文　献

1) NHK放送文化研究所．日本人の生活時間・2000 NHK国民生活時間調査．東京：日本放送出版協会；2002.
2) The National Sleep Foundation. 2002 Sleep in America. Washington DC : The National Sleep Foundation ; 2002.
3) 労働省．平成11年賃金労働時間制度等総合調査．東京：労働省；2000.
4) The Bureau of Labor Statistics of the U.S. Department of Labor. Workers on flexible and shift schedules in 2001. Washington DC : The Bureau of Labor Statistics of the U.S. Department of Labor ; 2002.
5) Chang PP, Ford DE, Mead LA, et al. Insomnia in young men and subsequent depression. The Johns Hopkins Precursors Study. Am J Epidemiol 1997 ; 146 : 105-14.
6) Spiegel K, Leproult R, Van Cauter E. Impact of sleep debt on metabolic and endocrine function. Lancet 1999 ; 354 : 1435-9.
7) Ozturk L, Pelin Z, Karadeniz D, et al. Effects of 48 hours sleep deprivation on human immune profile. Sleep Res Online 1999 ; 2 : 107-11.
8) 財団法人健康・体力づくり事業財団．健康づくりに関する意識調査報告書．東京：財団法人健康・体力づくり事業財団；1997.
9) Kripke DF, Garfinkel L, Wingard DL, et al. Mortality associated with sleep duration and insomnia. Arch Gen Psychiatry 2002 ; 59 : 131-6.
10) Tamakoshi A, Ohno Y. Self-reported sleep duration as a predictor of all-cause mortality : results from the JACC study, Japan. Sleep 2004 ; 27 : 51-4.
11) Marshall N, Bolger W, Gander P. Abnormal sleep duration and motor vehicle crash risk. J Sleep Res 2004 ; 13 : 177-8.
12) Gale C, Martyn C. Larks and owls and health, wealth, and wisdom. BMJ 1998 ; 317 : 1675-7.
13) 田ヶ谷浩邦，内山　真．XVI．機能性疾患 概日リズム睡眠障害．In：柳澤信夫，篠原幸人，岩田誠，ほか・編．Annual Review 神経2003．東京：中外医薬社；2003. p. 308-15.
14) Kamei Y, Urata J, Uchiyaya M, et al. Clinical characteristics of circadian rhythm sleep disorders. Psychiatry Clin Neurosci 1998 ; 52 : 234-5.
15) Scott AJ, Monk TH, Brink LL. Shiftwork as a risk factor for depression : A pilot study. Int J Occup Environ Health 1997 ; 3 : S2-S9.
16) Kawachi I, Colditz GA, Stampfer MJ, et al. Prospective study of shift work and risk of coronary heart disease in women. Circulation 1995 ; 92 : 3178-82.
17) Boggild H, Suadicani P, Hein HO, et al. Shift work, social class, and ischaemic heart disease in middle aged and elderly men ; a 22 year follow up in the Copenhagen Male Study. Occup Environ Med 1999 ; 56 : 640-5.
18) Xu X, Ding M, Li B, et al. Association of rotating shiftwork with preterm births and low birth weight among never smoking women textile workers in China. Occup Environ Med 1994 ; 51 : 470-4.
19) Steele MT, Ma OJ, Watson WA, et al. The occupational risk of motor vehicle collisions for emergency medicine residents. Acad Emerg Med 1999 ; 6 : 1050-3.
20) Uchiyama M, Kamei Y, Suzuki H, et al. Circadian features of rapid eye movement and non-rapid eye movement sleep propensities in healthy humans. In : Honma K, Honma S, editors. Circadian clock as multi-oscillation system. Sapporo : Hokkaido University Press ; 2003. p. 193-202.

*　　*　　*

J Occup Health 2004; 46: 448–454

Journal of Occupational Health

Mental Health Status, Shift Work, and Occupational Accidents among Hospital Nurses in Japan

Kenshu SUZUKI[1], Takashi OHIDA[1], Yoshitaka KANEITA[1], Eise YOKOYAMA[1], Takeo MIYAKE[1], Satoru HARANO[1], Yuko YAGI[1], Eiji IBUKA[1], Akiyo KANEKO[1], Takako TSUTSUI[1] and Makoto UCHIYAMA[2]

[1]Department of Public Health, School of Medicine, Nihon University and [2]Department of Psychophysiology, National Institute of Mental Health, National Center of Neurology and Psychiatry, Japan

Abstract: Mental Health Status, Shift Work, and Occupational Accidents among Hospital Nurses in Japan: Kenshu Suzuki, *et al.* Department of Public Health, School of Medicine, Nihon University—A questionnaire survey was conducted with questions from the 12-item General Health Questionnaire, among others, targeting 4,407 nurses in 8 general hospitals in Japan, in the hope of improving the work environment of nurses and to provide data that will allow a discussion of the measures necessary for preventing medical errors, thus improving occupational health. For each type of accident, the percentage of those who had made medical errors was significantly higher for the "mentally in poor health" group than for the "mentally in good health" group ($p<0.0001$). The percentage of nurses in the "mentally in good health" and "mentally in poor health" groups who had experienced occupational accidents over the past 12 months (i.e., whether they were "with errors" or "without errors") was calculated for each of the following four types of medical accident: (1) drug-administration errors, (2) incorrect operation of medical equipment, (3) errors in patient identification, and (4) needlestick injuries. For each type of accident, the percentage of those who had made medical errors was significantly higher for the "mentally in poor health" group than for the "mentally in good health" group ($p<0.0001$). Multiple logistic regression analyses revealed significant associations between experience of medical errors in the past 12 months and being mentally in poor health, with night or irregular shift work, and age.
(J Cccup Health 2004; 46: 448–454)

Received May 23, 2004; Accepted Sep 21, 2004
Correspondence to: Y. Kaneita, Department of Public Health, School of Medicine, Nihon University, 30–1 Ohyaguchi-Kamimachi, Itabashi-ku, Tokyo 173-8610, Japan (e-mail: qwu00740@nifty.ne.jp)

Key words: Mental-health status, General Health Questionnaire (GHQ-12), Occupational accidents, Shift work, Nurses, Japan

The number of women who work is increasing, but in Japan, nursing remains the profession that comprises the largest percentage of female workers. Female workers are generally exposed to more physical and mental stress than are male workers, because in addition to their jobs, additional burdens, such as household chores, childcare, pregnancy and childbirth tend to add to the stress[1,2]. It is notable that nurses are particularly prone to mental health problems compared with those who are engaged in other types of jobs because they work night or irregular shifts more often than others, which affects the circadian rhythm and disturbs other biorhythms, leading to failure of various physiological functions[3]. It is said that nurses are exposed to more mental stress than are other health-care professionals because in addition to working in a more mentally stressful work environment, nurses are required to develop increasingly higher skill levels because of advances in medical care and technology[3–7]. It is therefore very important from the viewpoint of personnel administration to clarify the mental health status of nurses.

