the individual was leaving nighttime work, therefore with a sleep deficit.

Some authors observe that the sleep architecture in adults had differences according to the subjects' age. In our research, the average age of the participants was 29 years, with little variance. Therefore, the analysis of this profile shows that the architecture of daytime sleep was different among the study subjects[15].

The effects of night shift work were verified according to the following parameters: average total sleeping time of 1h56, with little sleep efficiency, lower than 90%; for time spent awake during sleep, the average duration was 10min45s – considered a high value due to the number of awakening episodes. From a chronobiologic viewpoint, this is considered a permanent desynchronization that was manifested as a chronic sleep deficit.

The absence of sleep stages for two participants, resulting in unstable sleep and deficient paradoxal sleep, is possibly due to a desynchronization between the biological rhythms and the new environmental synchronizers – in this case night shift work.

CONCLUSIONS

The sleep journal showed that the subjects have the habit of going to sleep around 23h54m and awakening around 6h32m, with average sleeping times of 8h08m and average daytime sleeping periods of 4h41m.

Polysomnography, a precise instrument to record electroencephalographic waves, showed the exact parameters of daytime sleep for this population, complementing the subjective findings of the sleep journal.

For the qualitative assessment, daytime sleep was significantly worse when compared to nighttime sleep. A peculiar sleeping habit – fractioned sleep – was found for nurses working night shifts.

REFERENCES

1. Guyton AC, Hall JE. Tratado de fisiologia médica. 9ª ed. Rio de Janeiro: Guanabara Koogan; 1997.
2. De Martino MMF, Cipolla-Neto J. Repercussões do ciclo vigília-sono em enfermeiros do turno noturno. Rev Ciênc Med. 1999;8(3):81-4.
3. Campos MLP, De Martino MMF. Aspectos cronobiológicos do ciclo vigília-sono e níveis de ansiedade dos enfermeiros nos diferentes turnos de trabalho. Rev Esc Enferm USP. 2004; 38 (4):15-21.
4. Perdomo C. Estudo da ritmicidade circadiana do cortisol, ciclo vigília-sono em trabalhadores da área da saúde do turno noturno [dissertação]. Campinas: Faculdade de Ciências Médicas, Universidade Estadual de Campinas; 2002.
5. Cipolla-Neto J, Menna-Barreto L, Marques N, Afeche SC, Benedito-Silva AA. Cronobiologia do ciclo vigília-sono. In: Reimão R, editor. Sono: aspectos atuais. São Paulo: Sarvier; 1996. p. 50-87.
6. Cipolla-Neto J, Marques N, Menna-Barreto L. Introdução ao estudo da Cronobiologia. São Paulo: Ícone; 1988.
7. De Martino MMF. Estudo da variabilidade circadiana da tempe-ratura oral, ciclo vigília-sono e testes psicofisiológicos em enfermeiros de diferentes turnos de trabalho [tese]. Campinas: Instituto de Biologia, Universidade Estadual de Campinas; 1996.
8. Inocente NJ, Reimão R. Correlações entre sono e estresse. In: Reimão R. Avanços em medicina do sono. São Paulo: Zeppelini; 2001. p. 189-93.
9. Garay A. Distúrbios do sono devidos ao trabalho em turnos. In: Reimão R, editor. Sono: estudo abrangente. 2ª ed. São Paulo: Atheneu; 1996. p. 390-91.
10. Gadbois CH. L'exacte mesure des situations de travail posté: au-dela des similitudes formelles, des réalités différentes. Trav Hum. 1990;53(4):329-45.
11. Stampi C. Polyphasic sleep strategies improve prolonged sustained performance: a field study on 99 sailors. Work Stress. 1989;3(1):41-5.
12. Fetveit A, Bjorvatn B. Sleep disturbances among nursing home residents. Int J Geriatr Psychiatry. 2002;17(7):604-9.
13. Verhagen P, Cober R, De Smedt M, Dirkx J, Kerstens J, Ryvers D, et al. The adaptation of night nurses to different work schedules. Ergonomics. 1987;30(9):1301-9.
14. De Martino MMF. Estudo comparativo de padrões de sono em trabalhadores de enfermagem dos turnos diurno e noturno. Rev Panam Salud Publica. 2002;12(2):95-100.
15. Rechtschaffen A, Kales AA. Manual of standard terminology, techniques, and scoring system for sleep stages of human subjects. Los Angeles: Brain Research Institute; 1968.

Correspondence addressed to: Milva Maria F. de Martino
Rua Renato Reis, 56
CEP 13084-445 - Campinas, SP, Brazil