Sleep problems among nurses are also important and must be addressed. In the case of nurses who work night shifts, their sleeping hours will inevitably be in the daytime, the activities of others often making it difficult to secure enough sleep. Nurses who live with their families tend to have a shorter sleep duration because of their family's schedules, or they tend to wake up more often during sleep, and their quality of sleep tends to be poor because of noise and/or brightness[8,9]. Occupational errors or accidents involving nurses have a direct and critical influence on the life and prognosis of their patients, as such it is clear that this is yet another important

issue that must be addressed. Moreover, as prevention of medical errors and accidents is an urgent issue to be addressed from the viewpoint of industrial hygiene, working conditions that may lead to occupational errors or accidents among nurses also began to be addressed through various advanced approaches. That is, attempts are being made to analyze the workplace problems that increase the risk of medical accidents. These analyses have been made under the assumption that such accidents represent specific and remediable hazards rather than problems with individual nurses, and include studies on the factors associated with the typical working state of nurses (e.g., hypoglycemia)[10, 11], a study on subjective calculation methods for error rates[12], and error analyses based on the reporting system that is promoted by the Ministry of Health, Labor, and Welfare of Japan[13]. But it is also important to analyze factors related to medical accidents that can be attributed to individual nurses, such as working style, mental health, and whether or not they have sleep problems. There are two main methods for assessing medical errors and accidents: one is to define only reported accidents as medical accidents and count them, and the other is to define all occupational-error or -accident cases that have been recognized as errors or accidents by the subjects themselves who participate in self-administered questionnaire surveys[8]. The latter method was adopted in the present study since it may yield data on otherwise unreported and unrevealed occupational errors or accidents.

We therefore conducted a questionnaire survey targeting 4,407 nurses in Japan, focusing on occupational accidents (medical errors), in order to (1) measure the actual mental health status among nurses, and (2) analyze associations between mental health and medical errors, in the hope of securing better working conditions for nurses and to provide data that would enable a constructive discussion of measures for preventing occupational accidents and thus improve occupational health for these workers.

Methods

Subjects and method of data collection

The subjects of this study were nursing staff working in eight general hospitals equipped with 400 beds or more that were located in Metropolitan Tokyo or other cities in Japan. The survey was conducted for one month during September 2003. The target hospitals were those in which the staff agreed to cooperate in our study, and they included four hospitals that are affiliated with medical colleges in Metropolitan Tokyo, two hospitals in other cities that are also affiliated with medical colleges, and two other public hospitals in other cities. The number of responses to the questionnaire was 4,407, and the collection rate was 94.0%. Of these, 4,279 female inpatient nurses were selected as subjects.

Survey method

First, the person in charge of the survey at each hospital (the director of nursing) explained the purposes of the present study and requested the cooperation of the person responsible for each ward of the hospital, who in turn asked for the cooperation of his or her subordinate nursing staff. The distribution and collection of questionnaires was also performed through the person in charge of the survey at each hospital. An anonymous self-administered questionnaire was used, and to protect the privacy of the subjects and obtain the most candid responses possible, it was stated clearly on the questionnaire that completed questionnaires would not be seen by the staff of the institutions and that they would be collected in sealed envelopes. This survey was approved by the Ethics Committee of Nihon University, prior to its commencement.

Questionnaire

Identical anonymous self-administered questionnaires were used at all eight participating hospitals. In addition to questions on mental health, sleep, and occupational accidents, there were questions on subject characteristics (age, gender) and the shift-work system that they worked under. The sleep-related items included: (1) a subjective evaluation of their own sleep, (2) sleep duration, (3) whether they were with/without difficulty in going to sleep, (4) whether they were with/without difficulty in maintaining sleep, and (5) early-morning awakening and difficulty in getting back to sleep. The actual questions, which were taken from the Japanese version[14] of the Pittsburgh Sleep Quality Index (PSQI) questionnaire developed by Pittsburgh University, are shown here:

1. Do you get as much sleep as you need? (very sufficient/sufficient/insufficient/very insufficient/uncertain)—subjective sleep evaluation
2. On average, how many hours do you sleep?—sleep duration
3. Do you have difficulty falling asleep at night? (always/often/sometimes/seldom/never)—difficulty in going to sleep
4. Do you wake up too often during the night after you have gone to sleep? (always/often/sometimes/seldom/never)—difficulty in maintaining sleep
5. Do you wake up too early in the morning and have difficulty getting back to sleep? (always/often/sometimes/seldom/never)—early morning awakening

Since nurses can be involved in various types of occupational accident, the questionnaire included questions on whether or not they had experienced the four types of accident that are most commonly reported

among nursing staff: (1) drug-administration errors, (2) incorrect operation of medical equipment, (3) errors in patient identification, and (4) needlestick injuries, in the past 12 months. The Japanese version of the 12-item General Health Questionnaire (GHQ-12) was used to measure mental health status.

Analyses

SPSS for Windows Version 11.0 was used for statistical processing. The GHQ-12 was used as a scale for measuring the mental health of the nurses. The reliability of the GHQ-12 is given by a Cronbach alpha coefficient of α=0.8606, which means that the internal consistency and reliability of the question items of the GHQ-12 was sufficiently high[15]. A cutoff point of 3/4 was chosen.

(1) The mental health of the nurses who took part in the survey was examined first. The distribution, mean value, and median of the GHQ-12 scores were calculated.

(2) The associations between night or irregular shift work and mental health were examined. The rates of those who were mentally in poor health in the "with shift work" group and "without shift work" group were compared. Chi-squared test was used, and the level of statistical significance was set at 5%. In addition, the mean values of the GHQ-12 scores for the "with shift work" group and "without shift work" group were compared. As the GHQ-score distribution was normal, Student's t test was used, and the level of statistical significance was set at 5%.

(3) The associations between mental health and occupational accidents in the past 12 months were examined. A comparison of the "mentally in good health" group and the "mentally in poor health" groups was conducted with respect to whether or not the participating nurses had experienced any of the following four types of occupational accident: (i) drug-administration errors, (ii) incorrect operation of medical equipment, (iii) errors in patient identification, and (iv) needlestick injuries. Chi-squared test was used, and the level of statistical significance was set at 5%. In addition, the mean values of the GHQ-12 scores in the "with errors" group and "without errors" group were compared. Student's t test was used, and the level of statistical significance was set at 5%.

(4) Finally, univariate analyses and multiple logistic regression analyses were conducted with regard to medical errors experienced in the past 12 months. Those who had experienced any of the four types of error analyzed in the present study in the past 12 months were assigned to a "with errors" group, and those who had not were assigned to a "without errors" group. We took "with errors" and "without errors" as dependent variables, and we took mental health (in good health, in poor health), subjective sleep evaluation (insufficient, sufficient), with/without difficulty in initiating sleep, with/without difficulty in maintaining sleep, with/without early-morning awakening, age (in their 20s, 30s, 40s and 50s or older), with/without spouse, and with/without night/irregular shift work as independent variables. Univariate analyses and multiple logistic regression analyses were conducted to produce odds ratios and 95% confidence intervals. With regard to subjective sleep evaluation, those who answered "3. insufficient" or "4. very insufficient" were assigned to an "insufficient sleep" group, and those who answered "1. very sufficient" or "2. sufficient" were assigned to a "sufficient sleep" group. For difficulty in going to sleep, difficulty in maintaining sleep, and early-morning awakening, those who answered "4. often," or "5. always" were assigned to a "with" group, and those who answered "1. never," "2. seldom," or "3. sometimes" were assigned to a "without" group, and these data were used as independent variables.

Results

Characteristics of the survey participants

Of the entire subjects, 63.0% were 20–29 yr old, 20.8% were 30–39 yr old, 1.5% were 40–49 yr old, and 6.0% were 50 yr old or older. The average (SD) age was 30.3 (8.9) yr. Tokyo was the workplace of 62.8% of the participants, and the remaining 37.2% worked in other cities in Japan. With regard to marital status, 75.1% of participants were not married, and the remaining 24.9% were married (Table 1). The type of hospital, its location, number of beds, number of nurses, average age of the nurses, number of married nurses, and the response rate at each participating facility are given in Table 2.

GHQ-12 scores of the survey participants

The percentage of those who scored 3 points or less (considered to be mentally in good health) was 31.2%; the remaining 68.8% scored 4 points or more (considered to be mentally in poor health; Table 3). The mean (SD) GHQ-12 score was 5.42 (3.29), and the median was 5.0.

Night/irregular shift work and mental health

Of the "with shift work" group, 69.8% were mentally

Table 1. Attributes of targets analyzed

Age	20–29 yr	63.0%
	30–39 yr	20.8%
	40–49 yr	10.2%
	50+	6.0%
	Total (N=4279)	
Marital status	Not married	75.1%
	Married	24.9%
	Total (N=4279)	
Residence	Tokyo	62.8%
	Other cities	37.2%
	Total (N=4279)	

Table 2. Characteristics of participating facilities

	Type of hospital	Location	Number of beds	Number of full-time, inpatient nurses	Average age (SD)	Number of married nurses	Response rate (%)
Facility 1	University hospital	Tokyo	712	787	30.5 (9.1)	151	90.9
Facility 2	University hospital	Tokyo	905	933	27.8 (6.5)	118	93.2
Facility 3	University hospital	Tokyo	885	898	28.2 (6.9)	135	94.7
Facility 4	University hospital	Tokyo	441	369	27.0 (6.1)	49	92.1
Facility 5	University hospital	Tohoku district	571	390	33.3 (9.3)	164	98.7
Facility 6	University hospital	Kanto district (except Tokyo)	412	402	29.6 (9.4)	65	91.0
Facility 7	Public general hospital	Chubu district	417	407	31.7 (6.1)	173	100.0
Facility 8	Public general hospital	Kinki district	430	500	33.1 (9.7)	206	95.0

SD: Standard deviation

Table 3. Distribution of GHQ-12 scores

Score	Freq. (No. of people)	Cum. %
0	288	6.7
1	331	14.5
2	338	22.4
3	377	31.2
4	427	41.2
5	461	51.9
6	463	62.7
7	414	72.4
8	326	80.0
9	290	86.8
10	201	91.5
11	212	96.5
12	151	100

Table 4. Relationships between mental health and occupational accidents in the past 12 months

		Drug-administration errors	
Mental health/accidents	N	Without	With
In good health	1,322	64.0	36.0
In poor health	2,927	56.5	43.5
		Misoperation of medical equipment	
		Without	With
In good health	1,320	79.8	20.2
In poor health	2,920	72.7	27.3
		Errors in patient identification	
		Without	With
In good health	1,318	92.1	7.9
In poor health	2,930	89.8	10.2
		Needlestick injuries	
		Without	With
In good health	1,298	65.3	34.7
In poor health	2,936	63.0	37.0

Chi-square test $p<0.0001$

in poor health, compared to 55.6% in the "without shift work" group; the difference was significant ($p<0.0001$). Furthermore, the mean GHQ-12 score of the "with shift work" group (5.49) was significantly higher than that of the "without shift work" group (4.53; $p<0.0001$).

Associations between mental health and experience of occupational accidents in the past 12 months

With regard to (1) drug-administration errors, (2) incorrect operation of medical equipment, (3) errors in patient identification, and (4) needlestick injuries, the rates of those with or without medical errors in the "mentally in good health" and "mentally in poor health" groups were compared. The rates for those with medical errors were significantly higher in the "mentally in poor health" group than in the "mentally in good health" group for all four error types. In addition, the mean (SD) GHQ-12 score of the group of subjects who had made any of the four types of medical error included in the present study over the past 12 months was significantly higher at 5.69 (3.25) than for the group of those who had not [4.70 (3.21), $p<0.0001$; Table 4].

Factors related to occupational accidents experienced in the past 12 months

Significant associations were observed between experience of medical accidents over the past 12 months and being mentally in poor health, without a spouse, with

Table 5. Univariate and multiple logistic regression analyses regarding factors related to occupational accidents in the past 12 months

Factor	N	Univariate Unadjusted OR	95% CI	Multivariate Adjusted OR	95% CI
Mental health					
In good health	1,191	1.00		1.00	
In poor health	2,627	1.72	1.48–1.99	1.55	1.32–1.82
Subjective sleep evaluation					
Insufficient	2,105	1.00		1.00	
Sufficient	1,713	0.87	0.74–0.98	1.00	0.86–1.18
Difficulty in initiating sleep					
Without	2,890	1.00		1.00	
With	928	1.17	0.99–1.38	0.96	0.79–1.16
Difficulty in maintaining sleep					
Without	2,921	1.00		1.00	
With	897	1.07	0.90–1.26	0.99	0.81–1.12
Early-morning awakening, difficulty in getting back to sleep					
Without	3,389	1.00		1.00	
With	429	1.06	0.84–1.32	1.03	0.80–1.33
Age					
20s	2,441	1.00		1.00	
30s	785	0.69	0.58–0.83	0.96	0.81–1.14
40s	379	0.49	0.39–0.62	0.66	0.52–0.85
50s or older	213	0.34	0.26–0.46	0.62	0.45–0.85
Spouse					
Without	2,883	1.00		1.00	
With	935	0.59	0.50–0.69	0.90	0.74–1.09
Shift work*					
Without	274	1.00		1.00	
With	3,544	2.54	1.99–3.25	1.78	1.35–2.34

R^2 (Nagelkerke)=0.52

CI: Confidence interval OR: Odds Ratio, Adjusted for other factors in multiple logistic regression analysis with stepwise elimination, *Night/split/irregular

night/irregular shift work, and age (with the value for the 20–29 yr age group as a reference, associations were observed in the 40–49 and 50–59 yr age groups; Table 5).

Discussion

Few systematic surveys have been conducted on associations between mental health or sleep disorders and occupational accidents among nurses in Japan. Indeed, to our knowledge, no such report exists. The present report therefore represents the first such large-scale study.

The GHQ-12 questionnaire is the criterion developed by Goldberg in the United Kingdom as a screening test for nonorganic, nonpsychosis mental disorders[16–18]. It was reported that two factors that had been extracted from a factor analysis of a study on the GHQ-12 targeting workers (mental anguish and social dysfunction)[10, 11], and the GHQ-12 was considered to be appropriate for use in the present study. Fukunishi reported that the sensitivity, specificity, and error rate of the GHQ-12 were 85.6%, 66.9%, and 22.1%, respectively, for a cutoff point of 1/2, 74.2%, 88.5%, and 18.9%, respectively, for a cutoff point of 2/3, and 74.2%, 88.5%, and 19.9%, respectively, for a cutoff point of 3/4[19]. Furthermore, Mari *et al.* reported that when a cutoff point of 3/4 was chosen, the sensitivity and specificity were 85% and 79%, respectively[20]. As a consequence of these findings, a cutoff point of 3/4 was employed in the present study.

The rate of those who scored 3 points or less (i.e., considered to be mentally in good health) was only 31.2%, but that of those who scored 4 points or more (i.e., considered to be mentally in poor health) was 68.8%. The mean (SD) value of the GHQ-12 scores was 5.42 (3.29), and the median was 5.0. These results suggest that mental health of the target nurses was quite poor. It has already been established that nursing is a personal

service caring for patients who have become emotionally unstable because of their health problems, and that it involves excessively heavy work with night or irregular shift work, which may lead to irregular life patterns, usually with a lot of overtime and a heavy work load[3–7]. In addition, shift work has been shown to increase the risk of suffering from one of several diseases[21]. Associations between shift work and physical and mental diseases therefore deserve further attention in future studies.

The factor that has the strongest association with experience of medical errors in the past 12 months was night/irregular shift work. It was reported in a study conducted in the USA targeting hospital nurses that nurses working in rotating shifts tended to have more accidents while working and driving, and made more errors during work[8]. The results of our study are in accord with these findings, and lead us to the conclusion that improvement of mental health among the nurses is of critical importance.

Estryn-Behar *et al.* established associations between occupational stress among hospital workers and sleep disorders[22]. Since nursing is a profession that typically involves shift work, sleep problems are also critical for nurses. In the present survey, however, no association was observed between shift work and occupational accidents. In some studies, associations have been found between sleep disorders and occupational accidents, but in others, no such associations were noted. This discrepancy may be attributable to differences in the type of job, classification of occupational accidents, and the definition of occupational accidents used.

There are many reports on associations between night-shift work and sleep problems among nurses all over the world. Gold *et al.* pointed out that the percentage of those experiencing daytime sleepiness was higher among nurses who worked night-and-day shift schedules[8]. Escriba *et al.* noted a decrease in sleep duration and a degradation of sleep quality that was attributable to night-shift work[9]. In Japan, Ohida *et al.* reported that there was no association between sleep problems and night-shift work[23]. Takahashi *et al.* focused on differences between two-shift and three-shift systems, and reported that with regard to sleep problems, there were no significant differences between them[24]. Since the results of studies on associations between sleep problems and night-shift work are equivocal, further investigations are necessary.

The present study is significant from a public health point of view. There are, however, several limitations to this survey. First, a self-administered questionnaire was used, and as such there may be a reporting bias. In addition, the methods used for recognizing occupational accidents were subjective; more objective ones must be used in the future. Case-control studies must be conducted to examine the associations observed in the present study between occupational accidents and various risk factors for accidents. Although the reliability and validity of the GHQ-12 are uncertain in Japan, for the present study, we chose to use a cutoff point of 3/4 for analyses, referring to the findings of previous studies. In addition, since the present study was a cross-sectional study, causal relationships between poor mental health and occupational accidents remain to be determined. Finally, it is well known that organization factors are associated with medical errors[25]. This probably induced medical errors through personnel administration problems, but this study directly investigated the organization factors underlying medical errors. These limitations need to be borne in mind when interpreting the results of this study.

In conclusion, the results of the present study have revealed that the mental health of the hospital nurses studied was quite poor, as shown by the quite high mean GHQ-12 score (5.42), and that mental health is a factor that appears to be associated with occupational accidents among nurses. To ameliorate such conditions, it may be urgently required to take measures such as adopting stress-coping programs as one of the strategies for personnel administration. These findings represent the first step toward establishing measures for preventing medical errors among nurses and for improving their occupational health.

Acknowledgments: We would like to express our appreciation to all of the people in the medical institutions who took part in or cooperated with this study, and in particular the nurses who completed the questionnaires. We would also like to thank Ms. Hiromi Sekine for her contribution in preparing this report.

References

1) M Sato, H Yonezawa, M Ishizu, K Suga and R Ikemoto: The relationship between cumulative fatigue and subjective feeling of sleepiness in nurses working three consecutive shifts. J Jpn Soc Nurs Health 4, 28–35 (2002)
2) S Fujiwara: Studies on fatigue and shift work in nurses. Sangyo Igaku, 34, 225–235 (1992)
3) T Mori and T Kageyama: A cross-sectional survey on mental health and working environment of hospital nurses. J Occup Health 37, 123–134 (1995)
4) HJ Freudenberger: Staff burn-out. J Soc Issues 30, 159–165 (1974)
5) AM Pines and C Maslach: Characteristics of staff burn out in mental health settings. Hosp Community Psychiatry 29, 233–237 (1978)
6) C Maslach and SE Jackson: The measurement of experienced burn-out. J Occup Behav 2, 99–113 (1981)
7) S Koda, A Hisashige, T Ogawa, H Aoyama, N

Kurumatani and S Nakagiri: A study of burnout among hospital nurses. J UOEH suppl, 604–608 (1989)
8) DR Gold, S Rogacz, N Bock, TD Tosteson, TM Baum, FE Speizer and CA Czeisler: Rotating shift work, sleep, and accidents related to sleepiness in hospital nurses. Am J Public Health 82, 1011–1014 (1992)
9) V Escriba, S Perez-Hoyos and F Bolumar: Shiftwork: its impact on the length and sleep among nurses of the Valencian region in Spain. Int Arch Occup Environ Health 64, 125 (1992)
10) T Mogi, Y Wada, I Hirosawa, M Sasaki and A Koizumi: Epidemiological study on hypoglycemia endemic to female nurses and other workers. Ind Health 34, 335–346 (1996)
11) K Inoue, Y Kakehashi, S Oomori and A Koizumi: Biochemical hypoglycemia in female nurses during clinical shift work. Res Nurs Health 27, 87–96 (2004)
12) K Inoue, I Hirosawa, M Yatsuduka, T Yoshinaga and A Koizumi: Utilization of voluntary reporting system in quantitative risk assessment for medical tasks in a hospital setting-with special reference to tasks done by nurses. J Occup Health 44, 360–372 (2002)
13) K Inoue and A Koizumi: Application of human reliability analysis to nursing errors in hospitals. Risk Anal 2004 :(in press)
14) Y Doi, M Miowa, M Uchiyama and M Okawa.: Development of the Pittsburgh Sleep Quality Index Japanese Version. Jpn J Psychiatr Treat 13, 755–763 (1998)
15) LJ Cronbach: Coefficient alpha and the internal structure of tests. Psychometrika 6, 297–334 (1951)
16) Goldberg DP. The detection of psychiatric illness by questionnaire. London: Oxford University press, 1972.
17) N Iwata, Y Okuyama, T Kawakami and K Saito: The twelve item General Health Questionnaire among Japanese workers. Environ Sci, Hokkaido University 11, 1–10 (1988)
18) N Iwata, Y Okuyama, T Kawakami and K Saito: Factor structure of the General Health Questionnaire in a sample of Japanese workers. Ind Health 26, 69–74 (1988)
19) I Fukunishi: The assessment of cut-off point of the General Health Questionnaire (GHQ) in the Japanese version. Shinri Rinsho 3, 228–234 (1990)
20) JD Mari and P Williams: A comparison of the validity of two psychiatric screening questionnaires (GHQ12 and SRQ20) in Brazil, using relative operating characteristic (ROC) analysis. Psychol Med 15, 651–659 (1985)
21) A Knutsson, BG Jonsson, T Akerstedt and K Orth-Gomer: Increased risk of ischemic heart disease in shift workers. Lancet 2, 89–91 (1986)
22) M Estryn-Behar, M Kaminski, E Pegne, N Bonnet, E Vaichere, S Azoulay and M Giorgi: Stress at work and mental health status among hospital workers. Br J Ind Med 47, 20–28 (1990)
23) T Ohida, AMM Kamal, T Sone,T Ishii, M Uchiyama, M Minowa and S Nozaki : Night-shift work related problems in young female nurses in Japan. J Occup Health 43, 150–156 (2001)
24) M Takahashi, M Fukuda, K Miki, T Haratani, L Kurabayashi, N Hisanaga, H Arito, H Takahashi, M Egoshi and M Sakurai: Shift work-related problems in 16-h night shift nurses (2): effects on subjective symptoms, physical activity, heart rate, and sleep. Ind Health 37, 228–236 (1999)
25) Committee on Quality of Health Care in America, Institute of medicine. To err is human: building a safer health system. National Academy of Science, Washington, 2000

Dreaming During Non-rapid Eye Movement Sleep in the Absence of Prior Rapid Eye Movement Sleep

Hiroyuki Suzuki, PhD[1]; Makoto Uchiyama, MD, PhD[1]; Hirokuni Tagaya, MD, PhD,[1]; Akiko Ozaki, RN, RPSGT, PhD[1]; Kenichi Kuriyama, MD, PhD,[1]; Sayaka Aritake, RMT, RPSGT, MS,[1,2]; Kayo Shibui, MD, PhD,[1]; Xin Tan, MD, PhD,[1]; Yuichi Kamei, MD, PhD,[3]; Ryuichi Kuga, MA[4]

[1]Department of Psychophysiology, National Institute of Mental Health, National Center of Neurology and Psychiatry, Kohnodai; [2]Department of Life Sciences and Bio-informatics, Graduate School of Allied Health Sciences, Tokyo Medical and Dental University; [3]Department of Psychiatry, Kohnodai Hospital, National Center of Neurology and Psychiatry; [4]College of Humanities and Sciences, Nihon University, Japan

Study Objectives: There is a long-standing controversy surrounding the existence of dream experiences during non-rapid eye movement (NREM) sleep. Previous studies have not answered the question whether this "NREM dream" originates from the NREM sleep mechanism because the subject might simply be recalling experiences from the preceding rapid eye movement (REM) sleep.

Methods: We scheduled 11 healthy men to repeat 20-minute nap trials separated by 40-minute periods of enforced wakefulness across a period of 3 days. At the end of the nap trial, each participant answered questions regarding the formal aspects of his dream experiences during the nap trial, using the structured interviews.

Results: We obtained a total of 172 dream reports after naps containing REM sleep (REM naps) and 563 after naps consisting of only NREM sleep (NREM naps). Dream reports from NREM naps were less remarkable in quantity, vividness, and emotion than those from REM naps and were obtained more frequently during the morning hours when the occurrences of REM sleep were highest.

Conclusions: These results suggest that the polysomnographic manifestations of REM sleep are not required for dream experiences but that the mechanisms driving REM sleep alter experiences during NREM sleep in the morning. A subcortical activation similar to REM sleep may occur in human NREM sleep during the morning when REM sleep is most likely to occur, resulting in dream experiences during NREM sleep.

Citation: Suzuki H; Uchiyama M; Tagaya H et al. Dreaming during non-rapid eye movement sleep in the absence of prior rapid eye movement sleep. *SLEEP* 2004;27(8):1486-90.

INTRODUCTION

IN 1953, ASERINSKY AND KLEITMAN DISCOVERED HUMAN RAPID EYE MOVEMENT (REM) SLEEP AND DOCUMENTED THAT DREAM REPORTS WERE OBTAINED MOST FREQUENTLY WHEN SUBJECTS WERE AWAKENED FROM REM SLEEP.[1] Thereafter, many scientists conducted studies on dream and REM sleep and found a robust association between electrophysiologic phenomena and subjective experiences during REM sleep.[2-7] This well-documented association has led to the conclusion that dream experiences are psychological manifestations generated by the neural system controlling REM sleep,[8,9] yielding many innovative findings on the mind-body relationship. In contrast, researchers have also recorded dream reports from subjects upon awakening from non-REM (NREM) sleep; though the association has been shown to be weaker in comparison with that of dream reports upon awakening from REM sleep.[10-15]

Many human studies, together with some animal studies on REM sleep, have proposed a neural system responsible for human dream experiences. In the early pioneering studies on human REM sleep, researchers focused on the relationship between eye movements and visual experiences during REM sleep and postulated that REM and concomitant activation of the visual system of the brain account for human dream experiences.[2,4] Recent neurobiologic findings obtained from animal studies have led to the current understanding that phasic signals arising from the pons and impinging upon the cortex during REM sleep might give rise to dream experiences.[8,9]

Some studies have focused on dream experiences during NREM sleep; however, no documented findings have yet afforded an understanding of the mechanisms of dreaming during NREM sleep. Rather, researchers have generally made the assumption that dream reports upon awakening from NREM sleep may be a consequence of recalling dream experiences from the preceding REM sleep rather than indicate the existence of NREM-specific dream experiences.[7,16-17] However, only a few studies have aimed to determine whether dream reports after NREM sleep are derived from residuals of memory from the preceding REM sleep or actually arise from another type of dream experience during NREM sleep.

This may be due to the methodologic limitations of the conventional intermittent awakening method, in which subjects under all-night polysomnography are awakened several times upon reaching the target sleep stage and asked about their dream experiences. However, investigation of NREM dreaming may require a method in which subjects enter a sleep period only consisting of NREM sleep separated by a sufficient period of wakefulness to exclude the influence of the preceding REM sleep. These prerequisites, however, have not been satisfied in most previous studies except for a study that examined dream experiences during a short and discrete sleep period.[18]

In the study reported here, we used a repeated-nap trial, in which 20-minute sleep periods separated by 40 minutes of enforced wakefulness were repeated for 78 hours to allow the

Disclosure Statement
This is not an industry supported study. Drs. Suzuki, Uchiyama, Tagaya, Ozaki, Kuriyama, Aritake, Shibui, Tan, Kamei, and Kuga have indicated no financial conflicts of interest.

Submitted for publication February 2004
Accepted for publication July 2004
Address correspondence to: Makoto Uchiyama, MD, PhD, Department of Psychophysiology, National Institute of Mental Health, National Center of Neurology and Psychiatry, Kohnodai, Ichikawa, Chiba, 272-0827 Japan; Tel: 81 47 375 4756; Fax: 81 47 375 4771; E-mail: macoto@ncnp-k.go.jp

measurement of various REM-NREM parameters in association with reported dream experiences.

METHODS

Participants

Eleven healthy male volunteers aged 20 to 26 years (mean = 22.4, SD = 2.1) participated in the present study. They did not have any known sleep, physical, or psychiatric disorders or any history of using psychoactive drugs. The study protocol was approved by the Intramural Research Board of the National Center of Neurology and Psychiatry, and each participant gave his informed consent after the nature, purpose, and possible risks of the experiment had been explained in detail.

All the participants were instructed to abstain from alcohol, caffeine, and napping for a week prior to the laboratory experiment. They were asked to keep sleep logs for 2 weeks and to wear wrist activity recorders (Actiwatch-L; Mini-Mitter, Bend, Ore) for the second week. Consistent sleep-diary and activity data were obtained from all the participants.

Study Design

Each participant took part in a 4-day experimental laboratory session. The participants arrived at the laboratory at 11:00 AM and consumed a 700- to 800-kcal lunch at 12:00 PM on day 1. Electrodes for standard polysomnography were attached between 1:00 PM and 3:00 PM; electroencephalogram (C3–A2, C4–A1, O1–A2), electrooculogram (left and right), chin-surface electromyogram, and electrocardiogram electrodes were used. The light level was set at 200 lux from 11:00 AM to 4:00 PM.

The participants entered a repeated nap trial at 4:00 PM on day 1. This involved 20-minute nap trials every 60 minutes, with standard polysomnographic recordings performed as participants lay recumbent on a bed in a dark (< 0.1 lux) sound-attenuated room, and a 40-minute period of enforced wakefulness on a semi-upright sofa under conditions of dim light (< 8 lux). During the 40-minute periods, participants were kept awake and monitored closely by experimenters. At the end of the nap trial, each participant was awoken gently. While remaining in a recumbent position, each participant answered questions regarding the formal aspects of his dream experiences during the nap trial, using the structured interview form described below, and thereafter left the bed. This cycle was repeated 78 times until 10:00 PM on day 4 (Figure 1). In the repeated nap trial, saliva samples were taken every 60 minutes during the last 5 minutes of the 40-minute period using saliva collection tubes (Bühlmann Laboratories AG, Schönenbuch, Switzerland). During the repeated nap trial, the room temperature and humidity were controlled at 24.0°C ± 0.5°C and 60% ± 5%, respectively. Participants consumed a 150-kcal snack and 200 mL of water every 2 hours.

Measures

Polysomnographic Measures

Polysomnograms obtained during the nap trials were scored in epochs of 30 seconds according to standard criteria.[19] A nap trial that contained stage REM was defined as a *REM nap*, whereas a nap trial containing no stage REM but NREM stages was defined as a *NREM nap*. Nap trials not containing any sleep stages were excluded from further analyses. The summed duration of NREM sleep stages (stage 1, 2, 3, and 4) and stage REM in the nap trial were termed *NREM duration* and *REM duration*, respectively.

Saliva Melatonin

Saliva samples were immediately refrigerated at -30°C for later analysis of melatonin concentration. Saliva melatonin was measured with a highly specific direct double-antibody radioimmunoassay kit (Saliva Melatonin RIA kit, Bühlmann Laboratories AG).[20] The time point where the saliva melatonin level crossed 3.3 pg/mL was defined as the dim-light melatonin onset, as outlined by Campbell and Murphy.[21] Dim-light melatonin onset was used for determining relative clock time as described below.

Dream Report Questionnaire

A structured questionnaire was developed to investigate the formal aspects of dreaming, such as dream duration and quality. We did not ask the participants about detailed dream content at a given nap trial because this would have influenced dream reports at successive nap trials. The questionnaire contained the following questions:

Q1. "How much did you dream?" (0: none, 1: little, 2: a moderate amount, 3: a lot)

When the reply to Q1 was 0, Q2-4 were not asked. Otherwise, Q1 was followed by Q2-4.

Q2. "How vivid was the dream?" (0: not vivid at all, 1: rather vivid, 2: moderately vivid, 3: very vivid)

Q3. "How pleasant was the dream?" (0: not pleasant at all, 1: rather pleasant, 2: very pleasant)

Q4. "How unpleasant was the dream?" (0: not unpleasant at all, 1: rather unpleasant, 2: very unpleasant)

The participant's responses to Q1 were averaged separately for REM naps and NREM naps (dream duration). Likewise, the participant's mean scores for Q2, Q3, and Q4 (vividness, pleasantness, and unpleasantness) after REM and NREM naps were calculated. Participants were considered to have had a dream experience if their response to Q1 was 2 or 3. Data from 4 nap trials were eliminated because of difficulties with electroencephalogram recordings.

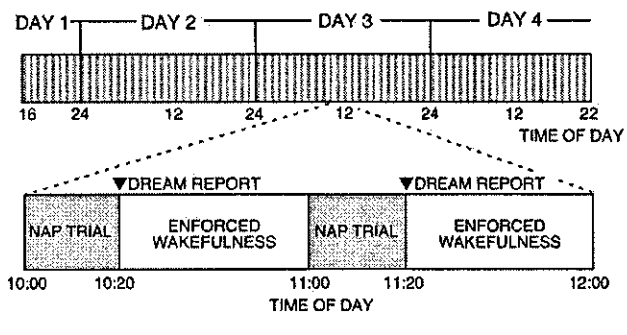

Figure 1—Experimental schedule. Participants followed a 60-minute sleep-wake cycle consisting of a 20-minute nap trial, followed by 40 minutes of enforced wakefulness. Standard polysomnographic recordings were made. This schedule was repeated for 78 hours from 4:00 PM on day 1 to 10:00 PM on day 4. At the end of each nap trial, a dream report was obtained using a structured interview.

Temporal Fluctuation

The data series obtained from the 78-hour experiment was time-locked to the dim-light melatonin onset, to which we designated a relative clock time of 10:00 PM. Thereby, we obtained standardized 72-hour data on all the participants. In this analysis, data obtained from only 9 participants were used, as melatonin measurements from 2 participants were not available because of lack of saliva samples.

Statistical Analyses

Paired t tests were performed to compare REM naps and NREM naps on measures of dream duration, vividness, pleasantness, and unpleasantness. For correlation analysis, we calculated Spearman correlation coefficients.

For analysis of temporal fluctuation, we used 72-hour data on REM duration, NREM duration, and dream duration. These were evaluated using 2-way repeated-measure analysis of variance (day and time of day) with a Huynh-Feldt epsilon correction. When a day effect was not observed, the 72-hour data was averaged into 2-hour bins in order to observe the 24-hour fluctuation of these measurements. For all the statistical analyses, the level of significance was set at $P < .05$. Statistical analyses were performed using StatView v5.0 (SAS Institute Inc., Cary, NC) and Super ANOVA (Abacus Concepts, Inc., Berkeley, CA).

RESULTS

Overview

Administering the structured questionnaire just after each 20-minute nap trial, we obtained a total of 854 dream reports from 11 participants. We excluded those reports obtained after nap trials without any sleep stages (n = 119); all the 30-second epochs were scored as stage wake. Finally, we had a total of 172 dream reports after REM naps and 563 after NREM naps.

Dream Reports from REM and NREM Naps

First, we compared the formal aspects of dream experiences between the REM naps and the NREM naps. Dream experiences were reported for 51.2% of the REM naps and 17.9% of the NREM naps. Dream experiences were more frequently found in the REM naps compared with the NREM naps (χ^2 (1) = 76.13, $P < .0001$). It was noted that dream experiences did occur during naps consisting of NREM sleep only. When dream experiences were averaged across participants, dream experiences were also more frequent in the REM naps than in the NREM naps (REM: 47.7%, NREM: 18.5%, $df = 10$, $t = -4.58$, $P = .0010$).

Table 1—Dream reports of NREM and REM naps

Dream report scores (range)	NREM NAP	REM NAP	*P* value
Dream duration (0-3)	0.47 ± 0.46	1.22 ± 0.76	.0003
Vividness (0-3)	0.46 ± 0.46	1.41 ± 0.93	.0003
Pleasantness (0-2)	0.41 ± 0.40	0.94 ± 0.47	.0057
Unpleasantness (0-2)	0.12 ± 0.22	0.41 ± 0.46	.0670

NREM refers to non-rapid eye movement; REM, rapid eye movement.

Subjective dream duration during the REM naps was significantly higher than that during the NREM naps ($df = 10$, $t = -5.41$, $P = .0003$) (Table 1). Dream experiences during the REM naps were more vivid and more pleasant than those during the NREM naps ($df = 10$, $t = -3.73$, $P = .0047$; and $df = 8$, $t = -3.74$, $P = .0057$, respectively). The level of dream unpleasantness during the REM naps was higher than that during the NREM naps, but this difference was not significant ($df = 8$, $t = -2.118$, $P = .067$). Dream experiences during NREM sleep seemed to be less

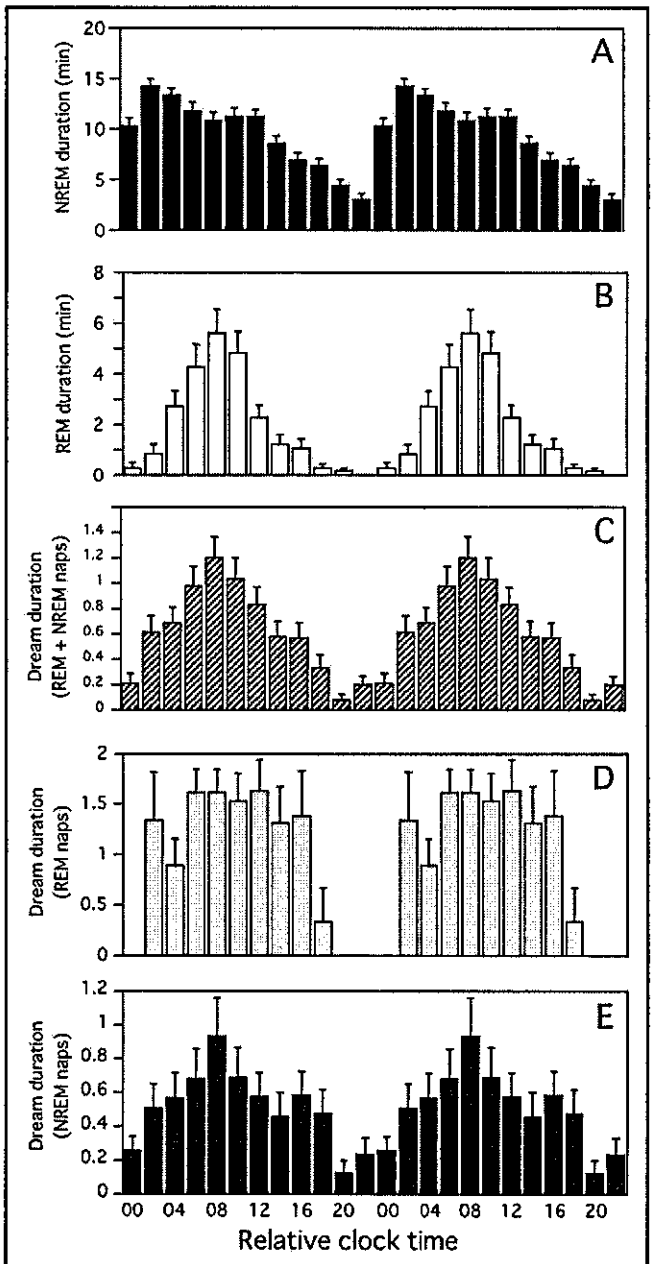

Figure 2—Temporal fluctuations in sleep duration and dream duration. All data are depicted in double-plot style and time-locked to the onset of melatonin release at a relative clock time of 10:00 PM. The peak of rapid eye movement (REM) duration (B) follows that of non-REM (NREM) duration (A) and coincides with that of the dream duration of REM + NREM naps (C). The dream duration of REM naps (D) shows no clear peak, whereas that of NREM naps (E) has a clear peak that coincides with the peak of REM duration but not with NREM duration.

remarkable in quantity, vividness, and emotion than those during REM sleep.

Temporal Fluctuations

Since it has long been recognized that REM sleep occurrence shows temporal characteristics across the day,[22] we then investigated the temporal fluctuations in NREM and REM duration and dream quantities across 2 days (72 hours). Two-way repeated analyses of variance (day and time of day) revealed a significant time-of-day effect on these 3 measures (NREM: $F = 8.64$, $P < .0001$, REM: $F = 3.92$, $P = .0055$, dream duration: $F = 2.75$, $P = .025$) but no day effect nor interaction, such that the 24-hour fluctuation curves did not differ in shape across the 3 days. We then averaged the data across the 72-hour period to obtain 24-hour fluctuation curves.

NREM duration increased sharply from 12:00 AM to 2:00 AM, where a clear peak on the fluctuation curve was evident (Figure 2, A). Thereafter, NREM duration showed a gradual decrease towards the late evening hours with a small peak at 12:00 PM. NREM duration was shortest during the late evening hours (10:00 PM). In contrast, REM duration gradually increased in the midnight and morning hours, showing a maximum at 8:00 AM and a gradual decrease thereafter (Figure 2, B). Dream duration of REM plus NREM naps (the mean value averaged across all REM and NREM reports) increased in the midnight and morning hours and reached a peak at 8:00 AM, followed by a gradual decrease towards the late evening hours (Figure 2, C). The peak in dream duration of REM plus NREM naps coincided with that of REM duration but not with that of NREM duration, which appeared 6 hours earlier. The fluctuation curve of dream duration of REM plus NREM naps appeared similar to that of REM duration in shape, but its distribution was wider.

Next, we constructed figures of the temporal fluctuations in dream duration with respect to the REM and NREM naps, separately. The dream duration of REM naps was high during the period 6:00 AM to 12:00 PM and showed no clear peak (Figure 2, D). In contrast, there was a clear peak at 8:00 AM with the dream duration of NREM naps (Figure 2, E). Surprisingly, this peak coincided with the peak in REM duration but not with that of NREM duration. Correlation analysis between REM duration and the dream duration of NREM naps revealed that REM duration explained a remarkable 75% of the temporal fluctuation of the dream duration of NREM naps ($r = .87$, $n = 11$, $P < .0001$, $r^2 = .75$).

DISCUSSION

In the present study, we conducted 20-minute nap trials every hour for 78 hours (repeated nap trial), calculated sleep indexes during the nap trials, and obtained dream reports at the end of each nap trial. Using the repeated nap trial, we compared the quantity and quality of dream experiences between REM sleep and NREM sleep and investigated the temporal fluctuations in dream duration.

Use of the repeated nap trial allowed us to determine that dreams reported at the end of a given nap trial were experienced exclusively during the period of that nap trial. In contrast, use of the conventional study methods—in which investigators typically monitor an all-night polysomnogram and wake subjects at targeted sleep stages—fail to determine when reported dreams were actually experienced. We found that the quantity, vividness, and emotional changes in dreams occurring during the REM naps were more marked than those experienced during the NREM naps and that dream experiences also occurred more frequently in REM naps than in NREM naps, the figures being comparable to those of previous studies conducted using the conventional paradigm.[17]

It was noted that 17.9% of the NREM naps were associated with dream experiences, suggesting that participants did experience dreams during nap trials consisting of NREM sleep only. Researchers conducting studies using the conventional paradigm have postulated that such NREM dreams do occur. However, no study has yet confirmed in which sleep stage dreams reported by subjects actually occurred, except for a study by Takeuchi et al,[18] in which experiences during short naps (about 10 minutes) were examined. Their results—that experiences during NREM sleep were strongly influenced by the duration of wakefulness contaminated in the nap—may suggest that 10 minutes are not enough to assess experiences during NREM sleep accurately. The fact that human dream experiences can occur during a sleep period without REM was first properly confirmed systematically in the present study, due to the advantage of using a 20-minute repeated nap trial.

Temporal Fluctuations of Dreaming

Dream duration showed an apparent peak in the morning hours, coinciding with peaks in REM duration but not NREM duration. It seems that humans are most likely to experience dreams in certain morning hours of the day.

When a differential analysis was undertaken on dream duration in the REM naps and NREM naps, the NREM curve showed a clear peak in the morning hours, whereas no clear peak was observed in the curve representing the REM naps. The present finding that dream duration in the NREM naps fluctuated across the day in parallel with REM duration suggests that human dream experiences in NREM sleep are strongly influenced by the REM sleep-generating mechanism. Prior animal studies on REM sleep and pontogeniculooccipital activity may provide an explanation for this assumption. In a study by Callaway et al, pontogeniculooccipital activity, which is generated in the brain stem and characterizes animal REM sleep, was observed to also occur in NREM sleep preceding the REM sleep period, even when the cortical electroencephalogram displayed characteristics of NREM patterns such as slow waves.[23] Pontogeniculooccipital activity observed in animal REM sleep is considered to be the most robust factor activating the visual cortexes and generating dream experiences.[9] Similar activation of the visual cortexes may occur in human NREM sleep, especially during the morning hours when REM sleep is most likely to occur, resulting in dream experiences during NREM sleep.

There is a long-standing controversy surrounding the existence of dream experiences during NREM sleep. Some researchers have assumed that dreams recalled upon awakening from NREM sleep are a consequence of the mnemonic effects of prior REM sleep.[7,16] Others have postulated that NREM dreams are different from REM dreams, possibly because the loci of REM and NREM sleep generation are exclusively independent.[24-26] Our results appear to support both early suggestions that NREM dreaming

may be due to activation of REM-related processes during NREM-REM transition periods[16,27] and the more recent suggestion that REM sleep processes can operate covertly to produce NREM dreaming at any time.[17] The results obtained from the repeated nap trial reported here provide understandings of the relationship between dream experiences and NREM sleep. The remarkable correlation we observed between REM duration and NREM dream duration suggests that increases in REM sleep propensity may lead to increased dream production even during NREM sleep.

ACKNOWLEDGEMENTS

This study was supported by the Health Science Grant (15130301) from the Ministry of Health, Labor and Welfare, a Special Coordination Funds from the Ministry of Education, Culture, Sports, Science and Technology.

REFERENCES

1. Aserinsky E, Kleitman N. Regularly occurring periods of eye motility, and concomitant phenomena, during sleep. Science 1953;118:273-4.
2. Dement W, Kleitman N. The relation of eye movements during sleep to dream activity. An objective method for the study of dreaming. J Exp Psychol 1957:53:339-46.
3. Goodenough DR, Shapiro A, Holden M, Steinschriber L. A comparison of "dreamers" and "nondreamers": eye movements, electroencephalograms, and the recall of dreams. J Abnorm Soc Psychol 1959;59:295-302.
4. Roffwarg HP, Dement WC, Muzio JN, Fisher C. Dream imagery: relationship to rapid eye movements of sleep. Arch Gen Psychiatry 1962;7:235-58.
5. Rechtschaffen A, Verdone P, Wheaton J. Reports of mental activity during sleep. Can Psychiatry Assoc J 1963;8:409-14.
6. Hobson JA, Goldfrank F, Snyder F. Respiration and mental activity in sleep. J Psychiatry Res 1965;3:79-90.
7. Kales A, Jacobson A, Paulson MJ, Kales JD, Walter RD. Somnambulism: psychophysiological correlates. I. All-night EEG studies. Arch Gen Psychiatry 1966;14:586-94.
8. Hobson JA, McCarley RW. The brain as a dream state generator: an activation-synthesis hypothesis of the dream process. Am J Psychiatry 1977;134:1335-48.
9. Hobson JA, Pace-Schott EF, Stickgold R. Dreaming and the brain: toward a cognitive neuroscience of conscious states. Behav Brain Sci 2000;23:793-842.
10. Foulkes D. Dream reports from different stages of sleep. J Abnorm Soc Psychol 1962;65:14-25.
11. Foulkes D, Vogel G. Mental activity at sleep onset. J Abnorm Psychol 1965;70:231-43.
12. Antrobus J. REM and NREM sleep reports: comparison of word frequencies by cognitive classes. Psychophysiology 1983;20:562-8.
13. Hori T, Hayashi M, Morikawa T. Topographical EEG changes and hypnagogic experience. In R. D. Ogilvie, J. R. Harsh, eds. Sleep Onset-Normal and Abnormal Processes. Washington: American Psychological Association; 1994;237-53.
14. Cavallero C, Foulkes D, Hollifield M, Rebecca T. Memory sources of REM and NREM dreams. Sleep 1990;13;449-55.
15. Cavallero C, Cicogna P, Natale V, Occhionero M, Zito A. Slow wave sleep dreaming. Sleep 1992;15:562-6.
16. McCarley RW. Dreams and the biology of sleep. In: Kryger MH, Roth T, Dement WC, eds. Principles and Practice of Sleep Medicine, 2nd ed. Philadelphia: WB Saunders; 1994: 373-83.
17. Nielsen TA. A review of mentation in REM and NREM sleep: "covert" REM sleep as a possible reconciliation of two opposing models. Behav Brain Sci 2000;23:851-66.
18. Takeuchi T, Miyasita A, Inugami M, Yamamoto Y. Intrinsic dreams are not produced without REM sleep mechanisms: evidence through elicitation of sleep onset REM periods. J Sleep Res 2001;10:43-52.
19. Rechtschaffen A, Kales A. A Manual of Standardized Terminology, Techniques and Scoring System for Sleep Stages of Human Subjects. Washington: US Government Printing Office; 1968.
20. Weber J, Schwander JC, Unger I, Meier D. A direct ultrasensitive RIA for the determination of melatonin in human saliva: comparison with serum levels. Sleep Res 1997;26:757.
21. Campbell SS, Murphy PJ. Extraocular circadian phototransduction in humans. Science 1998;279:396-9.
22. Czeisler CA, Khalsa SB. The human circadian timing system and sleep-wake regulation. In: Kryger MH, Roth T, Dement WC, eds. Principles and Practice of Sleep Medicine, 3rd ed. Philadelphia: WB Saunders; 2000: 353-75.
23. Callaway CW, Lydic R, Baghdoyan HA, Hobson JA. Pontogeniculooccipital waves: spontaneous visual system activity during rapid eye movement sleep. Cell Mol Neurobiol 1987;7:105-49.
24. Hobson JA, Stickgold R. Dreaming: a neurocognitive approach. Cons Cogn 1994;3:1-15.
25. Seligman ME, Yellen A. What is a dream? Behav Res Therap 1987;25:1-24.
26. Casagrande M, Violani C, Bertini M. A psycholinguistic method for analyzing two modalities of thought in dream reports. Dreaming 1996;6:43-55.
27. Steriade M. Central core modulation of spontaneous oscillations and sensory transmission in thalamocortical systems. Curr Opin Neurobiol 1993;3:619-25.

厚生労働科学研究費補助金　健康科学総合研究事業

２４時間社会における睡眠不足・睡眠障害による事故および健康被害の実態と根拠に基づく予防法開発に関する研究
平成 16 年度　研究成果報告

発行　平成 17 年 3 月
〒187-8553 小平市小川東町 4-1-1
国立精神・神経センター精神保健研究所　精神生理部
主任研究者　内山　真